THE SCIENTIFIC COUNTER-REVOLUTION

Mathematics, natural philosophy and experimentalism in Jesuit culture, 1580- c.1670

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... for Jesuits never content themselves with the *Theory* in anything, but straight proceed to *practise* ...

John Donne, *Ignatius his conclave* (1611)

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Abbreviations

APUG = Archivio della Pontificia Università Gregoriana, Rome

ARSI = Archivum Romanum Societatis Iesu, Rome

Birch = Thomas Birch, *The History of the Royal Society of London*, London; 1756-7

BL = British Library, London

BN = Bibliothèque Nationale, Paris

BNCF = Biblioteca Nazionale Centrale di Firenze

BNR = Biblioteca Nazionale "Vittorio Emmanuele II", Rome

Boyle, *Works = The works of the honourable Robert Boyle*, ed. Thomas Birch, London: J. & F. Rivington, 1772 (2nd edition)

CC = *Christoph Clavius: Corrispondenza*, ed. by Ugo Baldini and Pier Daniele Napolitani. Pisa: Università di Pisa, Dipartimento di Matematica, Sezione di Didattica e Storia della Matematica; 1992

F. G. = Fondo Gesuitico

HAB = Herzog August Bibliothek, Wolfenbüttel

MP=*Monumenta Paedagogica Societatis Iesu, Nova editio penitus retractata*, ed. Ladislaus Lukács, Rome, Institutum Historicum Societatis Iesu, 1965-

OC=*The Correspondence of Henry Oldenburg*, ed. and transl. by A. Rupert Hall and Marie Boas Hall, Madison, Milwaukee, and London, 1965-

OG= *Le Opere di Galileo Galilei*, Edizione Nazionale a cura di A. Favaro (1890-1909)

Sommervogel = Augustin de Backer, Aloys de Backer and Auguste Carayon, *Bibliothèque de la Compagnie de Jésus*, Nouvelle éd. par Carlos Sommervogel, 12 vols., Brussels: O. Schepens, Paris: A. Picard (1890-1932), Repr. Louvain (1960)

Introduction

The mid-seventeenth century satire of the Jesuit order, *Monarchia solipsorum*, or the "Monarchy of the Solipsists", began its biting attack on the institutions of the order with a depiction of the paradoxes inherent the geography of the Jesuit "kingdom":

> At the outset it would be worth teaching the Reader about the skies and place of the Kingdom, the expanse of its dominions and the confines of its people. But no mortal who has penetrated there has accomplished this simple task, so I will not attempt it. For although, like Homer's Ulysses, I have seen many of the towns and the customs of the men of that Kingdom, I have been unable to observe anything certain about the position of the heavens. For the constitution of their universe is very different from ours, as are the number and various names of the poles. For them the Moon is more often in the vertical than the Sun at midday. They have no differences of place or position, so that what is above is simultaneously to the right and what is to the left is simultaneously below. There is even no fixed or single centre. The manner of all of this diversity depends on the will of the Monarch.[1]

The passage cited alludes humorously to three of the aspects of the Society of Jesus that would have been most readily familiar to a broad seventeenth century readership - its global expanse, the extreme mobility of its members and its emphasis on obedience to a central authority -- the "Monarch", or General, in Rome. Through a wealth of recent literature, it is now clear that the Society of Jesus provided an institutional home for an enormous variety of scientific practices during the sixteenth and seventeenth centuries[2].

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[1]"Operae pretium foret, de Coelo, & situ Regni, de vastitate ditionis, populorumque confinijs Lectorem initio docere: Sed hactenus nulli mortalium, qui in illud penetravit, rem factu facilem, postremus ego non tentabo, qui cum Ulysse Homerico multas hominum eius Regni videns Urbes, & mores, de Coeli positione nihil certi servare novi. Nam & constitutio Universi apud eos longe diversa, & polorum numerus, nominaque varia, quibus & Luna saepius Verticalis, quam Sol in meridie: nulla loci, vel situs differentia, ut quod sursum, perinde & dextrum; quod sinistrum, idem imum; centrum denique nec unum, nec fixum. Tanta diversitatis ratio Monarchae stat arbitrio. Quod hic decernit, id solum ratum habetur, quicquid ratio, vel sensus relucetetur, ut nisi vapulare placet, non replices, nec nisi contra mentem, & sensum affirmes, gratiam apponas", *Lucii Cornelii Europaei Monarchia Solipsorum, Ad Virum Clarissimum Leonem Allatium*, Venice, 1645.

[2]See, in particular, Ugo Baldini, *Legem impone subactis. Studi su filosofia e scienza dei gesuiti in Italia, 1540- 1632*. Rome: Bulzoni; 1992, John L. Heilbron, *Electricity in the 17th and 18th centuries. A study in early modern physics*. Berkeley, California: University of California Press; 1979, esp. pp.101-114, Rivka Feldhay,*Galileo and the Church: Political Inquisition or Critical Dialogue?* Cambridge: Cambridge University Press; 1995, esp. pp. 110-170, Steven J. Harris, *Confession-building, long-distance networks, and the organization of Jesuit science.* Early Modern Science and Medicine. 1996; 1(3): 287-318, ibid., *Transposing the Merton Thesis: Apostolic Spirituality and the Establishment of the Jesuit scientific tradition.*

The types of activities in which Jesuit natural philosophers and mathematicians engaged were crucially conditioned by the changing local contexts in which they carried out their work. Their activities were nonetheless also conditioned by the changing non-local geography of the Society of Jesus as a whole, alluded to by the author the *Monarchy of the Solipsists*. It is precisely this tension between specific local contexts of natural investigation and a centralised global bureaucratic structure allowing the mobility of trained people and letters on natural subjects between distant sites that is uniquely characteristic of natural investigation by members of the Jesuit order during the early modern period. In the Jesuit collegiate network, the *Collegio Romano* had a special place. The efforts of Christoph Clavius and his successors established its status as a European centre of mathematical expertise. As well as being the flagship didactic establishment of the Jesuit order, the *Collegio Romano* (fig. 1) functioned as a clearing-house for people, letters, natural curiosities and instruments.

In the first chapter of the present thesis, I examine the origins of the distributed Jesuit mathematical community, largely through the political and pedagogical efforts of Christoph Clavius. Clavius argued for the importance of mathematical learning within the order both as an essential concomitant to the study of natural philosophy and theology and as a means for entering into relationships with the mathematically curious aristocracy that had emerged in sixteenth century Europe. The private mathematical academy run by Clavius in his *cubiculum* in the *Collegio Romano* to train future mathematics teachers for the other Jesuit provinces rapidly became a centre for advanced mathematical research, fueled by the correspondence carried out by Clavius and his successors with mathematicians and natural philosophers both inside and outside the Jesuit order.

Science in Context. 1989 Mar; 3(1): 29-65. Useful surveys of the literature include Luce Giard, *Le devoir d'intelligence ou l'insertion des jésuites dans le monde du savoir*, in L. Giard, ed., *Les Jésuites à la Renaissance: Système éducatif et production du savoir*, Paris: Presses Universitaires de France; 1995: XII-LXXIX and Mario Biagioli, *Jesuit science between texts and contexts*. Studies in History and Philosophy of Science. 1994; 25(4): pp. 627-647. Other studies are included in the bibliography.

As Paolo Galluzzi, Nick Jardine and Peter Dear have pointed out[3], the late sixteenth and early seventeenth centuries witnessed a transformation in the status of the mathematical disciplines which was closely related to the activities of the Jesuit 'school' of mathematics founded by Clavius. The second chapter traces the opposition faced by the mathematical school of the Collegio Romano, and its subsequent rise to a position of considerable authority in debates surrounding novel opionions concerning the natural world. Although dogged by unpalatable associations with judicial astrology, fatalism and demonic magic in the late sixteenth century, through the activities of Clavius and his disciples the mathematical disciplines came to be accepted as an essential part of natural philosophy in the early seventeenth century, despite the energetic objections of Jesuit natural philosophers including Benito Pereira and the suspicion with which Molinist theologians regarded mathematics. During this period the mathematical school of the *Collegio Romano*, headed by Clavius, acquired immense authority over the natural world. The debate over the existence of mountains on the moon's surface provides a graphic demonstration of the authority acquired by the Jesuit mathematical collectivity during this period.

Chapter 3 returns to examine the institutional context of mathematics in the local context of the *Collegio Romano*, focussing on the career of Clavius's successor, Christoph Grienberger, a Jesuit mathematician who worked almost exclusively within Jesuit-controlled institutions. I argue that the strategies of self-abnegation deployed by Grienberger, availing of every opportunity to remove his name from texts written with his pen and optical and astronomical instruments designed by him and built with his own hands, can reveal much about what it was to be both a Jesuit and a skilled mathematical practitioner in the early seventeenth century. Where Galileo found a legitimatory resource for certain types of mathematical practice in the colourful world of

[3]Paolo Galluzzi, *Il "Platonismo" del tardo Cinquecento e la filosofia di Galileo*. in Paola Zambelli, ed., *Ricerche sulla cultura dell'Italia Moderna*. Bari: Laterza; 1973: 37-79, Nicholas Jardine, *The forging of modern realism: Kepler and Clavius against the sceptics.* Studies in history and philosophy of science. 1979; X: 141-173, Peter Dear, *Jesuit mathematical science and the reconstitution of experience in the early seventeenth century.* Studies in History and Philosophy of Science. 1987 Jun; 18(2): 133-175.

the Medici court in Florence, his exact contemporary Grienberger found his Archimedean point for the upward leverage of the status of mathematics deep within the complex bureaucratic structure of the Jesuit order. Grienberger developed the public role of mathematical presentations within the College, a role that had been suggested by Clavius, and my interpretation of his career is based on unpublished drafts of these presentations which are published in the documentary appendix.

The following chapter considers the role of the Jesuit correspondence network in the scientific output of the order. The correspondence network of Athanasius Kircher, building on a tradition founded by Clavius and Grienberger, and centered in the *Collegio Romano*, allowed the accumulation of information sent to Kircher from distantly stationed correspondents both inside and outside the Society. The case of the measurement of magnetic variation at different points in the globe, as an 'extrinsic' solution to the problem of the measurement of longitude at sea, provides a rich case study for the discussion of this particular institutional aspect of Jesuit scientific practice.

Chapter 5 considers the constraints placed on the identity and authority of the Jesuit mathematical practitioner by disciplinary structures of the order, particularly as manifested in the changing structures of censorship during the disciplinary crisis of the 1640s and 1650s. The origins of the disciplinary crisis, previously suggested in the work of Claudio Costantini and Ugo Baldini[4], are traced to an attempted internal reform of organization of the order led by Melchior Inchofer. Different Jesuit mathematical practitioners responded to the increased emphasis on adherence to Aristotle in matters of natural philosophy in different ways, and this chapter focuses on the problematic clash between the corporate identity of the Jesuit mathematical practitioner and his participation in polemics concerning the natural world.

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[4]Claudio Costantini, *Baliani e i Gesuiti*. Florence: Giunti Barbèra; 1969, Ugo Baldini, *Legem impone subactis. Studi su filosofia e scienza dei gesuiti in Italia, 1540- 1632*. Rome: Bulzoni; 1992.

One of the most violent natural philosophical debates of the mid-seventeenth century surrounded the experiment performed by Evangelista Torricelli, and later carried out, with significant variations by Valeriano Magni, Blaise Pascal and others, to demonstrate the existence of the vacuum. Chapter 6 explores the Jesuit response to the vacuum experiments, which raise questions about the expert status of Jesuit mathematical practitioners and natural philosophers during the period of disciplinary enforcement discussed in the previous chapter. The violence of the Jesuit polemic with Valeriano Magni is related to his attempt to liberate the Charles university in Prague from the Aristotelian natural philosophy taught by the Jesuits. The Jesuit responses to the later vacuum experiments of von Guericke demonstrate simultaneously an enforced adherence to Aristotelian plenism, a desire to participate actively in experimental disputes, and a highly collectivist approach to the validation or invalidation of experiments. This chapter considers the capacity of Jesuit colleges to function as split laboratories in the seventeenth century, allowing local and non-local knowledge to be combined to back up positions adopted in a dispute.

Finally, Chapter 7 considers the theatrical context of Jesuit experimentation, relating it to the ceremonial visits made to Jesuit colleges. The disciplinary enforcement of the 1640s and 1650s was accompanied by a rising number of publications by Jesuits, particularly Athanasius Kircher and his disciples, relating to experimental magic, which drew their context from the courtly function of Jesuit experimentalism. These works avoided the disciplinary problems associated with deviant natural philosophy after the 1651 *Ordinatio pro studiis superioribus* by claiming to relate to art, or technique, rather than *physica*. The 'showiness' associated with Jesuit experimentation, particularly by members of the early Royal Society and their correspondents constituted grounds for questioning the credibility of Jesuit reports about experiments. By 1670, the *Collegio Romano* could no longer claim the degree of authority over the natural world that it had attained during its corroboration of Galileo's celestial observations in 1610. A variety of

institutional factors constrained experimental novelties to be presented by many Jesuits in the form of monstrosities or curiosities. Mathematics and experimentation were increasingly insulated in this new situation from the domain of natural philosophy.

While arguing for a series of transformations in the way mathematically trained Jesuits might conduct their careers and engage in debates concerning matters of natural philosophy during the seventeenth century, the present thesis also aims to express a deep continuity between the period in which Christoph Clavius was the senior mathematician of the *Collegio Romano*, and the period in which that position was occupied by Athanasius Kircher. Despite the manifest differences between the careers, opinions and literary output of Clavius, Grienberger and Kircher, they laid claim to a common space - the mathematical *cubiculum*, or 'mathematical museum' of the *Collegio Romano*, where they accumulated instruments, manuscripts, letters on mathematical subjects and natural phenomena and other topics and taught private disciples the mathematical disciplines to an advanced level. They participated in a local collegiate culture that was simultaneously global, occupying a vantage point that had no obvious equivalent in early modern Europe, enabling them to take advantage of the enormous range of the Jesuit missionary network to collect the results of observations and experiments performed at remote stations.

Rather than attempt a total history of this space, clearly an impossible project, I offer here a series of selections, in the hope of illustrating the complexity of the relationship between the local and the global in Jesuit scientific practice. Much recent historiography of science has laid particular emphasis on the importance of minute local studies in attempts to understand the resolution of scientific disputes and the micro-politics of the laboratory[5]. If the Jesuit example can teach us anything, however, it is that the place of scientific practice can be a centralised global network of trained correspondents just as much as an enclosed laboratory.

[5]For a survey of recent literature on the problem, see Adi Ophir and Steven Shapin, *The place of knowledge: A methodological survey.* Science in Context. 1991; 4: 3-21.

CHAPTER ONE

ESTABLISHING MATHEMATICAL AUTHORITY: THE POLITICS OF CHRISTOPH CLAVIUS

Introduction and summary

Prior to any detailed discussion of the work carried out by the globally distributed community of Jesuit mathematical practitioners in seventeenth century Europe, it seems advisable to ask just how such a community ever came to exist in the first place. How, we might ask, did its members became equipped with the mathematical instruments, books, and training that allowed them to enter into astronomical disputes, to perform geometrical demonstrations and to correspond with each other on topics of mathematical and philosophical import? How did mathematical practices came to be granted a sufficient amount of social and cognitive status within the political structure of each Jesuit college to nurture their continued existence within the Jesuit collegiate network?

To attempt to answer these questions, the present chapter will look at Christoph Clavius's project for establishing the Collegio Romano as a centre of mathematical skill and authority, with a view to granting special training to gifted Jesuit mathematical practioners before redistributing them to the different provinces of the order. In attempting to create an authoritative, distributed community of Jesuit mathematicians, Clavius faced a number of obstacles both inside and outside the order, which he was only able to overcome by enlisting powerful political support. Clavius's defense of the newly promulgated Gregorian calendar against the attacks of Michael Maestlin, Joseph Scaliger, François Viète and others played an important part in securing Jesuit mathematical authority in a wider European context.

As well as being indispensible for mastery of the other arts and sciences and for the administration of civic affairs, mathematical knowledge was presented by Clavius to his Jesuit superiors as an antidote to conversational embarrassment. Noblemen were interested in mathematical problems, and it would bring disgrace to the Jesuit order if its members were unable to discourse intelligently on mathematical subjects in the company of princes. The dinner-table was a politically charged space during the Reformation. The training of Jesuits as rhetoricians and humanists formed part of an attempt to reconquer this space, which had been encroached upon by Luther's *Tischreden* and by the myriad works of the Protestant humanists. Clavius inscribed mathematical training firmly within this project.

Unlike his Jesuit predecessor Balthasar Torres and many other sixteenth century mathematicians of a practical bent, Clavius embraced print culture. Apart from his own printed works, he was closely involved in the production of the mathematical part of enormous *Bibliotheca Selecta* produced by the Jesuit diplomat and scholar Antonio Possevino. Possevino's work was intended to be a sanitised reworking of the Protestant Conrad Gesner's *Bibliotheca Universalis*, as part of a larger vision of global evangelization through print, centralised correspondence and coordinated pastoral work. While Possevino intended to establish a centre for the training of missionaries in Rome, a project that eventually led to the foundation of the Roman *Collegium de Propaganda Fide*, Clavius established a centre for mathematical training, his mathematical academy. His purposes were closer to Possevino's than one might initially expect. The distribution throughout the Jesuit provinces of mathematical experts trained in the Roman centre, like the distribution of Jesuits skilled in *eloquentia*, Greek and Hebrew, would bring great glory to the Jesuit order and recover some of the souls to the Catholic church that had been lost through the alluring erudition of the great Protestant humanists of the sixteenth century.

Jesuit humanism and the Counter-reformation

At intermittent moments between 1562 and 1565, the Majorcan Jesuit Jerónimo Nadal took time off from the Council of Trent to compose a dialogue. Originating as a response to an attack on the Jesuits penned by Melanchthon's pupil and friend Martin Chemnitz, the dialogue was staged as an ecumenical meeting of three travellers, whose largely pacific encounter was made plausible by the peace of Augsburg of 1555, finally granting official tolerance to religious diversity in in German lands. The participants in Nadal's apologetic *mis-en-scène* were a Lutheran (Philippicus), a Catholic ill-disposed towards the Jesuits (Libanius), and Philalethes, a "friend and past pupil of the Society, who learned about the nature our Society's organization from the Jesuits in Cologne"[1]. Two of the projected four parts of the Dialogue were completed by Nadal. In the first, Philalethes explains the early origins of the Society to Libanius and Philippicus. In the second part, he elaborates on the organizational structure of the order. These were to be followed by two 'negative' parts, attacking, respectively, Chemnitz and his heretical associates, and the Dominican theologian Melchor Cano, a vigorous opponent of the early Society and the root of many of its initial troubles with the Inquisition[2].

The defense of the Jesuits mounted by Philalethes in Nadal's dialogue is threatened intermittently by the undisciplined wrath of Philippicus. Irritated by the learned Greek and Hebrew citations with which Philalethes sprinkles his discourse, Philippicus, transparently a mask for Melanchthon and his followers, threatens to destabilize the very conventions governing dialogue form:

> What shall we do, Libanius? What are we waiting for? We will not hear any more from this man. Let us prepare our blades for combat[3].

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[1]J. Nadal, Dialogus I (1562-1563), in *P. Hieronymi Nadal Commentarii de Instituto Societatis Iesu*, ed. Michael Nicolau, S.J. (= *Epistolae et Monumenta P. Hieronymi Nadal*, Tomus V) Romae: apud Monumenta Historica Societatis Iesu, 1962, pp. 524-600, on p. 536.
[2]On Cano's opposition to the Jesuits, see O' Malley, *The First Jesuits*, Cambridge, Massachusetts: Harvard University Press; 1993, pp. 292-3.
[3]"Quid agimus, Libani? quid moramur? Nihil est quod amplius ab hoc audiamus. Ad arma acies nostras instruamus", J. Nadal, Dialogus II (1562-1565), in *P. Hieronymi Nadal*

Despite these moments of dramatic tension, the dialogue between the three travellers continues for long enough to allow Nadal's mouthpiece Philalethes to expound upon the various aspects of the Jesuit ministry in some detail. The discussion of the Jesuit educational ministry, composed by an insider deeply involved in its development, draws heavily on the relevant sections of the recently published *Constitutions* of the order, and prefigures the *Ratio studiorum*, which Nadal was to be intimately involved with at the early stages[4]. Nadal defends the involvement of the Jesuits in pedagogy in purely apostolic terms:

> [T]hey [i.e. the Jesuits] judge that teaching the youth pertains to the ministry of the word of God; their only reason for opening the schools was so that with this hook they might draw students of literature to piety[5]

Shortly afterwards, after an official visit of inspection to the Jesuit college of Cologne, Nadal elaborated that

> The Society would never have undertaken the task of giving lessons in colleges, if it did not also understand that by so doing it was also giving a moral training [...] So for us lessons and scholarly exercises are a sort of hook with which we fish for souls[6].

As Gabriel Codina Mir, has observed, "on reading some of the statements made by Nadal, it is easy to believe that the Colleges of the Jesuits were only conceived in order to combat Protestantism, at least in Germany and in the countries affected by the Reformation, and that the study of letters was only envisaged with the aim of fighting

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Commentarii de Instituto Societatis Iesu, ed. Michael Nicolau, S.J. (= *Epistolae et Monumenta P. Hieronymi Nadal*, Tomus V) Romae: apud Monumenta Historica Societatis Iesu, 1962, p. 545, O'Malley, *The First Jesuits*, cit., pp. 200-242.

[4]See L. Lukáks, *De Prima Societatis ratione studiorum Sancto Francisco Borgia Praeposito Generali constituta*, AHSI 27 (1958) 209-232.

[5]"[A]d ministerium verbi Dei pertinere existimant iuventutem docere; alia enim illis non fuit causa scholas aperiendi, quam ut ad pietatem hoc hamo capiantur literarum studiosi." Nadal, Dialogus II, cit., p. 666.

[6]"Nunquam fuisse Societatem illud ministerium accepturam, nisi simul morum institutionem suscipere se cogitasset [...] Itaque lectiones illae et exercitia scholastica instar hami nobis sunt ad animas expiscandas" J. Nadal, *Exhortatio Coloniensis 6a* (1567), in *P. Hieronymi Nadal Commentarii de Instituto Societatis Iesu*, ed. Michael Nicolau, S.J. (= *Epistolae et Monumenta P. Hieronymi Nadal*, Tomus V) Romae: apud Monumenta Historica Societatis Iesu, 1962, p. 832, n. 21.

the Protestants with their own weapons. As *Belles-lettres* were in vogue, the Jesuits occupied themselves industriously with them, but always kept the apostolic goal which they had set for themselves clearly in view"[7].

The apostolic ends of Jesuit education were reflected clearly in the pyramidal disciplinary structure which characterised teaching in Jesuit colleges, as has been emphasised in a number of recent studies[8]. This structure, in which theology ruled over philosophy, which in turn ruled over mathematics and the lower disciplines, was inherited from the *modus parisiensis* - the educational structure of the University of Paris where the first Jesuits had received their education - praised by Nadal as "the most exact and the most fruitful".[9]

While the basic structure of the Jesuit *cursus* was provided by Paris, the apostolate of the order led to certain important departures. In particular, if a student was perceived to have particular intellectual gifts in a single direction, these would be nurtured by the Jesuit preceptors. Nadal gives a characteristically concise resumé:

> PHILALETHES - [The Jesuits] observe the natural faculties and propensities of minds, and if someone is seen to have sufficient talent for a particular discipline, he is ordered to devote all of his studies to that discipline towards which he is most inclined [...] In this way they hope that in the future they will train outstanding pracitioners and teachers of the different arts; but they don't wish anyone to be ignorant of those things that are necessary or even useful for helping souls
> LIBANIUS. - Such devotion to studies might be seen to tend towards curiosity or arrogance.

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[7]"A lire certaines expressions de Nadal, on croirait volontiers que les Collèges des jésuites n'étaient conçus que pour faire pièce au protestantisme, du moins en Allemagne et dans les pays atteints par la Réforme, et que l'étude des lettres n'y serait envisagée que dans le but de combattre les protestants avec leurs propres armes. La mode étant aux belles-lettres, les jésuites s'y seraient employés obstinément, mais toujours en fonction de l'objectif apostolique qu'ils s'étaient fixé." Gabriel Codina Mir, *Au Sources de la Pédagogie des Jésuites. Le "Modus Parisiensis"*, Rome: Institutum Historicum Societatis Iesu; 1968, p. 283

[8]See especially Ugo Baldini, *Legem impone subactis. Studi su filosofia e scienza dei gesuiti in Italia, 1540- 1632*, Rome: Bulzoni; 1992: pp. 19-73. Baldini argues convincingly that the organizing function of the apostolic goal of Jesuit philosophical and mathematical activities was of far greater importance to the development of these activities than specific conflicts between philosophical positions and Scriptural truth, such as the case of heliocentrism, emphasised in many past discussions of Jesuit science in the seventeenth century.

[9]"PHILI. - Quam rationem docendi tenent isti iesuitae? / PHILA. - Parisiorum Academiae, quae exactissima visa est ac fructuosissima."Nadal, Dialogus II, cit., p.738. See also O' Malley, *The First Jesuits*, cit., pp. 200-242.

PHILALETHES - It doesn't, Libanius, it doesn't; but towards necessity and utility, as I have said[10].

Nadal's text allows us to see certain elements of the Jesuit educational project in a nakedness that the complex later debates surrounding the *Ratio Studiorum*, as different Jesuit colleges presented their cases for modifications of the Jesuit cursus, would disguise. Whilst the details of the *Ratio* would undergo numerous modifications in the light of reports of the local problems facing teachers, as documented by Ladislaus Lukáks in his remarkable edition of the *Monumenta Paedagogica*[11], the overtly apostolic goals of the Jesuit educational enterprise described by Nadal at this early moment would rapidly become tacit and submerged in the immense bureaucratic structure engendered by Ignatius and his prolific secretary Juan de Polanco[12]. It remains to be seen just how the efforts of Christoph Clavius ensured that mathematical practices were perceived as converging with these goals.

Mathematics and humanism

The 16th century witnessed a dramatic transformation in the perceived status of the mathematical disciplines and their practitioners in the Italian peninsula. As Mario Biagioli has observed, after Charles VIII's sweeping invasion of Italy in 1494 and 1495, "the cannon-syndrome and the introduction of the bastion forced the *milites*, the

[10]"Observant enim naturales ingeniorum facultates atque propensiones, et ad quam disciplinam quisque magis inclinat, si ad eam videant idonea habilitate esse preditum, in illam eum iubent unice conferre sua studia omnia; ut illud nescio quid rarum et excellens persequi enitatur, cohortantur. Ita sperant futurum ut in singulis artibus parent insignes artifices et doctores; et tamen nullum volunt esse qui ea non noverit quae ad iuvandas animas sunt necessaria vel etiam utilia. LIB. - Tanta contentio studiorum videri poterit ad curiositatem spectare vel arrogantiam. PHILA. - Non ita est, Libani, non est; sed ad necessitatem et utilitatem, ut dixi", Nadal, Dialogus II, cit., p. 737.

[11]MP V (*Ratio atque Institutio Studiorum Societatis Iesu*), MP VI (*Collectanea de Ratione Studiorum Societatis Iesu (1582-1587)*), MP VII (*Collectanea de Ratione Studiorum Societatis Iesu (1588-1616)*)

[12]On Polanco, see O' Malley, cit., pp. 10-11. On the relationship between bureaucratic expertise and the organization of the early Society see Dominique Bertrand, *La politique de Saint Ignace de Loyola: L'analyse sociale*, Paris: Editions du Cerf; 1985.

professional warriors of aristocratic origins, to begin to rely less on their horses and more on Euclid for their survival as a distinct social group."[13]

Elsewhere in Europe, the social role of the mathematical practitioner and the prestige accorded to mathematical practices were undergoing related changes in the sixteenth century. In Philip II's Spain, military and navigational concerns, a renewed interest in Vitruvian architecture and a fervour for astrological prediction, only slightly dampened by the efforts of the Spanish Inquisition, combined to give increasing political importance to astronomy, mechanics and cosmography, epitomised in the careers of Philip's architect, Juan de Herrera, and his charismatic cosmographer Giovan-Battista Gesio[14]. Philip's foundation of the chair in the art of navigation and cosmography at the *Casa de la Contratación*, the training centre for pilots in Seville, in 1552, marked an important moment in this process, as did the creation of Juan de Herrera's mathematical academy in Madrid, which availed of a rich supply of instruments and a lavish library of ancient and recent works on mathematics, astrology and alchemy.[15] Navigational and mercantile concerns similarly governed the creation of Gresham college in London[16], while in the German lands the liminal and ambiguous personage of the astrologer was becoming an ever more stable figure at court, a feat of social mobility that was both confirmed and reproached by the Faust legends and plays that enjoyed such popularity during this period.[17] Musical fountains, anamorphoses, automata, perpetual-motion

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[13] Mario Biagioli, *The Social Status of Italian Mathematicians.* History of Science. 1989; 27(Part 1 Number 75): pp. 41-95. On mathematics and humanism in sixteenth century Italy, see especially Paul Lawrence Rose, *The Italian Renaissance of Mathematics: Studies on Humanists and Mathematicians from Petrarch to Galileo*. Geneva: Librarie Droz; 1975.

[14]On Gesio, see David C. Goodman, *Power and Penury: Government, Technology and Science in Philip II's Spain,* Cambridge: Cambridge University Press; 1988, passim.

[15]On the mathematical academy, see M.I. Vicente Maroto and M. Esteban Piñeiro, eds., *Aspectos de la Ciencia Aplicada en la España del siglo de oro*, León: Consejería de Cultura y Bienestar Social; 1991, pp. 69-134. On Herrera's library and instruments, see Luis Cervera Vera, *Inventario de los bienes de Juan de Herrera*, Albatros: Valencia; 1977.

[16]See J. A Bennett, *The Mechanics' Philosophy and the Mechanical Philosophy*, History of Science, 1986; pp. 24, 1-28, E. G. R. Taylor, *The Mathematical Practitioners of Tudor an Stuart England*, Cambridge; 1954.

[17]A survey of the German scene, which discusses the vogue for Faust plays, is William Clark, *The scientific revolution in the German nations* in R.S. Porter and M. Teich, eds. *The scientific revolution in national context*, Cambridge: Cambridge University Press; 1992: 90-114. On the status of mathematics and astronomy, see Robert S. Westman, *The Astronomer's role in the*

machines and other feats of mathematical magic were objects of fascination to the late sixteenth century European court, epitomised in Rudolphine Prague.[18]

Into this transforming European cultural landscape arrived a new hybrid creature - the Jesuit mathematician. Cleric and geometer, humanist and astronomer, court-confessor and experimenter, like all hybrids the Jesuit mathematician posed a threat to the *status quo* of the environments in which he made his presence felt, both inside and outside the Society of Jesus.

In 1582, the Jesuit General Everard Mercurian invited the professors of the Collegio Romano to give their opinions on the ways in which the different disciplines should be taught in Jesuit colleges. Christoph Clavius, who had occupied the official post of mathematics professor at the college since 1567[19], responded with a detailed report entitled *The way in which the mathematical disciplines can be promoted in the Society*[20]. The report emphasized the increased importance of mathematical competence for inserting Jesuits in courtly *conversazione* in late-sixteenth century Europe:

> [Mathematics] will also bring a great ornament to the Society when noblemen understand that ours [i.e. Jesuits] are not ignorant of mathematics, for it is discussed most frequently in their conversations and meetings. For this reason, ours would incur great shame and disgrace if they

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sixteenth century: A preliminary study. History of science, 1980; 18: pp.105-147, idem.,*The Melanchthon Circle, Rheticus and the Wittenberg interpretation of the Copernican theory*. Isis. 1975; 66: pp.165-193, idem, *Humanism and scientific roles in the Sixteenth century* in Rudolf Schmitz and Fritz Krafft (eds.), *Humanismus und Naturwissenschaft*. Boppard: Harald Boldt; 1980: 83-99.

[18]For a rich study of the culture of the Rudolphine court in Prague, see R. J. W. Evans, *Rudolph II and his world: A study in intellectual history, 1576-1612*, Oxford: Clarendon Press, 1973. On illusionism in Prague see Thomas DaCosta Kaufmann, *The Mastery of Nature: Aspects of Art, Science, and Humanism in the Renaissance*, Princeton, NJ: Princeton University Press; 1993. On optical devices, see Jurgis Baltrusaitis, *Anamorphoses ou magie artificielle des effets merveilleux*, Paris: Olivier Perrin; 1969.

[19]For biographical details, see James M. Lattis, *Between Copernicus and Galileo: Christoph Clavius and the collapse of Ptolemaic cosmology*, Chicago and London: University of Chicago Press; 1994, pp. 12-29, CC I.1, pp. 33-58, Ugo Baldini,*Christoph Clavius and the scientific scene in Rome*. in G.V. Coyne and O. Pedersen, eds., *Gregorian Reform of the Calendar: Proceedings of the Vatican Conference to Celebrate its 400th Anniversary 1582-1982;* 1982; Vatican Observatory. Città del Vaticano; 1983: 137-169.

[20]Christoph Clavius, *Modus quo disciplinae mathematicae in scholis Societatis possent promoveri*, in MP VII, pp. 115-117.

> were to remain silent in gatherings of this kind. This has been related most frequently by those people who were embarrassed in this way.[21]

There is a clear convergence between Clavius's remarks and Nadal's angling metaphor for the Jesuit educational apostolate. It would, however, be misleading to dismiss Jesuit mathematical practice as a response to purely external stimuli. In the Gregorian reform of the calendar, the late sixteenth century witnessed an unprecedented alignment between the business of the post-Tridentine Catholic church and mathematical expertise. As one of the chief elaborators of the new calendar, and its most vociferous defender in print, Clavius presented the Jesuit mathematician, for the first time, as the mathematical voice of the papacy[22].

Calendar reform and mathematical authority

> And yet not onely for this is our Clavius to bee honoured, but for the great paines also which hee tooke in the Gregorian Calender, by which both the peace of the Church, & Civill businesses have beene egregiously troubled: nor hath heaven it selfe escaped his violence, but hath ever since obeied his appointments: so that S. Stephen, John Baptist, & all the rest, which have bin commanded to worke miracles at certain appointed daies, where their Reliques are preserved, do not now attend till the day come, as they were accustomed, but are awaked ten daies sooner, and constrained by him to come downe from heaven to do that businesse.
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> John Donne, *Ignatius his conclave (1611),* ed. T.S. Healy, Oxford: Clarendon Press; 1969, pp. 17-19.

The papal bull "*inter gravissimas*" of 24 February 1582, promulgating the Gregorian calendar, began: "Among the most serious tasks, last perhaps but not least of those which in our pastoral duty we must attend to, is to complete with the help of God what the Council of Trent has reserved to the Apostolic See"[23]. The Council of Trent had left

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[21]Clavius, *Modus quo disciplinae mathematicae in scholis Societatis possent promoveri*, cit., p. 116: "vel et magnum Societati afferant ornamentum, ut frequentissime in colloquiis et conventibus principum virorum de illis sermo habeatur, ubi intelligunt nostros mathematicarum rerum non esse ignaros. Unde fit, ut necessario nostri in eiusmodi conventibus obmutescant, non sine magno rubore atque dedecore. Id quod iidem, quibus hoc ipsum contigit, saepius retulerunt".

[22]On Clavius's involvement in the development of the Gregorian calendar, see especially Ugo Baldini, *Christoph Clavius and the scientific scene in Rome*, in G.V. Coyne and O. Pedersen, eds., *Gregorian Reform of the Calendar: Proceedings of the Vatican Conference to Celebrate its 400th Anniversary 1582-1982*, Città del Vaticano: Vatican Observatory, 1983, pp. 137-169.

[23]*Bullarium Romanum*, Vol. 8, pp. 386-390, cited in August Ziggelaar, *The papal bull of 1582 promulgating a reform of the calendar*. in G.V. Coyne and O. Pedersen, eds., *Gregorian Reform*

it to the papacy to complete the reform of the mass book and breviary, which incorporated correction of the calendar. Whilst for Donne and other Protestant divines the resulting calendar may have been the object of ridicule and resistance, it is difficult to overstate the degree of legitimation which calendar reform conferred on astronomical, and hence mathematical, practices within the post-Tridentine church, despite their unpalatable contemporary associations with judicial astrology and fatalism. A suggestive illustration of the point is Francesco Ingoli's report to the Cardinals of the Congregation of the Index of 2 April 1618, which prefaces his list of corrections to Copernicus's *De Revolutionibus* with the entreaty that:

> [T]he aforementioned books of Copernicus must at all costs be conserved and supported for the use of the Christian Republic. For [measurements] of time, very much needed by the Christian people both for the celebration of divine solemnities and for the carrying out of business, derive from the calculations of Astronomers especially of the sun and the moon and the precession of the equinoxes, as is clear from the corrections carried out to the year during the happy reign of Gregory XIII.[24]

Although calendar reform raised the status of mathematical practices at the heart of the Roman curia, opposition to the new calendar was manifested immediately in the Lutheran stronghold of the University of Tübingen. Jakobus Heerbrandus cited the prophesy in the book of Daniel, "*putabit se posse mutare tempora*" (Dan. 7, 25), as evidence that calendar reform was the handiwork of the Antichrist. Another Tübingen professor, Lucas Ossiander, unmasked the Gregorian reform of the calendar as an illegitimate attempt by the papacy to establish a monopoly for the distribution of standards, under threat of penalties, on German soil. The Reichsconstitution and a number of Reichstags, Ossiander reminded his readers, had explicitly forbidden the

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of the Calendar: Proceedings of the Vatican Conference to Celebrate its 400th Anniversary 1582-1982, Città del Vaticano: Specola Vaticana; 1983: 201-239.

[24]BAV Barb. Lat. 3151 ff. 58r-61v (published in Massimo Bucciantini, *Contro Galileo: Alle origini dell'Affaire*, Florence: Olschki; 1995, pp. 207-9), on 58r: "praedictos libros Copernici omnino pro utilitatio Reip. Christianae conseruandos, ac sustinendos esse: nam temporum vices, quibus populus Christianus tum in diuinis solemnitatibus celebrandis, tum in negotijs peragendis summopere indiget, ab Astronomicis calculis pendent, solis praecipue, ac lunae, et praecessionis ecquinoctiorum, ut constat ex ijs, quae Greg. XIII fel. record sidenti, circa anni correctionem gesta sunt".

existence of such monopolies[25]. The most technical and sustained attack, however, came from Kepler's teacher Michael Maestlin, mathematics professor in Heidelberg, in his *Außführlicher und Gründlicher Bericht von dem allgemainen und nunmehr ben sechzehen hundert Jaren von dem ersten Kenser Julio biß auff jetzige unsere Zeit im ganzen H. Römischen Reich gebrauchter Jarrechnung oder Kalender In was Gestalt er anfänglich gseßt und was durch länge der Zeit für Irthumb darenn senen evangelischen. Item ob und wie er widerumb ohn merckliche verwürrung zu verbersseren were. Sambt Erklärung der newen Reformation welche jetziger Bapst zu Rom Gregorius XIII in demselben Kalender hat angestellet und an vilen Orten eyngeführet Und was darvon zuhalten seye. Gestellet durch M. Michaelem Maestlimum Goeppingen. SEM. Matheseos Professorem zu Heydelberg.* (Heidelberg: Jakob Müller; 1583).

Maestlin took issue with the new calendar on all levels. One of his more fundamental objections was that the imminence of doomsday made calendar reform superfluous, and a source of unnecessary confusion. Indeed, the attempted papal reform of the calendar was itself a symptom of the approach of the apocalypse. At a less radical level, he claimed that the attempted promulgation of the new calendar by Gregory XIII was an invasion of the evangelical freedom of Protestant Germany that followed the Peace of Augsburg. Additionally, the connection between religious rites and time-calculations was purely conventional for Maestlin, who followed Luther in suggesting the stipulation of a fixed date for Easter. The dates of religious festivities could not, he argued, be made articles of religious faith[26].

As well as undermining the authority of the papacy to reform the Julian calendar, Maestlin questioned the expertise of the pope's mathematicians. His only *ad hominem* attack was reserved for Clavius, involved in calendar reform "nit alleyn als ein Clericus,

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[25]Ferdinand Kaltenbrunner, *Die Polemik über die Gregorianische Kalenderreform*, Vienna: In Commission bei Karl Gerold's Sohn; 1877.

[26]Maestlin, op. cit., passim. On the Clavius-Maestlin controversy, see F. Kaltenbrunner, *Die Polemix über die Gregorianische Kalenderreform*, Wien, 1877, pp. 32-6, 48-50, 57-62, 63-9 and CC 2.2, pp. 80-8 (letter 46 note 2).

sonder auch als ein Mathematicus" ("not just as a cleric, but also as a mathematician"). In the 1581 edition of Clavius's *Commentary on the Sphere of Sacrobosco*[27] Clavius had announced the impending reform of the calendar. However, Maestlin continues,

> In the whole of the same book he mentions no new observation or new tables, but doubtless he would have made this proclamation or announcement more worthily if the author had had such [observations and tables] and used them. How can he make a certain calculation of the year and month by the Sun and Moon when he does not know how late or soon the Sun and Moon complete their courses? For this reason, this first astronomical basis of the Pope's calendar is utterly disorderly, and anything might follow from it[28]

Such an accusation clearly posed a threat to the credibility of Clavius as a mathematician representing, simultaneously, the papacy and the Society of Jesus. Clavius did not pick up the gauntlet immediately, but allowed the task of defending the calendar to be carried out by someone more used to battling with heretics, the Mantuan Jesuit Antonio Possevino, who inserted a section *On the emendation of the Year and Easter* into his 1587 work *Muscovy, and other Works on the state of this century against the enemies of the Catholic church.*[29]The section, reviewed by Clavius prior to publication, gives short shrift to "the 'Examination' of a certain heretic, Michael Maestlin, who writes that he is a mathematician from Tübingen". Criticising Maestlin's discussion of the vernal equinox on technical grounds, Possevino concludes that "not only does [his Examination] display his incompetence [*imperitia*] and vanity, but it even [...] provides further confirmation of the Gregorian emendation"[30].

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[27]*Christophori Clavii Bambergensis ex Societate Iesu in Sphaeram Ioannis de Sacro Bosco Commentarius Nunc iterum ab ipso Auctore recognitus, et multis ac varijs locis locupletatus*, Romae: Ex Officina Dominici Basae; 1581.

[28]"[I]m selben ganzen Buch gedenckt er keyner newen observation oder newen tabularum, welche er on zweiffel auch würder angemeldet oder gerühmet haben wann der author solche gehabt und gebraucht het. Wie kans dann muglich seyn das er ein gewisse Jar und Monat rechnung nach der Sonnen und dem Mon anstellen könte all die weil er noch nit weysst wie lang oder wie bald Sonn und Mon ihren Lauff vollbringen? Ist derwegen diser erste Astronomische Grund des Bapsts Kalendere sehr bawfällig es komme gleich hernach was da wölle", Maestlin, *Außführlicher und Gründlicher Bericht* , cit., p. 159.

[29]Antonio Possevino, *Moscovia, et, alia Opera, de statu huius seculi, adversus Catholicae Ecclesiae hostes*, [Coloniae, Agrippine]: In officina Birckmannica, sumptibus Arnoldi Mylij; 1587, Sectio IV, pp. 206-223, *De anni et Paschae Emendatione, Sectio IIII, Olim a Nicaenis Patribus facta, ac nunc ab Ecclesia Catholica ad pristinam normam ac rationem revocata: Quae ab haereticis nescientibus quid loquantur reprehensa satis ostendit, quanti Chytraeus, & reliqui veritatem, & decreta Synodorum probatarum, & purae, quam vocant, Ecclesiae faciant*.

[30]Possevino, *Moscovia*, cit., p. 223: "QUENDAM MICHAELEM MAESTLINUM, qui se scribit mathematicum Tubingensem, dum novissime conatus est altero (ut vocat) examine a se edito

In response, Maestlin taunted Clavius further with a *Defensio alterius sui examinis* published in 1588, which noted that the only Roman answer to his 1583 *Außführlicher und Gründlicher Bericht* was Possevino's *Moscovia*, and insinuated that Rome was unable to provide a stronger rebuttal. This, at last, brought Clavius directly into the fray, and in the letter of dedication to Emperor Rudolph II of his *Novi Calendarii Romani Apologia, Adversus Michaelem Maestlinum Gaeppingensem, in Tubingensi Academia Mathematicum*[31]he drew on the anti-heretical rhetoric of his Mantuan friend Possevino[32]:

> Such is either the natural vice or the depraved perversion of the studies of certain men, MOST INVINCIBLE CAESAR, that just as there is nothing so false and absurd that it will not have its defenders, and there is nothing so true and praiseworthy that it will escape from all of the calumnies of quibblers. This might be demonstrated [...] by the Roman Calendar lately liberated from errors [...] through the authority of Pope Gregory XIII, with the immense approval of the other princes and schools of the Catholic world, and then of your Holy Majesty, and finally either published or accepted in almost all nations as a result of great study. Although this was done rightly and correctly, and produced in accordance with the method and use that the church of God has always held in celebrating the holy day of Easter, and the other feasts that are termed moveable, Michael Maestlin, a mathematician from Tübingen, has contrived to oppose this most excellent and esteemed Calendar and

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Kalendarium emendatum carpere, non solum imperitiam, & vanitatem suam prodidisse, verumetiam (licet inuitum, ac non cogitantem) magis confirmasse Gregorianam emendationem. Caput X. Et denique cuiusdam haeretici Michaelis Maestlini, qui se Tubingensem Mathematicum scribit, erupit novissimum examen, quo Gregorianum Kalendarium conatur evertere. Contra quem quoniam ijdem, de quibus supra locuti sumus, abunde responderunt, hoc unum satis fuerit dicere. Nempe gloriosam illam inscriptionem, qua universos provocat ad respondendum, nisi (inquit) velint haberi impostores, aut imperij turbatores, satis ostendere hominis ventosum ingenium ac proinde in eius scripti recessu, multo minus esse, quam fronte promittat. Nam ut pleraque in eo sunt putida, certe cum fateatur tabulas tam Alphonsinas quam Prutenicas exacte cum caelo non congruere, cur item de aequinoctiali termino non dubitabitur, an sit exactissimus, quem exorbitatione sua opponit medio loco in 21. Martij ex auctoritate Nicaeni Concilij affixo? Veruntamen & eo conatu comprobat ipsomet calculo Astronomico 21. diem permanere intermedium inter utramque exorbitationem, versus 19. & 24. dies Martij. Quamobrem Gregorianum computum astruit magis, quam negat, confirmat quam infirmat, ac veriorem illam esse omnibus alijs notationem annorum civilium inuitus etiam fatetur".

[31]Christoph Clavius, *Novi Calendarii Romani Apologia, Adversus Michaelem Maestlinum Gaeppingensem, in Tubingensi Academia Mathematicum Tribus Libris Explicata.* Romae: Apud Sanctium, & Soc.; 1588.

[32]See, in particular, Antonio Possevino,*Atheismi Lutheri, Melanchthonis, Calvini, Bezae, Ubiquetariorum, Anabaptistarum, Picardorum, Puritanorum, Arianorum, & aliorum nostri temporis haereticorum. Duo item libri Pestilentissimi Ministrorum Tranßylvanicorum, cum thesibus Francisci Davidis, adversus sanctißimam Trinitatem. Refutati ab Antonio Possevino Societatis IESU. Denique Antithesis haereticae perfidiae, contra singulos articulos orthodoxae fidei.* Vilnae: Apud Ioannem Velicensem; 1586. On Ubiquitarians, see ff. 32v-39r.

aims to dissolve the concordance of the Catholic church by nefarious fraud, as he is a man infected with the stain of Ubiquitarian heresy.[33]

In the body of the *Apologia*, Clavius elaborated on Maestlin's heretical tendencies[34], castigated his pride and arrogance[35], and came to the defense of Possevino, the target of

[33]"Tanta est nonnullorum hominum sive naturae vitio, seu pravo ipsorum studio perversitas CAESAR INVICTISSIME, ut quemadmodum nihil unquam tam falsum absurdumque fuit, quod non suos patronos habuerit; ita nihil adeo verum, ac laudabile, quod vituperatorum calumnias omnes effugerit. Argumento esse potest (ne longius abeam) Calendarium Romanum nuper ex auctoritate GREGORII XIII Pont. Max. ingentique cum caeterorum Principum, gymnasiorumque orbis Catholici, um vero sacrae Maiestatis tuae approbatione, ab erroribus, quos dies paulatim attulerat, vindicatum: et aliquando maximis omnium prope nationum studiis vel editum, vel receptum. Quod quidem tametsi et recte atque ordine factum est, et concinnatum apposite ad morem, usumque eum, quem semper DEI Ecclesia tenuit in celebrando sacrosancto Paschae die, caeterisque festis, quae mobilia appellantur; inventus est tamen Michael Maestlinus, Mathematicus, Tubingensis, qui ut est homo Ubiquetariae haeresis labe infectus, ut egregium hoc spectatumque Calendarium oppugnando, Ecclesiae Catholicae concordiam dissolvere nefaria fraude tentaret", Clavius to Rudolph II, dedicatory letter to *Novi Calendarii Romani Apologia, Adversus Michaelem Maeslinum Goeppingensem, inTubingensi Academia Mathematicum, tribus libris explicata,...* Romae, Apud Sanctium, et Soc. 1588 (sig. a2), Rome, 18 October 1588, published in CC II.1, pp. 130-133. Ubiquitarianism, as the name suggests, is a term used to refer to the doctrine adopted by some Lutherans that the body of Christ is in some sense everywhere, rather than localised in the Eucharist.

[34]Clavius, *Apologia*, cit., p. 316, "Primum enim Maestlinum haereticum esse, nemo qui illum norit, nisi forte haereticus ipse sit, negabit. Nam ut taceam, quod plerique in Germania sciunt, eum, quod Ubiquetarius esse, pulsum esse Heidelberga, Professio fidei, qu Maestlinus in sua hac Defensione usus est, ut haeretici nomen vitaret, profecto est talis, ut si nullum pareterea haberemus indicium, sua ipsum confessione iugulare possemus. Name & Patrum traditiones respuit, & Sanctorum patrocinium contenit, & soli fidei iustificationem ac beatitudinem trubuit: denique se Ubiquetarium, etsi non verbo, at re profitetur. Quo igitur ore haeretici nomen recusat, qui tot, tamque apertas haereses tam studiose suscipiat?" Clavius pointed out Maestlin's heresy again in the dedicatory letter, to Cardinal Francisco Toledo, of his reply to Scaliger, *Iosephi Scaligeri Elenchus, et Castigatio Calendarij Gregoriani a Christophoro Clavio Bambergensi Societatis Iesu castigata*, Romae: Apud Aloysium Zannettum; 1595, p. 3-7 (also in CC III.1, pp. 118-9), on p. 4: "Vix adeo Gregorianum Calendarium summa ope, curaque perfectum (quod res ipsa omnium consensu vulgandi iam maturitatem dabat in lucem prodierat, cum Tubingae, quae urbs est Haereticorum in Germania, teterrimus turbo exortus est Michael Maestlinus mathematicus nobilis, sed haeresi Ubiquetaria infamis. Is orthodoxae religionis, Pontificisque Romani odio furens, libro edito, Gregorianum Calendarium convellere, funditusque evertere est connisus".

[35]Clavius, *Apologia*, cit., p. 323, "QUAE cum ita sint, quis erit, Maestline, tam proiecte audaciae, praeter unum te, qui novuum Calendarium carpere adeat, eo quod vitata in eo non sint, quae nullo modo possunt vitari? Nec vero dubito, quin ob innatam tibi arrogantiam Calendarium novum post hoc meum responsum iterum invasurus sis, ne victus, & causa cecidisse videaris: quanquam veritatis auctoritatem apud te tantum valere ficte, ac simulate asseras, ut ei lubentissime cessurus sis, si quis ex fontibus huius negotij te aliud docuerit", and ibid., pp. 313-4: "Nonne videtur miles iste gloriusus iam parta laetus victoria canere triumphum? Miror equidem, vehementerque miror, eum posse tam elato esse animo, ut prae se, non dicam omnes totius orbis Mathematicos contemnat, sed arbitretur, neminem reperiri, qui cum illo paribus viribus congrediatur. Aut enim necesse est eum superbiae spiritu inflatum veritatem ipsam nolle aspicere, aut (quod eius Examen declarat) ceremoniarum Ecclesiasticarum, quibus ad hoc usque tempus in toto Christiano orbe Pascha celebratum est, prorsus ignarum essem atque expertem; cum contradicendi cupiditate excaecatur inetias suas, quas contra novum Calendarium affert, non videat".

Maestlin's most recent work, while dealing with his technical objections patiently and at great length. All of Maestlin's works appeared on Sixtus V's Index of 1590, representing a further fortification of the Roman defense[36]. The calendar polemic raged on, nonetheless, with further volleys at Clavius coming from Joseph Scaliger. Reflecting bitterly on Clavius's comportment at a later moment, Scaliger neatly summarized the new public persona forged by Clavius for the Jesuit mathematician during this period: "*Est Germanus, un esprit lourd & patient, & tales esse debent Mathematici; praeclarum ingenium non potest esse magnus Mathematicus*" ("He is a German, a heavy and patient mind, and mathematicians must be like this. An outstandingly ingenious person cannot be a great mathematician")[37]. During the protracted polemic, the reputation of the Society of Jesus and the propogation of the calendar became inextricably linked. In 1609, Clavius's editor, Johann Reinhard Ziegler, made this clear when wrote to his master about the most recent opponent of the Gregorian calendar Georg Germann that

> Even this fly is worth driving away [...] This is important both for the good name of the Society and for the reputation [*existimatio*] of the calendar[38]

[36]F. H. Reusch, *Der Index der verbotenen Bücher: ein Beitrag zur Kircher- und Literaturgeschichte*, Bonn: Verlag von Max Cohen & Sohn; 1883-5, pp. 504, 566.
[37]*Scaligerana. Editio altera. ad verum exemplar restituta, & innumeris iisque foedissimis mendis, quibus prior illa passim scatebat, diligentissime purgata.* Coloniae Agrippinae: Apud Gerbrandum Scagen; 1667, p. 51 (s.v. 'Clavius').
[38]"[N]am et hanc muscam opere precium est abigere [...] Interest id ad bonum Societatis nomen, et Calendari existimationem", Johann Reinhard Ziegler to Clavius, Mainz, 16 January 1609, in CC VI.1, 128-9

Clavius and the *Bibliotheca Selecta*

This may be an convenient moment at which to leave the calendar polemic to run its course and have a closer look at the relationship between Clavius and Antonio Possevino's plan for "world-evanglization" through arms and print-culture, a relationship that was to have enormous significance for the status of mathematical practices in the Jesuit order[39]. During the 1580s, as we have seen, the interests of Possevino and Clavius converged significantly over the issue of the calendar, and the brief collision of these two contrary Jesuit career trajectories - the political man turned scholar and the mathematician turned politician - coincided with the crucial years for the development of Jesuit educational policy. In 1586, after almost 30,000 miles of travel as papal nuncio and legate[40], Antonio Possevino was sent by the Jesuit General Claudio Aquaviva to the Jesuit college in Padua, in an attempt to remedy his perceived detachment from the internal life of the Society of Jesus, which he had joined relatively late in life[41]. While Possevino had been very close to Aquaviva's predecessor Everard Mercurian, working for some time as his personal secretary, the new General apparently feared him as something of a loose cannon. In Padua, relieved from teaching duties in the Jesuit college, Possevino read voraciously. His biographer recounts a turning-point in this studious exile:

> While in Padua, *he says in a letter to one of his friends*, I was penetrated with pain on seeing that the *Bibliotheca* of a certain Gesner was filled with an infinity of books equally dangerous for the Faith and morals. I wondered if I couldn't engage my friends, both within the Society and outside, to work each according to his talent to collect that which could allow one to become competent in each faculty, after having purged it of all of the errors which might have slipped in, and to make a Library from this collection, that one could consult fruitfully and without danger. I didn't flatter myself that I could carry out such a great plan alone. With this in mind, I cast my eyes on Fr. Francesco Turriano, who had special knowledge of the Church Fathers, on Fr. Clavius, who is excellently skilled in mathematics, and on some lay-people who were perfectly versed in Civil and Canon Law. I

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[39]For a useful summary of Possevino's enterprise, see John Patrick Donnelly, *Antonio Possevino's plan for world evangelization*. The Catholic Historical Review. 1988; 74: 179-198.
[40]The figure is provided by Donnelly, op. cit..
[41]Donnelly, op. cit., CC I.2, pp. 80-1, Giuseppe Castellani, *La vocazione alla Compagnia di Gesù del P. Antonio Possevino da una relazione inedita del medesimo*, Archivum Historicum Societatis Iesu, 14 (1945-6), 102-124.

> attempted to persuade them to undertake a part of the Work each, which I judged to be one of the most important for the glory of God and the service of the Church.[42]

Conrad Gesner's *Bibliotheca Universalis*[43], the source of Possevino's discomfort, had enjoyed immense success in Catholic and Protestant territories alike after its publication in Zurich in 1545-8, despite its appearance on the Venetian Index of 1554 and the Roman Indices of 1559 and 1564[44]. Possevino's *Bibliotheca Selecta*, composed as a sanitized, Catholic answer to Gesner, took its lead from the disciplinary divisions adopted by the earlier work[45]. The mathematical disciplines, within which Gesner had included a lengthy section *De Divinatione cum licita tum illicita, & magia*, little short of anathema to the Roman censors[46], were no exception to Possevino's purgative

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[42]"Etant à Padouë, *dit il en écrivant à un de ses amis*, je fus pénétré de douleur en voyant que la Bibliotheque d'un certain Gesnerus, se remplissoit d'une infinité de livres également dangereux pour la Foy et pour les moeurs; il me vint en pensée si je ne pourrois point engager les amis que j'avois, tant de la Compagnie qu'au dehors, à travailler chacun selon son génie à recüeillir ce qui dans chaque Faculté pourroit contribuer à s'y rendre habile, aprés l'avoir purgée de toutes les erreurs, qui auroient pû s'y glisser, et de former du recüeil, que feroient plusieurs personnes de sçavoir et de mérite, une Bibliotheque, qu'on pourroit consulter avec fruit et sans danger; je ne me flattois point de pouvoir tout seul exécuter un si grand dessein. Dans cette vûë je jettay les yeux sur le Pere François Turriano, qui avoit une speciale connoissance des Saints Peres, sur le Pere Clavius, qui entend excellement les Mathématiques, sur quelques personnes, qui dans le siecle possedoient parfaitement le droit Civile et Canonique, je tâchay de leur persuader d'entreprende chacun une partie de cet Ouvrage, que je jugeouis être des plus importans pour la gloire de Dieu et le service de l'Eglise", Jean Dorigny, *La vie du Père Antoine Possevin de la Compagnie de Jésus*, Paris: Chez Etienne Ganeau, 1712.: pp. 500-1.

[43]*Bibliotheca Universalis, sive Catalogus omnium scriptorum locupletissimus, in tribus linguis, Latina, Graeca, & Hebraica*, Tiguri, apud Christophorum Froschoverum, 1545. (Tom. 1), *Pandectarum sive Partitionum univeralium*, Tiguri, apud Christophorum Froschoverum, 1548 (Tom. 2)

[44]J.M. de Bujanda, ed., *Index des Livres Interdits*, Québec: Centre d'Études de la Renaissance, Éditions de l'Université de Sherbrooke, Librairie Droz, 1990, vol. VIII (Index de Rome),: p. 396, A. Moreni, La *Bibliotheca Universalis* di Konrad Gesner e gli Indici dei libri proibiti, in *La Bibliofilia*, LXXXVIII (1986), pp. 131-150

[45]On the relationship between the two works, see Alfredo Serrai, *Storia della Bibliografia. IV. Cataloghi a stampa. Bibliografie teologiche. Bibliografie filosofiche. Antonio Possevino*. A cura di Maria Grazia Ceccarelli, Roma: Bulzoni; 1993, pp. 713-760, and Helmut Zedelmaier, *Bibliotheca Universalis und Bibliotheca Selecta: Das Problem der Ordnung des gelehrten Wissens in der frühen Neuzeit*, Köln, Weimar, Wien: Böhlau Verlag; 1992, especially pp. 128-150 which provides a systematic comparison. On the *Bibliotheca Selecta*, see also Albano Biondi, *La Bibliotheca Selecta di Antonio Possevino. Un progetto di egemonia culturale* in Gian Paolo Brizzi, ed., *La "Ratio Studiorum": Modelli culturali e pratiche dei Gesuiti in Italia tra Cinque e Seicento*, Rome: Bulzoni; 1981: 43-75.

[46] Gesner, *Bibliotheca Universalis*, cit., Tom. 2 pp. 73-76: Arithmetica, pp. 77-80: Geometria pp. 81-86: De musica, pp. 87-94: De astronomia, pp. 95-98: De Astrologia, pp. 99-106: De Divinatione cum licita tum illicita, & magia, pp. 107-116: De Geographia.

enterprise. In opening Book XV of the *Bibliotheca Selecta*, which deals with mathematics, Possevino explicitly acknowledges Clavius's assistance in selecting a mathematical bibliography more suitable for a Catholic readership than Gesner's indiscriminate agglomeration of potentially dangerous texts:

> In this matter, among others, the judgement, and the excellence (as it may truly be said) of Christoph Clavius, Mathematician of our Society, were of enormous help to me[47]

As Adriano Prosperi has shown, Possevino's project went beyond a merely virtual library. He functioned as something of a walking-bookshop at times. On a visit to Montemagno, as Prosperi recounts, Possevino met schoolmasters, preachers and parish-priests in a church without doors which allowed animals to enter freely. Opening his chests, he distributed books to everyone according to his particular needs.[48]

Clavius's relationship with Possevino, formed during the calendar polemic[49], gave mathematics a prominent place in the latter's project for fomenting piety through the judicious deployment of print culture. The long section on mathematics in the *Bibliotheca Selecta* extolls the necessity, dignity and utility of mathematics in terms highly redolent of the prefaces to Clavius's own published works. While enlisting Benito Pereira's attack on illicit magic to exclude judicial astrology and the other forms of divination that inhabited Gesner's *Bibliotheca Universalis*[50], Possevino placed sanitized

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[47]Quam ad rem, praeter alios, Christophori Clavij Mathematici Societatis nostrae, iudicium, &, quae vere dici potest, praestantia, magno mihi auxilio fuit", Possevino, ref.

[48]Adriano Prosperi, *Tribunali della coscienza. Inquisitori, confessori, missionari*, Milan: Einaudi; 1996, pp. 617-8, citing ARSI Ven. 105, II, f. 368r.

[49]On Possevino's relationship with Clavius, see also CC II.2, p. 44 (note 2): "Tra 1584 e 1588 le relazioni di Clavio con Possevino furono più intense di quelle documentate nelle quattro lettere collegabili all'affaire Lathos [i.e. J. Lathos's objections to the Gregorian calendar, which Possevino sent to Rome]; esse conpresero una consulenza data da Clavio per la parte dedicata al calendario nelle Notae divini verbi [...] In seguito Clavio sarà consulente per il libro XV della Bibliotheca selecta, dedicato alle scienze matematiche. [...] i principali momenti di collaborazione tra i due coincisero con periodi di soggiorno di P. a Roma".

[50]Possevino, *Bibliotheca Selecta,* cit., Tom. 2, pp. 202-206, esp. p. 205: "Accessit praeter alios erudita hoc de toto negocio Benedicti Pererij tractatio, tanto dignior lectu, quanto post istos, quos perlegere potuit, ad haec capita breuiter eam, ut peracri est iudicio, redegit: Primo igitur capite Diuinationem Astrologicam Diuinae Scripturae, disciplinae Ecclesiasticae, ac doctrinae Theologicae docet esse contrariam. Secundo capite, a Philosophia redargui, & conuinci, primum quidem ea ratione, quod istiusmodi Astrologi caelestium rerum sint

mathematical practices firmly within the domain of the pious Catholic scholar. The heroic stories of the mathematically-enabled military exploits of Archimedes and Proclus were linked in his account with the technical wonders of Renaissance Italy and the use of astronomical knowledge to excite admiration for the divine opus[51]. The mathematician and post-Tridentine theologian, in Possevino's description, were close allies, not just because of the Gregorian reform of the calendar, but also because of the widespread mentions in Scripture of stars, orbs, measures, the architecture of the temple of Solomon, and "of more than six-hundred other things".[52] Given a seal of authority by a warm prefatory letter from Clement VIII, Possevino's *Bibliotheca Selecta*, despite undergoing a lengthy period of censorship prior to its publication, situated mathematics within a Jesuit-led strategy of spiritual recovery in late sixteenth-century Europe.

Shortly after the appearance of Possevino's *Bibliotheca Selecta*, Clavius presented his own plan for world-evangelisation through polite letters, probably on the occasion of

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imperitissimi. Tertio capite: Etiam si astrologi summam rerum caelestium cognitionem tenerent, non posse tamen eos futura diuinare. Quarto capite. Non modo astra non esse caussas, sed neque esse signa futurarum rerum. Quinto capite: Quanam ratione nonnulli Astrologi multa vera praedixerint."

[51]"Et Aristoteles Mechanica docuit, litterisque prodita evulgauit. Neque vero ij tantum ex hac re percepti sunt fructus, quod Architas ligneae columbae volatum indiderit, quam ita libramentis suspenderat ut aura spiritus occulta concitaretur; vel quod Archimedes, & Possidonius sphaeras eas fabricauerint, in quas, ut Cicero inqui, cum Solis & Lunae, ac quinque errantium motus alligassent, effecerunt idem, quod ille, qui in Timaeo mundum aedificauit Deus, tu tarditate, ac celeritate motus dissimillimos una regeret conversio: vel quod muscam, & Aquilam Geometricis pennis illatam Norimberga exhibuerit: vel quae Claudius hisce proximis annis Tybure in Aestini Cardinalis hortis visus sit pene nova naturae miracula edidisse, cum effecisset, ut aquarum leni, ac placido illapsu aeneae aviculaae motu, voce, cantu ad noctuae aduentum opportune intermisso, ad eius discessum repetito opportunius, ita imitarentur veras, ut postius qui fictas afferreret temeratij, quam qui veras aestimaret, nimis creduli nomen mereretur: (Addidit autem & hydraulicum, e quo suavissimus & harmonicus sonus inaudiebatur) Quodque (quod sane fuit adhuc magis admirandum) ad eius arbitrium caelestis arcus, quem Latini Iridem dicunt, ita eleganter, ac vere circumduxerit; ut esset laudandus Deus, qui tale, etiam in rebus huiusmodi, acumen humanis ingenijs dedisset. Non hi tantum inquam ex mathematicbus percepti sunt fructus in rebus huiusmodi, acumen humanis ingenijs dedisset", Possevino, *Bibliotheca Selecta*, cit., Tom. 2, pp. 177-8

[52] "Iam ad ipsam quoque Theologiam noscendam quantopere Mathematicae pertineant, monstrarunt antiqua saecula, & illud potissimum, quo Nicaena Synodus est habita: novissima item, in qua, ut in Nicaena, de tempore Paschatis, ac de reliquorum, ut vocant, mobilium festorum celebratione agendum fuit: qua una re totius Christianae Reip. ordo, ac gubernatio continetur; ne modo digrediar ad ea, quae passim in scripturis occurrunt de stellis, orbibus, mensura, & architectura templi Salomonis, & de alijs plusquam sexcentis", Possevino, *Bibliotheca Selecta*, cit., Tom. II, Lib. XV, p. 177.

the Fifth General Congregation of the Society (1593-4) in Rome. The text, which remained unpublished for reasons that will shortly become apparent, was entitled *Discourse of a very close friend of the Society of Jesus on the method and way in which the Society can improve the opinion which men have of it, to the greater honour of God and the profit of souls, and by which the estimation of all heretics in literary matters (upon which they greatly depend) can be most rapidly and easily destroyed*[53].

In his *Discourse*, Clavius summarized the centrality of erudition to the success of the global Jesuit apostolate:

> The great reputation that the Society of Jesus generally holds amongst foreigners in distant parts of the world has come from [its contributions to] the Universe of Letters. For, although, as we believe, it has possessed singular moral uprightness, this has only been clearly perceived by those who are very close to it, and most people, ignorant of this, have regarded it as no different in this respect to the other religious orders. However the praise of its most elegant erudition, in comparison with the other barbarous orders, is such that even one of the enemies will perceive a great unanimity. It is by this one thing alone that [the Society] has acquired so much authority amongst many men living very far away that people who were hesitant in faith have retained the Catholic one, and people who have entered into heresy have revoked it, persuaded solely by their belief that so many men of such prodigious learning who are so unanimously agreed cannot be ignorant of the truth.[54]

Learning and unanimity played a fundamental role in ensuring the superior credibility of the Jesuit line on matters of faith with respect to the other religious orders. However, the Ignatian emphasis on *mediocritas*, manifested in the *Constitutions* and in the organization of studies in the *Ratio Studiorum*, still undergoing modification at this point, threatened to undermine this privileged position:

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[53]*Discursus cuiusdam amicissimi Societatis Iesu de modo et via qua Societas ad maiorem Dei honorem et animarum profectum augere hominum de se opinionem, omnemque haereticorum in literis aestimationem, qua illi multum nituntur, convellere brevissime et facillime possit*, (c. 1594), ARSI Stud. 3, ff. 485-487 (Clavius autograph), published in MP VII, pp. 119-122.

[54]"Magna aestimatio Societatis Iesu quam habet apud exteras, longeque positas regiones fere existit a literis universa. Nam, si qua creditur singularis morum probitas, ea nonnisi a coniunctissimis perspecta, a plurimis ignoratur, et communis cum aliis religiosis existimatur. At vero, laus elegantioris eruditionis, cum caeterae religiones barbarae putentur, huic etiam inimicorum consensu tribuitur maxima; qua una et sola re tantum auctoritatis apud multos homines remotissime degentes acquisivit, ut eos vel haesitantes in fide catholica retinuerit, vel ingressos haeresim revocaverit eo solo persuasos argumento, quod existiment, viris tam doctis, tam multis, tam unanimi consensu asseverantibus, ignorationem veri inesse non posse", Clavius, *Discursus*, ed. cit., p. 119.

> This opinion of the erudition of the Society and its high reputation must therefore be safeguarded and be amplified in every possible way, as some would attempt to diminish it for the following reason: there are in the Society many men who are moderately learned, but none who are exceptionally so. For besides philosophy and scholastic theology, which the heretics deprecate, calling one a hodge-podge of opinions and the other Thomist and Scotist sophistries, in the rest of the so-named polite arts and in the knowledge of various languages they claim that the Society is inferior to them. They would demonstrate this with the examples of Tremellius in Hebrew, Wolf in Greek, Sturm in oratory and Melanchthon, most excellently versed in every kind of history. They judge that there are no equals in the Society against whom these men could be set.[55]

In mathematics, oratory, Greek and Hebrew, Clavius contended, the Jesuit order lacked specialists who could compete with heretical laymen for the attention of Catholic princes. Clavius's diagnosis of the reasons for this state of affairs provides a rich illustration of the conditions of Jesuit training:

> The cause of this situation is manifest. For, since members of the laity often concentrate on a single subject, it is necessary by this approach, that they stand out with the course of time as extremely learned. In the Society, however, all follow the same method and way of studies. For after a short, but sufficient introduction to *Literae Humaniores*, they devote their constant attention to three years of philosophy and four of scholastic theology, so during their career their eyes neither can, nor should , be deflected towards anything else. When, however, these years are over everyone is sent to work immediately, pressed by incessant affairs, with the result that there is no spare time afterwards to allow them to touch any part of another science in any depth whatsoever. Thus it happens that although most or almost all men of the Society attain a moderate knowledge of many things, very few attain excellent knowledge of even one. I mean to except theology. I also mean to except some men who studied certain subjects to an outstanding level before they joined the Society.[56]

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[55]"Est ergo tuenda Societati et amplificanda modis omnibus haec eruditionis opinio et existimatio, quam nonnulli hac conantur ratione minuere: Esse quidem Societatis homines mediocriter doctos non paucos, insignite vero nullum. Nam praeter philosophiam et theologiam scholasticam, quas haeretici contemnunt, vocantes opinionum farraginem alteram, alteram Scoti, Thomaeque sophisticam; in caeteris politioribus (ut loquuntur) artibus et variarum linguarum cognitione inferiorem contendunt Societatem illis esse; probantque, afferentes e suis in hebraica lingua Tremellium, in graeca Wolfium, in facultate orationis Sturmium, in omni varietate historiae Melancthonem perexcellenter versatum; quibus pares ex Societate opponi non posse, arbitrantur", ibid.

[56]"Huius re causa in promptu est. Nam cum apud saeculi homines in rebus singulis singuli saepe elaborent, fore necesse est, ut in ea re cui student soli, evadant decursu temporis doctissimi. In Societate vero omnes sequuntur eandem studiorum rationem et viam. Nam post exiguam, sufficientem tamen humaniorum literarum perceptionem, tres annos philosophiae, quatuor theologiae scholasticae dant ea assiduitate, ut in eo curriculo ad quicquam aliud oculos deflectere nec possint, nec debeant. His autem decursis annis, mittuntur statim ad opus omnes, ubi sic urgentur perpetuis negotiis, ut otium non sit attingendi postea, nisi valde leviter, aliarum scientarum ullam partem. Ex quo fit, ut cum multi et fere omnes Societatis viri adipiscantur multarum rerum cognitionem mediocrem, paucissimi tamen vel unius exquisitam. Excipio semper theologiam. Excipio praeterea nonnullos homines, qui antequam se Societati adiunxerint, quibusdam in rebus elaborarant eximie", ibid.

The future reputation of the Society, and hence its ability to perform its work in the vineyard of the Lord, demanded the cultivation of excellence:

> [T]here is no one who does not perceive how much it is central to every objective of the Society to have some men who are most outstandingly erudite in these minor studies of mathematics, rhetoric, and language [...] who would spread the eminent reputation of the Society far and wide, unite the love of noble youths, curb the bragging of the heretics in these arts, and institute a tradition of excellence in all those disciplines in the Society.[57]

The public gaze, so abhorred by Ignatius Loyola, was to be reconquered hypnotically by Jesuit intellectual celebrities in Clavius's project:

> I believe it to be so ordained by nature that eminence in any subject, even of the least importance, causes the eyes of everyone to converge on oneself. This was the cause of that veneration of ancient kings towards remarkable painters and sculptors. It is for this reason that in these times many Catholics have surrendered their sons by the reputation of more excellent erudition to be instructed and lost to heretics; the noble King of Scots his son to the poet Buchanan, noble Frenchmen their sons to Petrus Ramus, and now the Germans to Hieronymus Wolf, an impious heretic excellently versed in Greek Letters. [...]
>
> It is only the Society [of Jesus] that can pursue [eminence] both very quickly and very easily. For it possesses diverse and most beautiful minds of youths, it has free time, it has masters, it has the authority to direct its subjects to whichever kind of study that suits them the most. Thus, with no effort and no extra expense, in a very brief time in all of these matters that I have mentioned, in eloquence, mathematics and discoursing in Greek and Hebrew, the Society of Jesus can have brilliant and most eminent men. When they are distributed in various nations and kingdoms like sparkling gems these will be a source of great fear to all enemies, and an incredible incitment to make young people flock to us from all the parts of the world, to the great honour of the Society[58]

Clavius proposed to implement his project through the establishment of four Jesuit academies, one for eloquence, one for Greek, one for Hebrew and one for mathematics. Each would be located in one of the great colleges of the order, Rome, Coimbra, Milan and Paris, and would contain ten men, chosen from ten different provinces. Following

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[57]"Iam vero, quanti intersit ad omne propositum Societatis habere in his minoribus studiis, [...] homines, mathematicae, rhetoricae, linguarumque aliquos valde insigniter eruditos, qui eminentes caeteris famam Societatis longe disseminent, amorem nobilioris iuventutis concilient, haereticam in his artibus iactantiam compescant, et ipsius Societatis sobolem ad omnem harum rerum excellentiam instituant, nemo est, qui non perspiciat", ibid.

[58]"Sola Societas est, quae hanc consequi cum brevissime, tum facillime possit. Habet enim varia, pulcherrimaque iuvenum ingenia, habet otium, habet magistros, habet auctoritatem cogendi subditos ad id genus studii, cui erunt aptissimi. Unde nullo negotio, nullo extraordinario sumptu, brevissimo tempore in his omnibus, quas dixi, rebus, eloquentia nimirum, mathematica, graeco, hebraicoque sermone clarissimos et eminentissimos viros habere possit, qui per diversas nationes et regna tanquam fulgentes gemmae distributi, magno honori Societati, ingenti terrori inimicis omnibus, incredibili incitamento iuvenibus, ex omnibus ut orbis partibus ad nos confluant, sunt futuri", ibid.

their completion of the philosophy course, the chosen academicians would undergo four years of private training in which they would be permitted "to pursue their own excursions independently in the works of various authors"[59]. The teacher would be present as a *moderator* of the academy, ensuring that his gifted pupils were not led astray. Once the alumni of these academies were redistributed to the different Jesuit provinces, Clavius hoped,

> by the praise of [their] most excellent erudition, snatched away from the impious, and, as it were, gathered under the banner of the Society, the youth of the world will be drawn to it, the booty of the heretics will be recovered and an infinite multitude of souls will be acquired for Christ our Lord and the Doctors[60]

The Ignatian *Constitutiones* had stipulated the necessity of knowledge of the mathematical disciplines for members of the Jesuit order only "in so far as they are suitable to the end which is before us"[61]. While his role as defender of the Gregorian calendar was establishing the reputation of the Jesuit mathematician in the wider *orbis christianus*, Clavius's internal campaign for mathematics sought to convince his Jesuit superiors that a high degree of carefully cultivated mathematical expertise, like oratorical skill, might be entirely consonant with the higher goals of the Society.

Mobile mathematicians: Clavius's disciples

Although the fate of Clavius's three other projected academies is uncertain, Ugo Baldini has shown that a private level of mathematical teaching appears to have existed in the Collegio Romano since the time of Balthasar Torres, long before Clavius's dramatic

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[59]"Ad maiorem igitur variarum rerum parandam copiam perutile multum videretur, ut horum iuvenum in academiis praeceptor non eos perpetuis praelectionibus detineat, sed post sufficientem introductionem, maxime in linguis, permittat eis in varios auctores excursiones proprio Marte prosequendas. Ipse vero, tanquam cursus moderator, assistat, dirigens si qua deflexerint, iter; maximeque providens, ne aliis se studiis impertinentibus implicent, sed omnibus viribus, ventis, velisque ad portum animo praestitutum ferantur", ibid.
[60]"[O]mnis laus excellentis eruditionis, erepta impiis, et in sinum quasi Societatis collecta, pertraheret ad eam iuventutem universam, nudaret haereticos sua solita praeda, et infinitam animarum multitudinem Christo Domino et Doctori omnium acquireret", ibid.
[61]"Tractabitur [...] logica, physica, metaphysica, moralis scientia et etiam mathematicae, quatenus tamen ad finem nobis propositum conveniunt"MP I, p. 283

presentation of the apostolic role of mathematical expertise[62]. Given the vast production of mathematical works by Jesuits during the seventeenth century[63], the existence of a private level of tuition can hardly come as a surprise. The public mathematics course provided in Jesuit colleges during the second year of the philosophy course[64] was simply too basic to allow Jesuits to reach a level of mathematical competence sufficient to compose original mathematical works or construct instruments, unless they had received a mathematical apprenticeship prior to entering the Society. The alumni of the informal *academia mathematica* became mathematics teachers in the different provinces of the Society, or used mathematics in other ways to further the apostolic goals of the order. Matteo Ricci was merely the most famous of Clavius's private pupils. His translation into Chinese of the first six books of Clavius's *Euclidis Elementorum*[65] and his use of cartographic and astronomical skills, which combined with his mnemonic abilities and dress-sense to ingratiate him into the late Ming court[66], can be directly related to his period of private mathematical tuition with

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[62]On the mathematical academy of the Collegio Romano, see Baldini's description in CC I.1, 68-89, which describes its activities up to 1610-11, when Clavius's old age and illness forced him to cede its direction fully to Grienberger. Baldini (CC I.1, p. 69) cites the suggestion made by Torres between 1557 and 1560: "Y si alguno discipulos, los mas ingeniosos y aptos a la mathematica, pareciere ser cosa conveniente que oyan mas que esto, para ser mas sufficientes, se les podrà leer las fiestas del año una lectiòn familiar en camara el tercer año, en la qual se les declaren sphaerica Theodosii et Menelai et Maurolici, y una introduction de tablas, o almanach perpetuo, con algun quadrante o anulo o radio", published in MP II, pp. 433-5.

[63]For a quantitative analysis of Jesuit printed works on mathematics during this period, based on Sommervogel, see Steven J. Harris, *Apostolic Spirituality and the Jesuit scientific tradition.* Science in Context. 1989 Mar; 3(1): pp. 29-65.

[64]See MP V, pp. 109-110, 177, 236, 284-5, 402, MP VII 109-115, Giuseppe Cosentino, *Le mathematiche nella "Ratio Studiorum" della Compagnia di Gesú.* Miscellanea Storica Ligure. 1970; II(2): 171-213, idem., *L'insegnamento delle mathematiche nei collegi Gesuitici nell'Italia settentrionale. Nota introduttiva.* Physis. 1971; 13: pp.205-217, A. C. Crombie, *Mathematics and Platonism in the Sixteenth-century Italian Universities and in Jesuit Educational Policy* in Y. Maeyama and W.G. Daltzer (eds.), *Prismata: Naturwissenschaftsgeschichtliche Studien (Festschrift für Willy Hartner),* Wiesbaden: Franz Steiner; 1977: pp.63-94.

[65]Christoph Clavius, *Euclidis Elementorum libri XV,* Romae: Apud Vincentium Accoltum, 1574.

[66]On Ricci's translation of the *Elements*, mentioned in almost all treatments of the Jesuit presence in China, see in particular Pasquale D'Elia,*Presentazione della prima traduzione cinese di Euclide,* Monumenta Serica, 1956; XV-1: 161-202, Peter Engelfriet, *The Chinese Euclid and its European Context*, in Catherine Jami and Hubert Delahaye, eds., *L'Europe en Chine: Interactions Scientifiques, Religieuses et Culturelles aux XVIIe et XVIIIe siècles*, Paris: Collège de France, 1993, pp. 241-252. On his mnemonic techniques, see Jonathan D. Spence, *The memory palace of Matteo Ricci*, London: Faber and Faber; 1985. On his dress-

Clavius in the Collegio Romano between 1575-7[67]. From China, Ricci wrote to Clavius and his fellow academician Giulio Fuligatti to discuss sundials and globes that he had made with the help of Clavius's printed works to display to his Chinese callers.[68] The pattern of recruitment from the Provinces, apprenticeship in Rome, redistribution to the periphery and correspondence with the master was to become standard. Clavius's first recorded private academician, the Scottish Jesuit John Hay, subsequently resided in Vilnius, Bordeaux, Paris, Tournon, Louvain, Liège and Pont-à-Mousson[69]. James Bosgrave, an English Jesuit, left Clavius's tutelage to live in Olmutz, Vilnius, Braunsberg, Poznan and Kalisz[70]. Other early disciples left the Collegio Romano for Cluj in Transylvania, Vienna, Prague, Lisbon, Coimbra, Douai, Louvain, Macao and almost anywhere else in the globe where the Jesuits had a foothold. Rapidly Clavius's mathematically trained offspring began their own private "academies" in these outposts, training disciples who were unable to make the journey to Rome. These second-generation disciples, however, still recognised Clavius as their mathematical ancestor, with his printed works acquiring the status of devotional objects. Johann Falckestein wrote to Clavius "*ut Oraculum consulam*" about a new astrolabe, and added that:

> Besides the fact that your commentaries were like teachers [*Magistrorum instar*] to me, I had Your Reverence's pupil the Scotsman John Hay as my master[71]

The geographical displacements of pupils of the Roman academy run by Clavius and subsequently continued under Christoph Grienberger (himself a second-generation disciple[72]) and Athanasius Kircher opened up new channels along which letters, books,

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sense, see Willard J. Peterson, *What to wear? Observation and participation by Jesuit missionaries in late Ming society*, in Stuart B. Schwartz, ed. *Implicit Understandings: Observing, Reporting, and reflecting on the encounters between Europeans and other peoples in the early modern era*, Cambridge: Cambridge University Press; 1994: 403-421.

[67]See CC I.1, p. 85, note 62.

[68]Ricci to Giulio Fuligatti and Clavius, Nanjuang, 12 October 1596, in *Opere storiche del P. Matteo Ricci S.J.*, ed. P. Tacchi Venturi, Macerata; 1911-13, Vol. II, pp. 213-8, also published in CC III.1, 175-81.

[69]CC I.2, 59-60

[70]CC I.2, 20-21

[71]"Nam praeterquam quod eius commentarii fuere mihi Magistororum instar, Magistrum habui V. Rae. discipulum P. Io. Hayum Scotum", Johann Falckestein to Clavius, Chambéry, 28 May 1594, CC.III.1, 82-3.

[72]Grienberger was first taught mathematics in Prague by Paul Pistorius, who was an academician in the Collegio Romano from 1577-8. CC I.1, p. 85.

instruments and mathematical problems could flow to and from Rome. Although Rome retained special status as a centre of authority, other important geographical centres emerged around the principal courts of Catholic Europe. Lisbon, as the point of departure for Jesuit missions to India, China, Japan and Brazil, became particularly significant. The *Indepetae* of the Jesuit archives in Rome are full of letters from mathematically trained Jesuits requesting to be sent to the Indies to use their abilities for the saving of souls. Grienberger left Clavius in Rome temporarily in 1599 to supervise the training of Jesuit mathematicians for the missions in Lisbon directly. One of his pupils, Giovanni Antonio Rubino, wrote from Chandrapur, the seat of the Rajah of Vijayanagar, to Clavius in 1609:

> I am in the great Kingdom of Bisnagà, attempting to procure the conversion of these souls, but for the moment *clausa est ianua*, we are waiting for the Lord to open it, so that many souls will be saved from going miserably to hell. The Brahmans, who are the *literati* of this kingdom, are very given to the cognition of the movements and conjunctions of the planets and stars, and in particular of 27 of them by which they govern and rule themselves. Your Reverence will be amazed at how they predict the hour and minute of eclipses of the sun and the moon, without knowing the way in which eclipses occur. I have attempted many times to make them state the way in which they derive the conjunctions of the planets, but I was never able to get them to declare it, and they don't wish to teach the things they know to others, except in secret to their relatives[73]

Rubino added that "There is nothing that I desire more than Your Reverence's *Astrolabium*, which is not to be found in the whole of the Indies"[74], demonstrating the importance of the transmission of Clavius's published works in the contests of mathematical expertise that were to become a trademark of Jesuit missions to the Orient. The mathematicians who stayed in Europe, often frustrated missionaries,

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[73]"Io me ne stò in questo gran Regno di Bisnagà procurando la conversion di queste anime, ma per adesso clausa est ianua, stiamo aspettando, ch'il Signore l'apra, accioche si salvino tant'anime, che si miserabilmente se ne vanno all'Inferno. Questi Bramani, che sono i letterati di questo regno sono molto dati alla cognit<ion>e delli movi<men>ti, et aspetti delli pianeti, e stelle, e principalmente di 27 per le quali si governano e reggono, e V.R. si stupirà come predicono l'hora, e minuto degl'eclissi cosi del sole, come della luna, con non sapere il modo come si faccino gl'eclipsi. Io pensai molte volte di farmi dichiarare il modo con che tirano gl'aspetti delli pianeti, ma non fu mai possibile a volermelo dichiarare, e le cose che sanno non le vogliono insegnare ad altri, se non a suoi parenti, et in secreto", Rubino to Clavius, Chandragiri, 25 October 1609, CC VI.1, 142-3, also in P. Tacchi Venturi, *Alcuni lettere del P. Antonio Rubino D.C.D.G.,* Torino, 1901.

[74]"[N]iuno cosa desidero più, che l'Astrolabio di VR, il quale non si ritrova in tutte l'Indie", ibid.

sometimes placed their mathematical activities within an apostolic context. Paul Guldin reminded readers of his *Centrobaryca* that to save a single human soul was more important than any mathematical problem, including the squaring of the circle.[75] Despite Guldin's distinction, the labours of the school of Clavius were arguably based on a firmly held belief that circle-squaring (which Clavius held to be possible[76]) and the saving of souls were entirely compatible forms of activity. Clavius's earlier suggestions to his Jesuit superiors about the importance of mathematical conversation to forming powerful links between the Jesuits and European aristocrats were confirmed in practice. Bernardino Salino wrote to Clavius from Genoa in 1595 to describe such an encounter:

> A few days after I arrived in Genoa from Corsica, as Marchese Pietro Francesco Malaspina had heard from one of ours [i.e. a Jesuit] that there was a father in our college who understood a little mathematics, he came immediately to find me in the College, and wished to talk with me about many things. He asked me to teach him some new demonstration, if I had any.[77]

Later Malaspina became the "*Moecenas [...] munificentissimus*" of works written by another of Clavius's disciples, Giuseppe Biancani[78]. Biancani and Malaspina had "*stretta conversatione*" in Piacenza in the Winter of 1602-3, discussing the conics of Apollonius of Perga, and the wealthy Marchese, delighted by Biancani's demonstrations and inventions, such as a sundial that could tell the time in the shade, later took theology courses in the Jesuit college of S. Rocco in Parma where Biancani taught.[79]

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[75]Paul Guldin, *De centro gravitatis, liber tertius, de fructu et usu centri gravitatis* Viennae: Formis Matthaei Cosmerovij in Aula Coloniensi, 1641, p. 209: "unamque animam perditam Conditori suo restituere pluris esse iudicavi, quam omnia Mathematica Inventa, ipsamque Circuli Quadraturam", cit. in Duhr, *Geschichte der Jesuiten in den Ländern deutscher Zunge*, Freiburg: Herdersche Verlagshandlung; 1913, Vol. II. 2, pp. 433.

[76]"Ego sane nullo modo dubitare possum de possibilitate quadraturae circuli", Clavius to Johann Hartmann Beyer, Rome, 19 December 1609, CC VI.1, p. 146.

[77]"Pochi giorni dopo che io fui gionto in Genova da Corsica, havendo l'Illmo. Sr. Marchese Pietro Francesco Malaspina inteso da uno de nostri che in Collegio nostro vi era un Padre il quale s'intendeva qualche poco di Mathematica; vene subito a ritrovarmi in Collegio desiderando conferir meco di molte cose. e mi prego, che se io haveva qualche Salino to Clavius, Genova, 19 July 1595, CC III.1, 120-134

[78]G. Biancani, *Aristotelis loca Mathematica*, Bononiae: Apud Bartholomaeum Cochium, 1615, idem., *Sphaera mundi, seu Cosmographia*, Bononiae: Typis Sebastiani Bonomij, 1620. The description of Malaspina is from the dedicatory letter of *Aristotelis loca mathematica* (see CC V.2, pp. 36-7, note 2).

[79]Biancani to Clavius, Bologna, 27 May 1603, CC V.1, 79-81, and CC V.2, pp. 36-7 note 2, which cites two letters from Biancani to Guldin (January, March 1615, in the

As Clavius had predicted, mathematical works could play an important role in ensuring local Jesuit patronage in Europe. Johann Reinhard Ziegler wrote to Clavius in 1607 to say that

> [T]here is a certain Catholic Count in Aquisgrana who is extremely studious of mathematical matters, and has even wanted to transcribe with his own hand that which I have taught in the various parts of this science in classes. He is a friend and great patron [*fautor*] of the Society and, especially of the College of Aquisgrana, and if you would dedicate some little work to him in the future it would be worthwhile[80]

Where munificent, mathematically literate patrons were not locally available, lack of books and mathematical instruments often made the replication of the Roman academy in the Provinces difficult. Bernardo Salino wrote to Clavius to give a very clear picture of the situation in Genoa, after Malaspina's interest and financial support had been transferred to the more mathematically sophisticated province of the Veneto[81]. His letter is revealing of the immense difficulties involved in exporting the Clavian model, so it is, I think, worth quoting at some length:

> I think your Reverence will already know that I teach mathematics here in Genoa[82], and, as this science has never been taught in this place before, I have found the College to be completely unfurnished with both the books and the instruments necessary for this profession. And as, until know, I have had to teach Cases of Conscience, I have not been able to take care of making much provision of books or of instruments, having no time to attend to these studies apart from that required by the lessons. Now the Rector of the College, seeing that I couldn't attend well to both the one and the other to satisfy the desire of these Gentlemen, who, in addition to the lesson, often want to chat with me and ask various things relating to this science, has obtained with the Fr. Provincial that I should be relieved of the burden of Cases, but as he has found noone for the moment who was capable of lecturing in them, he has begun to teach them himself in my place. Thus, desiring to attend more diligently to the teaching that has been imposed on me, I have acquired some few books by way of Milan, but some of those that I included in my list could not be found. For this reason, necessity has forced me to have recourse to Your Reverence, to make provision via Rome for all of the things that I require. I have all of

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Universitätsbibliothek, Graz, ms. 159, letters 58. 59) mentioning Biancani's conversations with Malaspina.

[80]"Est prope Aquisgranam Comes quidam Catholicus valde rerum mathematicarum studiosus, qui etiam sua manu, quod ego in scholis tradiderim in varias partes huius scientiae describere voluit. Amicus est et fautor magnus Societatis et inprimis Aquisgranensis Collegii, et si aliquod opusculum dedicaretur futurum esset operae pretium", Ziegler to Clavius, Mainz, 9 November 1607, CC VI.1, 65-8, on p. 67.

[81]On the Jesuit mathematical school in the Veneto, see Baldini, *Legem impone subactis*, cit., pp. 347-465.

[82]Salino had already written several letters, apparently unanswered, to Clavius in this capacity.

your works apart from Theodosius *de Sphericis* with the table of sines[83] and the Gregorian Calendar[84], and two *Compendii de Horologiis*[85]. I would also like Apollonius of Perga *De Conicis Elementis*[86], the *Tavole perpetue* of Magini[87], and some new ephimerides if they can be found. I have borrowed Magini's from a gentleman[88], and even if no others can be found I can still take these. I'd like the book of a Dane who has made experiments [*esperienze*] of the celestial motions[89], the book of a German gentleman who saves the motions of the planets with new hypotheses[90], and some curious books about Mechanics and practical geometry. As for the instruments, I need, first, a compass for drawing mathematical figures on the large board in the classroom, a celestial and terrestrial globe, of medium size. Because they are very insistent that I should teach the recognition of the stars, and the art of measuring distances, heights and depths, I need some instruments for these purposes, a quadrant and an astrolabe. If these instruments are secondhand, I don't mind, as it might cost too much to make new ones. For the money to purchase these things, you need only ask the *Procurator Generalis*, who knows where to procure it. Your Reverence need only ensure that the Fr. Rector orders someone to buy these things, and look to see if they are of good quality, before sending them to me when you have a convenient moment.[91]

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[83]C. Clavius, *Theodosii Tripolitae Sphaericorum libri III. A Christophoro Clavio Bambergensi Societatis Iesu perspicuis demonstrationibus, ac scholiis illustrati*, Romae: Ex Typographia Dominici Basae, 1586.

[84]idem, *Romani Calendarii a Gregorio XIII. P.M. restituti explicatio S.D.N. clementis VIII. iussu edita*, Romae: Apud Aloysium Zannettum, 1603.

[85]idem, *Horologiorum nova descriptio*, Romae: Apud Aloysium Zannettum, 1599, and *Compendium brevissimum describendorum horologiorum Horizontalium ac Declinantium*, Romae: Apud Aloysium Zannettum, 1603.

[86]F. Commandino, *Apollonii Pergaei conicorum libri quattuor,* Pistorii: ex nova typographia Stephani Gatti, 1596[2].

[87]G. A. Magini, *Tabulae primi mobilis quae directionum vulgo dicunt*, Venetiis: Apud Damianum Zenarium, 164.

[88]Probably G. A. Magini, *Ephemerides coelestium motuum ... Ab Anno Domini 1598 usque ad Annum 1610*, Venetiis, Apud Damianum Zenarium, 1599.

[89]Presumably Tycho Brahe, *Astronomiae instauratae progymnasmata*, Prague, 1602.

[90]Presumably J. Kepler, *Mysterium Cosmographicum*, Tubingae: Georgius Gruppenbachius, 1596.

[91]"Credo che V. Rev. gia sapra che io leggo la Matematica qua in Genova, e perche mai altre volte si e letta questa scientia in questo luogo, per questo ho trovato il Collegio sfornito e di libri e di instromenti necessarij per questa professione. e perche sin hora mi e bisognato insieme con la Matematica legere li casi di conscienza, non mi sono curato di fare molta provisione di libri, ne di instromenti, non havendo tempo di attendere a questo studio se non quanto era necessario per le lettioni. Hora il P. Rettore del Collegio vedendo che io non poteva attendere bene a l'uno e l'altro e sodisfare al desiderio di questi Gentilhuomini, i quali oltre la lettione, desiderano ben spesso di trattar meco e dimandar varie cose appartenenti a questa scientia, ha procurato col P. Prov<inci>le che io fossi sgravato del peso de Casi, ma non trovandosi altro per adesso che li potesse leggere, esso ha cominciato a legere in luogo mio. e percio hora desiderando di attendere piu diligentemente a questa lettura che mi e stata imposta, per via di Milano ho fatto venire alcuni pochi libri. ma alcuni di quelli che haveva datto in lista, non si sono trovati. si che la necessita mi sforza a riccorrere da V. Rev. di far provisione per via di Roma di tutto quello che mi bisogna. le opere sue le ho tutte eccetto Theodosio de sphericis con la tavola de sini e il Calendario Gregori<an>o, e doi Compendii de Horologiis. vorrei di piu Apollonio Pergeo de Conicis elementis, le Tavole perpetue del Magino, e qualche effemeridi nove se se ne trovano, quelle del Magino io le ho inprestate da un Gentilhuomo, pure se non si trovano altre potra pigliare anchor queste. Vorrei il libro di un Dano che ha fatto le esperienze de moti coelesti, {il libro di un Gentilhuomo todesco il quale salva li moti de // pianeti con nove hippothesi} e qualche libro curioso circa le Mechaniche e circa le praxi Geometriche. Quanto alli instromenti ho bisogno primo [di un] compasso per fare le figure matematiche su la tavola grande che si trova in scuola u[n glo]bo celeste e terrestre, di moderata grandezza, perche mi fanno grande instranza che io li insegni la cognitione d[e

Three months later, without an anwer from Clavius, Salino reiterated that "*de libri ne ho pochissimi, e de instromenti nissuno penitus*". The college was financially crippled by the costs of building work and land-acquisitions, so Salino had to be content with a few books and some wooden instruments that he had made himself.[92] From Poland, Simon Kaczorononski wrote that "we suffer from a terrible penury of mathematical books, so Your Reverence will not be surprised if we do not give sufficient satisfaction with our minds"[93]. With the same letter, Kaczorononski sent an astronomical quadrant that he had made "in furtive hours" using Clavius's *Astrolabium*. He pleads for his crude efforts to be corrected by the master: "If something might be added or made in a better way, you would teach one who desires to learn"[94]:

> In the division of the horizon, I have erred. And I have placed the stars in the parallels of the same, not in their places according to longitude, but I know this now.[95]

The correspondence of Clavius is filled with examples of disciples seeking correction of demonstrations, instruments and opinions from Rome. They looked to Clavius to hunt out the "*anguis latens in herba*" - the serpent in the grass, or concealed paralogism, in new attempts to square the circle. They asked Clavius's colleague in Rome Juan Bautista Villalpando to send metrological assistance through the post - a "*piede antico Romano, in legno o altra materia salda*", and an "*oncia antica agiustata*",[96] to correct unreliable local measures. Most of all, apprentice Jesuit mathematicians in the Provinces looked to

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ste]lle, e l'Arte del misurare le distanze, le Altezze, e profondita, e percio ho bisogno di qualche instromento a questo effetto, e di un quadrante, un Astrolabio e anchior che questi instromenti siano usati non mi curo: perche a farli far novi forsi costaranno troppo. Per li denari di accomprar tutte queste cose, basta far ricorsi al Procuratore generale, perche esso sa dove li ha da pigliare. Solamente V. Rev. procuri che il P. Rettore ordini ad alcuno che accompri queste cose, et essa le veda prima se sono buone, e poi mi siano mandate quando vi sara commoda occasione", Bernardo Salino to Clavius, Genova, 14 January 1605, CC V.1, pp. 143-4.

[92]Salino to Clavius, Genova, 19 April 1605, CC V.1, 155-6.

[93]"Maximam penuriam librorum mathematicorum patimur, unde non miretur V.R. si non ingenio nostro, ut volumus, satisfacimus", S. Kaczorononski to Clavius, Kalisz, 27 August 1606, CC VI.1, 42-44

[94]"Mitto V.R. quadrantem meum, horis furtivis factum ex Astrolabio V.ae R.ae ut si quid addi possit, aut melius fieri, discere cupientem doceat", ibid. p. 43

[95]"In partitione horizontis erravi, et stellas in parallelis ipsarum longitudinem posui, sed hoc iam scio", ibid., p. 44.

[96]Mark Welser to J.B. Villalpando, Augsburg, 18 October 1602, CC V.1, pp. 44-5.

Clavius and his colleagues in Rome for painless discipline. On 15th August 1593, the Sicilian mathematician Nicolò Calandrino wrote to Clavius from Reggio Calabria:

> It seems to me that our Sicilians are *in rebus mathematicis* like a sciotheric sundial, on which the lines have been drawn correctly, placed in the proper place and site, which has no gnomon to tell the time. Your Reverence was to be that gnomon[97].

When Clavius, or his successor Grienberger, did grace a college with their presence, most notably the case in Naples, the replication of the Roman mathematical academy was achieved most easily[98]. Not all confessions that made their way to Clavius were of a mathematical nature. One of the closest mathematical collaborators of Clavius, Grienberger and Villalpando, Marino Ghetaldi[99], left Rome hurriedly after involvement in a dirty deed:

> I never thought I'd have to leave Rome without saying a word to my friends, but unthinkable things intervened. Your Reverence knows that I am a stranger to affrays [*costioni*], but believe me that I was driven to do what I have done. Nonetheless, even in that rage I never wanted to kill him, though he had given me good reason, but just meant to teach him a lesson. But, because one doesn't measure blows, I did more than I meant to do.[100]

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[97]"Parmi che i nostri Siciliani siano in rebus Math<ematic>is come saria un'horologio Sciotherico il quale tutto ben lineato e posto nel debito luogo e sito non ha gnomone che mostri l'hore. V.Rev. havea d'esser questo gnomone", Nicolò Calandrino to Christoph Clavius, Reggio Calabria, 15 August 1593, in CC II.1, pp. 27-30, on p. 27.

[98]The financial resources available to Jesuit mathematicians in Naples were clearly on a different scale to those in other cities. In 1606, Giovanni Giacomo Staserio could ask Clavius for thirty copies of the new edition of his Sphaera, writing "et si vuole, li farò dare costì li danari da adesso; credo non passaranno alla stampa cinque giulii l'una" (Staserio to Clavius, Naples, 13 January 1606, CC VI.1, p. 15). On the academy in Naples, see Romano Gatto, *Tra Scienza e immaginazione. Le matematiche presso il collegio gesuitico napoletano (1552-1670 ca.),* Florence: Olschki; 1994, especially pp. 59-120. On the academy founded by Grienberger in Lisbon, see Grienberger to Clavius, Lisboa, 24 March 1601, in CC IV.1, pp. 136-9. On the academy in Palermo, see Grienberger to Clavius, Palermo; 21 April 21 1609 in CC VI.I, pp. 136-9. On the situation in Paris, see Chastellier to Clavius, Paris, 4 December 1594, CC III.1, 98-111, on p. 99. More often than a fully fledged academy, it seems that Jesuit mathematics professors were permitted to have one or two "private" pupils, who would also assist them in preparing printed works.

[99]On Ghetaldi's involvement with the mathematicians of the Collegio Romano, see especially P. D. Napolitani, *La Geometrizzazione della realtà fisica: il peso specifico in Ghetaldi e in Galileo.* Bolletino di Storia delle Scienze Mathematiche. 1988; VIII: pp.139-237.

[100]"Non credevo mai dover partir di Roma senza far motto agli amici, ma intravengono al mondo cose che non si pensano V.R. sa quanto sono alieno dalle costioni, ma credami certo che sono stato tirato per li capelli a fare quello che ho fatto, nondimeno ne anco in quella colera non hebbi animo d'ammazzarlo sebene m'haveva dato una gran causa, ma cercavo bene di segnarlo ma perche non si mesurano i colpi feci più che non volevo", Ghetaldi to Clavius, Venice, 21 June 1603, CC V.1, p. 82

Once he had reached the safety of Ragusa, Ghetaldi's morally questionable action did not exclude him from continued epistolary commerce with Clavius and Grienberger, with whom he continued to exchange mathematical demonstrations in the years after the homicide.[101]

Conclusion - The circulation of Clavius's image

The precise nature of teaching, including mathematical teaching, in Jesuit colleges could vary dramatically from place to place, depending on local needs and competition from other educational institutions, as a number of recent local studies have demonstrated[102]. One could not, thus, construct a simple "family-tree" of Jesuit mathematicians having Clavius as its only root[103]. Nonetheless Clavius's project for raising the status of the mathematical disciplines was at base a social project of distributing trained practitioners, instruments and books throughout the Jesuit empire.

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[101]E.g. Ghetaldi to Clavius, Ragusa, 6 June 1604, CC V.1, pp. 101-2, Ghetaldi to Clavius and Grienberger, Ragusa, 20 February 1608, CC VI.1, p. 79, Ghetaldi to Clavius, Ragusa, 20 May 1608, CC VI.1, p. 84, Ghetaldi to Clavius, Ragusa, 13 September 1608, CC VI.1 pp. 89-90.

[102]For France, see especially Antonella Romano, *La Compagnie de Jésus et la Révolution Scientifique: Constitution et diffusion d'une culture mathématique jésuite à la Renaissance (1540-1640),* Thèse de doctorat, Université de Paris-I, 1996. For Germany see Marcus Hellyer, *"Because the authority of my superiors commands": Censorship, physics and the German Jesuits.* Early Modern Science and Medicine. 1996; 1(3): 319-354.

[103]This picture is made more complex by a number of other factors - the recruitment of members of other religious orders into Clavius's circle (e.g. Gulio Fuligatti's efforts to teach the Observant Franciscan Bonaventura da Cingoli to make sundials), the importance of other teachers (the founder of the mathematical school in the Veneto, Giuseppe Biancani, to give one example, learned mathematics both outside of the order and with Marc Antonio de' Dominis before coming into contact with Clavius. See Bonaventura da Cingoli (OFM Obs.) to Clavius, Recanati, 16 August 1601, CC IV.1, 152-3: "se bene non la cognosco per vista, tuttavia gli porto aff<etio>ne grande per le sue rare virtù", Lorenzo Terzo (Rector of the Jesuit College of Padua) to Clavius, Padua, 28 February 1598 (following Biancani to Clavius, Padua, 28 February 1598 CC IV.1, pp. 34-37): "questo [i.e. Biancani] ha imparato parte al secolo, e parte dal già P. Marcantonio de Dominis, hora eletto di Segna". Despite the difficulties, and necessary simplifications, involved in constructing a genealogical tree of Clavius's second and third generation 'disciples', the type of prosopographical method employed by Antonella Romano in tracing the teaching activities of Clavius's pupils in France might bear much fruit if applied to the other provinces of the order. See Antonella Romano, *La Compagnie de Jésus et la Révolution Scientifique: Constitution et diffusion d'une culture mathématique jésuite à la Renaissance (1540-1640)*, cit., esp. part 2, ch. 3 (pp. 301-359) and Annexe 3 (pp. 555-618)

In May 1611 Johann Reinhard Ziegler wrote to Paul Guldin to discuss the publication of the first volume of Clavius's *Opera Omnia*.

> I have written the dedication in the *persona* of Clavius. If I wrote anything unworthy of him or other than he desired, I ask for indulgence. I wished to obey, not to offend. I have not yet presented the first volume to his Reverence the Bishop of Bamberg[104]. However I shall do so soon, and it will be elegantly bound. To honour Fr. Clavius, he is taking care to ornament the front of the work with an engraved title page at his expense. He even wishes for the likeness of Fr. Clavius that has been circulating in Germany to be reprinted. If it is not a good representation, be patient, as the book itself will certainly express the mind.[105]

The likeness (*effigies*) of Clavius to which Ziegler referred was the engraving carried out by Franciscus Villamena in 1606 (fig. 1), which was rapidly copied by other engravers. During sixteenth century Europe (particularly in the German lands) woodcuts of famous men had become stock-in-trade of the *colporteur*, along with the more traditional images of saints, miracles and *canards* describing monstrous births. Dürer's engravings of Erasmus and Melanchthon, both carried out in 1526, are early examples of this privilege being extended to scholars for a more elite audience. The title-page of the first volume of Clavius's *Opera Omnia* incorporates a rough copy of Villamena's engraving carried out by Johannes Leypolt, in which Clavius has been artificially aged by means of a grizzly beard. The elderly mathematician, pictured in his Roman *cubiculum*, is surrounded by the tools of his trade - a pair of compasses, a quadrant, an armillary sphere, an astrolabe and a number of books, containing geometrical diagrams. Whereas the authenticity of the likeness presented in the original engraving was guaranteed by a papal privilege and the "authority of the Superiors", the book itself was sufficient warranty for the integrity of Leypolt's copy. "God gave me knowledge of the course of

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[104]Johann Gottfried von Aschhausen, a pupil at the Jesuit colleges of Würzburg, Pont-à-Mousson and Mainz, made Prince Bishop of Bamberg in 1609.

[105]"Dedicationem scripsi fingens personam Clavii, si quid eo minus dignum scripsi aut aliter quam voluisset, peto veniam, obsequi volui, non offendere. Rmo. Bambergensi necdum obtuli primum tomum. offeram tamen brevi, eleganter compactum. Ille ut exornarit P. Clavium, curavit suo sumptu frontem operis titulo [...] inciso ornari. Voluit etiam reprimi effigiem P. Clavii, quae in Germania circumferebatur. Si non repraesentet, patientia, certe liber ipse ingenium exprimit", Johann Reinhard Ziegler to Paul Guldin, Mainz, 14 May 1611, Universitätsbibliothek, Graz, ms. 159, letter 2, quoted in CC VI.2, p.9.

the year and the positions of the stars"[106] the title-page announced, citing the book of Wisdom, and the remaining elements - the opposite figures of *Astronomia* and *Geometria*, presided over by the Virgin Mary, and the medieval saints Heinrich, founder of the bishopric of Bamberg, and his notoriously chaste wife, Kunigund, are indicative of the world in which Clavius's mathematical authority was being proclaimed. The publication of the *Opera*, which consciously emulated the succesful Mainz edition of Suarez's *Metaphysicae Disputationes*[107], was a laborious and thankless task for Ziegler, who wrote to Clavius constantly asking for advice and copper-plates, but only received meaningful collaboration from Odo Maelcote and Paul Guldin in Rome. "*Totus sum in delineandis figuris*" ("I am all [immersed] in drawing the figures"), he wrote to Clavius in October 1609. "I am now writing my fifth letter to Your Reverence," he wrote three months later, "and I have not received a single answer. But I do not despair. I am the willing servant of Your Reverence, from love of the Society and of Mathematics".[108] The circulation of Clavius's authority and reputation, epitomised by the publication of his *Opera mathematica*, was enabled by the circulation of his obedient and self-effacing disciples.

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[106]"Dedit mihi Deus ut sciam anni cursus et stellarum dispositiones" (Wisdom, 7), title-page of Clavius, *Opera mathematica*, vol. 1.

[107]"De forma editionis, illud placuit, ut fieret in folio ea quantitate, qua alias hic recusa metaphysica R. Patris Franc. Suarez", Ziegler to Clavius, Mainz, 27 June 1608, CC VI.1, pp. 86-7, on p. 86, referring to Suarez, *Metaphysicarum disputationum*, Moguntiae: Balthasar Lippius; 1606.

[108]"Iam quintam ad R.V. scribo epistolam, nec quidquam responsi accipio. Tamen non despero. Ego R.V. servus sum volontarius, amore Societatis et Matheseos", Ziegler to Clavius, Mainz, 1 December 1609, CC VI.1, p. 144.

CHAPTER TWO

TRUSTING THE JESUIT *MATHEMATICUS*

Introduction

In attempting to carve a role for the credible, pious Jesuit *mathematicus* in the business of the Apostolic See, Clavius faced formidable opposition from theological and philosophical factions who wished to deny the legitimacy and cognitive force of mathematical practices. This chapter explores some of the opposition to the use of mathematics to acquire knowledge of the natural world amongst Molinist theologians and Aristotelian natural philosophers, and the responses made by Clavius and his disciples to the need to cleanse mathematical practices of their unsavoury connotations. The *mathematicus*, I argue in the first part of the chapter, was a highly ambiguous figure in late sixteenth century Europe, being widely associated with the practice of judicial astrology. Within the Jesuit order, astrological fatalism was particularly abhorrent to many influential theologians and philosophers, who adopted Molina's conception of the relationship between grace and free will. In the case of Benito Pereira, his concern to remove the credentials of the judicial astrologer to speak on behalf of nature were associated with a campaign to reduce the cognitive powers of the mathematical disciplines in general.

Inside the walls of the Collegio Romano, the mathematical disciplines were additionally treated with open disrespect by students and professors alike at the end of the sixteenth century. To remedy this situation Clavius sought to give mathematics a public, ceremonial function that it had lacked with his predecessor at the Collegio Romano, Balthasar Torres. The mathematics professors would participate actively in degree-awarding ceremonies and public disputations. Students would be praised for performing succesful mathematical demonstrations in public. Orations extolling the virtues of the mathematical disciplines with recourse to an arsenal of ancient authorities and anecdotes

would be given regularly in the presence of the professors of the other faculties. Other professors would be banned from ridiculing the mathematical disciplines and mocking the inelegance of the epicycles that astronomers ascribed to planetary trajectories. Instead, the mathematical disciplines were to be accepted as true *scientiae* by the philosophers, capable of providing certain, demonstrative knowledge about the natural world, and immune to the vagaries of interpretation of ancient authorities that led to bitter discord amongst the different philosophical "sects".

Molinism and mathematics

Benito Pereira's influential attack on astrological and magical practices, *Adversus fallaces & superstitiosas artes,*[1] was published in Ingolstadt in 1591. A Spanish Jesuit from near Valencia, Pereira became one of the most influential philosophy professors of the Collegio Romano[2]. Five years before the publication of Pereira's discussion of astrology, on 5th January 1586, Sixtus V had condemned judicial astrology, equating it with a plethora of other superstitious practices in his bull *Coeli et Terrae*[3]. Despite condemning the tacit demonic pacts involved in all attempts to discover future and secret things, Sixtus did not deny the influence of the stars on human affairs altogether. Rather, he reinforced the popular conception of the "guardian angel" which had become

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[1]Benito Pereira, *Adversus fallaces & superstitiosas artes, id est, De magia, de observatione somniorum, et de divinatione astrologica. Libri tres*. Venice: Apud Ioan. Baptistam Ciottum, Senensem.; 1592 [First edn. Ingolstadt, 1591]. Citations are from the 1598 Cologne edition, *De magia, de observatione somniorum, et de divinatione astrologica. Libri tres. Adversus fallaces & superstitiosas artes... Accesserunt indices duo*, Coloniae Agrippinae: Apud Ioannem Gymnicum, 1598.

[2]See G. C. Giacobbe, *Un gesuita progressista nella "Questio de certitudine mathematicarum" rinascimentale: Benito Pereyra.* Physis. 1977; 19: pp. 51-86, Ugo Baldini, *Legem impone subactis. Studi su filosofia e scienza dei gesuiti in Italia, 1540- 1632*. Rome: Bulzoni; 1992. pp. 569-70, R. G. Villoslada, *Storia del Collegio Romano dal suo inizio all soppressione della Compagnia di Gesù.* Rome; 1954, Sommervogel *s.v.*, C. H. Lohr, *Latin Aristotle Commentaries. II. Renaissance Authors*. Florence; 1988. *s.v.*., Marcial Solana, *Historia de la filosofía española. Época del renacimiento (siglo XVI).* III. Madrid: Real academia de ciencias exactas, fisicas y naturales; 1941, pp. 373-400.

[3]For a helpful discussion of the Sistine bull, which is published in *Magnum Bullarium Romanum* (Turin, 1863) Vol. VIII pp. 646-650, see Germana Ernst, *Astrology, religion and politics in Counter-Reformation Rome*, in Stephen Pumfrey, Paolo Rossi and Maurice Slawinski (eds.), *Science, Culture and Popular belief in Renaissance Europe*. Manchester and New York: Manchester University Press; 1991: 249-273.

increasingly present in iconographical traditions of sixteenth-century Italy[4] and was soon to play a key role in Jesuit theatrical productions[5]. "For," Sixtus asked rhetorically, "if angels take care of men, what can the stars, in no way comparable to angels, attempt or carry out when [the angels'] providence and protection is against them?"[6] The other fork of Sixtus's argument, which drew heavily on Augustine's attack on diviners in *De Doctrina Christiana*, concerned the limits of human knowledge. Man, the proud animal, should not aspire to know higher things, but should be fearful and lie prostrate upon the ground to revere the immense majesty of his creator, who has reserved for himself alone the knowledge of what will come and the recognition of future matters.[7] Sixtus's castigations of the vertical aspirations of humankind occurred at a moment when he was concerned, following the Council of Trent, to enforce centralised authority for the Church in Rome. His devotion to this task was revealed by, among other things, the energy which he devoted to transforming the structure of the Roman congregations and, perhaps more notoriously, to "correcting" the Vulgate. The fatalism encouraged by the *Genethliaci*, or casters of horoscopes, posed a significant threat to the centralised model of civic order propounded by Sixtus V. Since about 1530, public prophecy had been effectively driven underground in Italy[8], and the types of practices condemned by Sixtus, including the use by *mulierculae* of mirrors and candles to predict

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[4]See Émile Mâle, *L'Art réligieux après le concile de Trente*, Paris: Librairie Armand Colin, 1932 pp. 304-309.

[5]See e.g. the role of Cenodoxophylax in Jacob Bidermann's tremendously succesful 1602 "comico-tragoedia", *Cenodoxus* (edited and translated by D.G. Dyer, Edinburgh: Edinburgh University Press; 1975).

[6]"Quod si Angeli homines custodiunt, quid adversus Angelorum custodiam, & tutelam astra moliri, aut efficere poterunt, quae cum ipsis Angelis nullo modo sunt comparanda?"*Magnum Bullarium Romanum* (Turin, 1863) Vol. VIII pp. 646-650

[7]"Tamen, ut superbum animal homo non altum saperet, sed timeret, & immensam conditoris sui maiestatem, humi stratus veneraretur, sibi soli eorum, quae euentura sunt, scientiam, & futurarum rerum cognitionem reseruauit. " *Magnum Bullarium Romanum* (Turin, 1863) Vol. VIII pp. 646-650. On the history of the Pauline imperative *Noli altum sapere, sed time* [Romans 11:20] see Carlo Ginzburg, *The High and the Low: The theme of forbidden knowledge in the sixteenth and seventeenth centuries* in Ginzburg, *Clues, Myths, and the Historical Method*, Baltimore and London: The Johns Hopkins University Press; 1989 pp. 60-76

[8]See Ottavia Niccoli, *Prophecy and People in Renaissance Italy*, translated by Lydia G. Cochrane, Princeton, NJ: Princeton University Press; 1990 pp. 189-196.

the future[9], reflect this shift of divinatory practices to the private realm. In Spain, Pereira's country of origin, the 1580s saw a dramatic rise in politically subversive prophecy, centering on the weakness of Philip II and the supposedly imminent invasion of Spain. In 1589 the renowned Jesuit scholar Pedro de Ribadeneira (Rivadeneyra) wrote condemning the "mujercillas", the "crowd of deceived, evil women whom we have recently seen in many of Spain's most illustrious cities; those who with their trances, revelations and stigmata have excited and deceived their priests and confessors"[10]. Such credence was lent to the apocalyptic dreams of one prophetess, Lucrecia de León, that the Royal Architect, Juan de Herrera, became involved in the construction of a cave-shelter to serve as a refuge from a horde of dreamed invaders[11].

In condemning the activities of *genethliaci*, both as nefarious and ineffectual, due to the ignorance of the future even on the part of demons, Sixtus V made an explicit distinction between the illicit investigation of the natural world, as practised by judicial astrologers driven by impious curiosity, and permissible natural investigation. The latter consisted of "judgements and natural observations that are useful in navigation, agriculture, and medicine"[12]. According to Sixtus, and crucially for later discussions of the status of

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[9]"Alij quoque praestigiatores, frequentius vero mulierculae quaedam superstitionibus deditae in phyalis, seu vasculis vitreis aqua plenis, vel in speculo accensus candelis, etiam benedictus sub nomine Angeli Sancti & albi, Diabolum omnium malorum fatorem supplices adorantes, vel in unguibus, aut palma mendacij Diabolo alijs incantationibus, aut varijs superstitiosis observationibus, futurorum, & occultorum huiusmodi veritatem quaerunt, & homines praedicere contendunt"*Magnum Bullarium Romanum* (Turin, 1863) Vol. VIII pp. 646-650

[10]Pedro de Ribadeneira, *Tratado de la Tribulación*, in Ribadeneira, *Obras*, Madrid: Biblioteca de autores españoles, vol. 60; 1868: 439, translated in Richard L. Kagan, *Lucrecia's dreams: Politics and prophecy in sixteenth century Spain*, Berkeley, Los Angeles, Oxford: University of California Press; 1990, p. 115.

[11]Kagan, *Lucrecia's dreams:* pp. 123-4. Elsewhere in his treatise, Pereira is adamant in his refusal to allow the future to be predicted from dreams: "Et vero, scire velle futura, quae DEUS in sua solius potestate posuit, arrogans et impia est curiositas. Putare autem certa futurorum signa contineri in somnijs, quae nullam cum rebus futuris connexionem & conuenientiam habent, fatuum est: parum dixi, plane impium, & stultum est: hoc enim arguit eiusmodi somniorum observatores, stultis, impiis, & absurdis opinionibus esse infectos, atque depravatos". Pereira, *De Magia*, (ed. cit.), Liber II, Qu. VII, pp. 143-4

[12]"Permissis tamen iudicijs, & naturalibus observationibus, quae navigationis, agriculturae, sive medicae artis iuvandae gratia conscripta fuissent", *Magnum Bullarium Romanum*, loc. cit.

mathematics, the practices of *mathematici* were legitimate only insofar as they were construed as ancillary to other arts of clear benefit to society.

Just as the Sistine bull against astrologers was being promulgated, a dispute between Jesuits and Dominicans was breaking out in Spain which was also closely concerned with the foreknowledge of future events. The debate, which originated from a set of theological theses defended by a Jesuit at the University of Salamanca, reached its zenith in 1588, when the Jesuit Luis de Molina published his *Liberi arbitrii cum gratiae donis...Concordia*. This work consituted a new attempt to reconcile divine foreknowledge of future events with the freedom of the will, by attributing to God a type of "middle knowledge" or *scientia media*, which amounted to certain knowledge on God's part of events that were not in themselves necessary, as they depended on human will.

A number of Dominican theologians, led by Domingo Bañez, attacked Molina's book, arguing that the theory of divine foreknowledge of future contingents that it contained was heretical[13]. The Jesuits were accused of semi-Pelagianism, for placing too much emphasis on the role of good works in salvation, and for reducing the role of divine grace in free actions to that of a partial cause. Although the debate, which raged until it Paul V's 1607 decree forbidding either side of the debate to call the views of the other side heretical or temerarious, became widely associated with Molina's work, the conceptions of grace, free will, and divine foreknowledge[14] on which it centred had deep roots in

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[13]Useful summaries of the the *de auxiliis* controversy, so called from the *Congregatio de auxiliis* appointed by Clement VIII to deal with the dispute concerning the operation of divine grace, can be found in Rivka Feldhay, *Galileo and the Church: Political Inquisition or Critical Dialogue?* Cambridge: Cambridge University Press; 1995 pp. 171-198, J. Brodrick, *Robert Bellarmine, Saint and Scholar*. London: Burns & Oates; 1961. Chapter 7 and in the introduction to Alfred J. Freddoso's translation of the fourth part of the Concordia (Luis de Molina, *On Divine Foreknowledge (Part IV of the Concordia)*, Translated, with an Introduction and Notes, by Alfred J. Freddoso. Ithaca and London: Cornell University Press; 1988). For more detailed treatments, see especially G. Sérry, *La Storia de auxiliis*. transl. R. Norimene, Brescia, 1771, G. Schneemann, *Controversiarum de divinae gratiae liberique arbitrii concordia initia et progressus*, Freiburg, 1881 and, particularly for the subsequent history of the controversy, Stegmuller, Friedrich,*Geschichte des Molinismus*, Münster i. W. : Aschendorff, 1935.

[14]Molina introduced the notion of *scientia media*, or "middle knowledge" to describe God's foreknowledge of contingent human acts.

Jesuit culture. In Ignatius's "Rules for thinking in the Church" he referred (rule 17) explicitly to the problem of free will, stating that "We ought not to speak of or to insist on the doctrine of grace so strongly as to give rise to that pernicious teaching that takes away free will. Therefore, we may treat of faith and grace, as far as we may with the help of God for the greater glory of his Divine Majesty; but not in such a way, especially in these dangerous times of ours, that works or free will receive any detriment or come to be accounted for nothing."[15] Unlike the Jesuits, the Dominican theologians who accused Molina of heresy identified God's knowledge with his will, and regarded divine grace as the primary cause of human actions. By doing so they reduced the autonomy of the created world from its creator, and dissolved the boundary between heaven and earth, stressing the role of God's grace as an efficient cause in the natural world. On the other hand, the rejection of the cloister that characterised the Jesuit apostolate required a reworking of the relationship between nature and grace, if missionary activities were to play a role in salvation.[16]

Molinism had widespread consequences for Jesuit culture beyond the domain of theology. Just as late sixteenth-century Jesuit authors of sacred tragedy attempted to excise pagan references to fate[17], the approaches to natural phenomena adopted by the natural philosophers and mathematicians of the order also had to steer a *via media* between the predestinarianism of the Calvinists and the voluntarism of Molina's Dominican opponents. As the Sistine bull suggests, a crucial theatre for any discussion

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[15]Ignatius Loyola, *Para el sentido verdadero que en la Iglesia militante debemos tener, se guarden las reglas siguientes*, "La décimaséptima, asimismo non debemos hablar tan largo instando tanto en la gracia, que se engendre veneno para quitar la libertad. De manera que de la fe y gracia se puede hablar cuanto sea posible mediante el auxilio divino para mayor alabanza de la su Divina Maiestad; mas non por talsuerte, ni por tales modos, mayormente en nuestros tiempos tan periculosos, que las obras y líbero arbitrio reciban detrimento alguno, ó por níhilo se tengan". These "Rules" were appended to later editions of the *Spiritual Excercises*. See J. Brodrick, *Robert Bellarmine, Saint and Scholar*. London: Burns & Oates; 1961, p.191.

[16]Discussions of the relationship between the active nature of the Jesuit apostolate and the scientific production of members of the order can be found in Stephen J. Harris,*Apostolic Spirituality and the Jesuit scientific tradition*. Science in Context. 1989; 3(1): 29-65 and Rivka Feldhay, *Knowledge and Salvation in Jesuit Culture*. Science in Context. 1987; 1(2): 195-213.

[17]See e.g. Louise George Clubb, *Giambattista della Porta dramatist*. Princeton, New Jersey: Princeton University Press; 1965, pp. 78-79.

about foreknowledge, either human or divine, was in the context of the debate on judicial astrology.

Benito Pereira's treatise on astrological divination allows us to observe the extent to which Jesuit theological currents permeate discussions of the natural world, and delineate the boundaries of debates that, at least on the surface, might appear to have little theological relevance. In arguing against the ability of *mathematici*, to acquire knowledge of the future without God's grace, one of Pereira's key tactics is to point out the inaccuracy of their celestial observations:

> The intelligence of heavenly things must needs be of a far greater difficulty and labour, Heaven being so far removed and distant from us, and onely discoverable by the sole sense of the eye, which ofttimes is deceived, and brought into errour through the longinquity of Intervals, or the violent and swift whirling about of the Heavens, the depraved and indisposed affection of the medium, or of the sight; the fault and imperfection of the Astrolabe, Tables, or other Astronomical instruments [...] This sufficiently confutes Astrologers, who pretend to discover all humane events, of which most have their dependency upon the most inscrutible will and councel of the most High and Mighty God.[18]

Such an argument, although crucial to Pereira's purposes, clearly threatened astronomers as much as it did astrologers. The senses on which the astronomer relied, and the instruments with which he investigated the heavens were inherently incapable of mediating accurate celestial knowledge. Reflecting a common trope in Jesuit iconographic programmes, the light of reason, for Pereira, is more capable than the light of sense of revealing natural causes[19]. God's power to bring about similar effects by

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[18]Benito Pereira, *The astrologer anatomiz'd or, the vanity of Star-Gazing art discovered by Benedictus Pererius And rendered into English by Percy Enderby, Gent*. London: Ralph Wood; 1661, p. 26, translating Pereira, *De Magia*, (ed. cit.) Liber III, Cap. II, p. 171: "...cognitio verò rerum caelestium maximi laboris & difficultatis est, cum tam longè distet à nobis coelum, nec alio quàm unico oculorum sensu mortalibus pateat: quem tamen saepe falli contingit propter tantam intervalli longinquitatem, vel summam vertiginis coeli velocitatem, vel pravam affectionem medij aut visus, vel propter vitium astrolabij, tabularum & instrumentorum astronomicorum [...] / / Extremum autem huius sententiae, omninò redarguit Astrologos, qui humana omnia eventa quorum multa ex secretissimo DEI consilio & voluntate pendent, divinare se posse profitentur."

[19]See William B. Ashworth, (Jr), *Light of Reason, Light of Nature - Catholic and Protestant Metaphors of Scientific Knowledge*, Science in Context, 1989; 3(1): pp. 89- 109.

different means, including those contrary to the common course of nature, also rendered attempts at astrological prediction futile:

> [T]he supreme Deity not unfrequently useth to effect things in a way, different from the common course and ordinary providence; and by this means the Devil is very many times deceived and mistaken: And pray then, what rational soul will believe Astrologers infallibly to speak truth, when we see the Devil himself cannot do it? what do I thus trouble myself with this infernal fiend, when the most learned Divines and School-men affirm, that the Beatified Spirits and Celestial Intelligences, who clearly and face to face behold the Divine Essence, know the nature of the Stars and Heaven, and all other Natural causes, yet cannot prophesie of things to come, which have their dependency upon mans free-will, unless it shall please the Heavenly Majesty to give unto them a particular revelation thereof, if it be not ridiculous to give more power to Star-gazing Astrologers then Beatified Spirits and Celestial Intelligences, I know not what we shall call madness.[20]

Pereira's influential Aristotelian physics textbook extended his attack to the cognitive potential of mathematics in general, denying that mathematics had the status of a *scientia* at all, as it did not demonstrate its conclusions through causes.[21] Despite this general attack on mathematics, it is, I think, clear that his main target remains the astrologer, but he is not afraid to throw out the mathematical baby with the divinatory bath water. He places particular emphasis on the differences between the sub-lunar and supra-lunar regions, and between the physicist's approach to the heavens and that of the astrologer, recruiting the Thomist conception of epicycles as convenient devices that, when assumed, allow the appearances to follow.[22] And as for the mechanical arts:

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[20]*The astrologer anatomiz'd or, the vanity of Star-Gazing art discovered by Benedictus Pererius. And rendered into English by Percy Enderby, Gent.* London: Printed by Ralph Wood, and are to be sold by Mr. Wright, at the Kings Head in the Old Bailey; 1661, p. 26.

[21]Benito Pereira, *De Communibus omnium rerum naturalium principiis & Affectionibus, Libri quindecim. Qui plurimum conferunt, ad eos octo libros Aristotelis, qui de Physico auditu inscribuntur, intelligendos*. Parisiis: Apud Micaëlem Sonnium; 1579. Liber Primus, Cap. XII (p. 40): "Mea opinio est, Mathematicas disciplinas non esse propriè scientias: in quam opinionem adducor tum aliis, tum hoc uno maxime argumento. Scire est rem per caussam cognoscere propter quam res est; & scientia est demonstrationis effectus: demonstratio autem (loquor de perfectissimo demonstrationis genere) constare debet ex his quae sunt per se & propria eius quod demonstratur; quae verò sunt per accidens, & communia, excluduntur a perfectis demonstrationibus sed Mathematicus neque considerat essentiam quantitatis, neque affectiones eius tractat prout manent ex tali essentia, neque declarat eas per proprias caussas, propter quas insunt quantitati, neque conficit demonstrationes suas ex praedicatis propriis, & per se; sed ex communibus, & per accidens, ergo doctrina Mathematica non est proprie scientia..."

[22] Pereira, *De Communibus omnium rerum naturalium principijs & affectionibus,* Romae: Impensis Venturiini Tramezini, Apud Franciscum Zanettum, & Bartholomaeum Tosium socios; 1576, Liber Secundus, Cap. III, pp. 47-8, citing *Summa Theologia*, pars prima, q. 32, ar. 1, "Ad secundum dicendum quod ad aliquam rem dupliciter inducitur ratio. Uno modo ad probandum sufficienter aliquam radicem; sicut in scientia naturali inducitur ratio sufficiens ad

> Noone, however, will place the mechanical arts as parts of philosophy. For who would call a brass-worker or carpenter a philosopher? On the contrary, these are like the handmaids and servant-girls of the State[23]

In denying true knowledge (*scientia*) of nature to the astrologer and emasculating the *mechanicus*, Pereira was adopting a contrary position to that adopted by Clavius. In his 1574 *Prolegomena* to his translation of and commentary on Euclid's *Elements*, Clavius had exclaimed that "we perceive, finally, with the eyes of our mind, that the whole world, that immense work of God and Nature, is subject [*subjectum*] to Geometry with great use and benefit"[24]. Such a view of the universal applicability of mathematics, which drew heavily on Francesco Barozzi's interpretation of Proclus[25], posed a direct threat to the relationship between creation and creator espoused by Sixtus V and Pereira. Barozzi himself, a correspondent of Clavius, transgressed the boundaries conspicuously, and was one of the first casualties of the Sistine bull. On 16 October 1587 Barozzi was condemned by the Holy Office for apostasy and suspected heresy. He was charged with consulting two sisters who were both sorcerers (*maghe*) and witches (*strighe*) in order to find out secret things and future events (*le cose future e segrete*). According to his sentence, one of the sisters had the Holy Sacrament, consecrated according to the Greek rite, sewn into one of her shoes to make her

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probandum quod motus caeli semper sit uniformis velocitatis. Alio modo inducitur ratio non quae sufficienter probet radicem; sed quae radici jam positae ostendat congruere consequentes effectus; sicut in astrologia ponitur ratio excentricorum et epicyclorum, ex hoc quod hac positione facta possunt salvari apparentia sensibilia circa motus caelestes; non tamen ratio haec est sufficienter probans, quia etiam forte alia positione facta salvari possent". On this passage in Pereira, see also James M. Lattis, *Between Copernicus and Galileo: Christoph Clavius and the collapse of Ptolemaic cosmology*. Chicago and London: University of Chicago Press; 1994. p. 109.

[23] "Artes autem mechanicas, nemo, qui bene sentiat, posuerit partes philosophiae; quis enim fabrum aerarium, aut lignorum appellet philosophum? sed sunt quasi famulae & administrae facultatis politicae..." Pereira, *De Communibus omnium rerum naturalium principijs & affectionibus,* Romae: Impensis Venturiini Tramezini, Apud Franciscum Zanettum, & Bartholomaeum Tosium socios; 1576, Liber primus Cap. XVIII, p. 35

[24]"Hoc denique ingens Dei, & Naturae opus, mundum, inquam, totum, mentis nostrae oculis, munere ac beneficio Geometriae subiectum conspicimus", Christophorus Clavius, *Euclidis elementorum libri XV. Accessit XVI de solidorum regularium comparatione*. Romae: V. Accoltum; 1574. *Prolegomena*

[25]*Proclu Diadochi Lycii in primum Euclidis elementorum librum commentariorum ad universam mathematicam disciplinam principium eruditionis tradentium libri IIII a F.B....cunctis mendis expurgati: scholiis et figuris, que in greco codice omnes desiderabantur aucti: primum iam Romane lingue venustate donati...*, Patavii 1560

invisible. Given the seriousness of his crime, and the suspicion that he had initiated his children and others into his Pythagorean and Hermetic magical practices, partly based on the spurious fourth book of Cornelius Agrippa's *De Occulta Philosophia*, his sentence was relatively mild, consisting of fines amounting to only 2.5% of his annual salary and imprisonment at the pleasure of the Inquisition[26]. A subsequent victim of the bull was none other than Galileo, denounced to the Holy Office in 1604 accused "*di haver ragionato che le stelle, i pianeti et gl'influssi celesti necessitino, et di vivere hereticalmente*". Galileo was alleged to have cast horoscopes to supplement his income as a university mathematics lecturer in Padua, illustrating the diffusion of such practices amongst the mathematically literate in Italy, though the charges against him were subsequently dropped.[27] Unlike Barozzi and Galileo, who illustrate the ambiguity of the figure of the *mathematicus* in late sixteenth-century Italy, Clavius never seems to have come under suspicion of practising judicial astrology. He made it explicit in his 1570 *Sphaera* that judicial, or practical astrology was not his concern.[28] Giuseppe Biancani, Clavius's disciple emphasized the distinction between the pious and impious *mathematicus* when he wrote of the opponents of mathematical practices that

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[26]Barozzi's sentence is published in B. Compagni, *Intorno alla vita ed ai lavori di Francesco Barozzi*, Bolletino di bibliografia e di storia delle scienze matematiche e fisiche, XVII, 1884: 795-848, on pp. 837-847. On Barozzi's life see Paul Lawrence Rose, *A venetian patron and mathematician of the sixteenth century: Francesco Barozzi (1537-1604).* Studi Veneziani. 1977; N.S. I: pp. 119-178 and DBI *s.v.*

[27]See Antonio Poppi, *Cremonini e Galilei inquisiti a Padova nel 1604: Nuovi documenti d'archivio*. Padova: Editrice Antenore; 1992, pp. 35-64.

[28]"PRACTICA vero Astronomia, quam alii Iudicariam, seu Prognosticam, is est, Divinatricem dicunt, omnia ista ad usum vitae humanae accommodat; Contemplatur enim complexiones, et naturas tum signorum, constellationumque, tum etiam Planetarum, reliquarumque stellarum, explicatque quaenam signa sint calida, quae frigida, quae temperata, quae masculina, quae foeminina, et id genus alia. Rursus ex motibus orbium, et stellarum futuros eventus in hisce inferioribus praedicit. Verum quoniam huic Astronomiae parti multi multa temerarie, ac perperam ausi sunt adiicere, adeoque hanc partem prognosticam amplificare voluerunt, ut sit iam res omnino supersitiosa, exosaque, et merito ab Ecclesia suspecta habeatur, mirumque in modum a B. Augustino damnata in libris de Doctrina christiana; propterea nihil omnino de ea nobis dicendum existimo."Christoph Clavius, *In Sphaeram Ioannis de Sacro Bosco Commentarius*. Romae: Apud Victorium Helianum; 1570, p. 7. Despite this disclaimer it is interesting to note that Clavius seems to have included some astrological material in the first manuscript version (1564) of his commentary on the *Sphere* of Sacrobosco (BAV Urb. Lat. 1303-4), cited in Ugo Baldini, *La formazione scientifica di Giovanni Battista Riccioli* in *Copernico e la questione copernicana in Italia*, a cura di Luigi Pepe, Florence: Olschki; 1996: 123-182, on p. 142, note 47.

> [T]hey add either as a joke, or from sheer ignorance [...] that mathematicians were often proscribed and condemned by both secular and sacred law, and that they were expelled more than once from the Empire by the edicts of Roman Emperors. In fact, we should never respond to this, for nobody can be so much lacking in erudition, as not to know that these pseudomathematicians were those called more aptly astrologers [*Genethliaci*] or fortune-tellers [*Chaldaei*] or soothsayers [*Iudiciarii*]. whose teaching nobody can prove to me by any means, as it relies neither on experience, nor on reasons, but it is sheer deception and fraud, and often just supersitition. [...] But those act cantankerously who try to shift the blame from these rascals to all mathematicians.[29]

Unlike fraudulent astrologers, Clavius and Biancani argued that the good Jesuit *mathematicus* was more capable of providing true and certain knowledge than his philosophical counterpart, constantly involved in wrangles. Even amongst the peripatetics, as Clavius had argued in 1574, there were bitter disputes on which form of Aristotelianism truly represented the thought of the master, whereas there were no rival Euclidian sects to be found amongst mathematicians.[30] Against the attacks of Pereira and others who wished to disarm the instruments of mathematical pracitioners, Clavius proudly presented the astrolabe as the most accurate and manipulable representation of the heavens available to the mobile *fin-de-siècle* astronomer:

> Of all the instruments used to display those things that follow from the motion of the *primum mobile* from East to West, or pertain to that motion in any way, I have never seen any that was more excellent than that which Claudius Ptolemy calls the planisphere, commonly called the Astrolabe. In this instrument, by geometrical methods, all of the celestial circles of the *primum mobile* are truly projected into the plane in such a way that their single points and arcs are arranged no less accurately and exquisitely than in any perfectly round globe depicting the *primum mobile*. [...] It is a plane instrument, most convenient for travelling, as it can obviously be transferred from place to place without effort and stored easily. Consider also that even in the most diligently constructed globe, it is not possible to include all of the necessary circles and all of the distinct points [...] These difficulties do not occur in the plane, as in any plane surface, even on paper, three or four circles can easly be described which are going to be of the greatest use to us, omitting others which are not required at the present: Then, to avoid confusion, after this piece of paper has been disposed of another piece can be taken on which other circles can be drawn for other uses.[31]

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[29]Giuseppe Biancani, *De mathematicarum natura dissertatio una cum clarorum mathematicorum chronologia*, Bologna, 1615, transl. by Gyula Klima in Paolo Mancosu, *Philosophy of Mathematics and Mathematical Practice in the Seventeenth Century*, New York, Oxford: Oxford University Press; 1996, pp. 178-212, on p. 203.

[30]Clavius, *Prolegomena*, 1574, cit.

[31]"Inter omnia instrumenta, quibus ea, quae primi mobilis motum ab ortu in occasum consequuntur, vel ad eum aliquo modo pertinent, explicari, atque investigari solent, ab Astronomis magna solertia excogitata, nullum mihi unquam visum est praestantius eo, quod Claudius Ptolemaeus Planisphaerium inscripsit: vulgo Astrolabium dixere. in quo nimirum omnes circuli caelestes primi mobilis rationibus Geometricis ita in planum proijciuntur, ut singula eorum puncta, & arcus dimetiri non minus accurate, & exquisite liceat, quam in globo aliquo perfecte rotundo, qui primum mobile referat [...] Est enim instrumentum planum, iter facientibus commodissimum, quippe quod & sine labore ex uno in alium locum transferri, &

Possevino too included a list mathematical instruments in his *Bibliotheca Selecta*, published in the same year as Clavius's work on the astrolabe[32], further confirming the position of mathematical instruments in the *studium* of the pious scholar, an inclusion ludically represented in the *intarsia* representations of *trompe-l'oeil* astrolabes and armillary spheres in the ducal palace of Urbino, home of Clavius's dedicatee Duke Francesco Maria II della Rovere[33].

Most of all, Clavius presented the mathematician as exceptionally believable. The stories he likes to tell to his readers about the tremendous accomplishments achieved by mathematics are more often than not tales of the extraodinary credibility of mathematical practitioners. To quote one such story, borrowed by Clavius from Barozzi's translation of Proclus:

> When Hieron, King of the Syracusans was to build a ship that he intended to send to Ptolemy, King of the Egyptians, it was so heavy that even all of the Syracusans working together were unable to move it from its place: Archimedes, most skilled in geometry, promised the king that he would ensure by the powers of geometry alone that the king himself could move the ship by only the powers of geometry. When he carried this out, in the view of everyone the King is said to have exclaimed, with astonishment: From this day on, whatever Archimedes says, he is to be believed.[34]

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facile illae sum custodiri queat. Adde, fieri non posse, ut in globo vel diligentissime elaborato, omnes necessarij circuli, omniaque puncta distincte ponantur [...] Quae difficultas in plano locum non habet, cum in quauis plana superficie, etiam in charta per exigua, tres quatuorque circuli facile describantur, qui nobis maxime sunt usui tunc futuri, omissis aliis, quibus in praesent non indigemus: Deinde, ut omnis confusio vitetur, reiecta hac charta, alia assumi potest, in qua alii circuli alium in usum efformentur", Christoph Clavius, *Astrolabium.* Romae: Ex Typographia Gabiana; 1593, sig. a recto.

[32]Possevino, *Bibliotheca Selecta*, cit., Lib. XV, Cap. IX.

[33]Clavius, *Astrolabium*, cit., dedicatory letter to Francesco Maria II, Duke of Urbino (sig. *2 recto - sig. [*4] recto).

[34]Christoph Clavius, *Euclidis Elementorum Libri XV*, 1574, (sig. **[):(6]** *verso*): "Quale est illud, quod de Archimede Syracusio testantur historiae. Cum enim Hieron Syracusarum Rex navem, quam Ptolemaeo Aegyptiorum Regi mittere statuerat, tantae esset molis fabricatus, ut eam omnes una Syracusij a loco dimovere minime valerent: Archimedes Geometra peritissimus, unius Geometriae viribus fretus Regi promisit, se effecturum, ut ipsam solus Rex absque ullo labore subduceret. Quod cum praestitisset, in conspectu omnium Rex stupefactus excalamasse perhibetur; Ab hac die, quidquid dixerit Archimedes, illi credendum est". See Francesco Barozzi, *Proclu Diadochi Lycii in primum Euclidis elementorum librum commentariorum ad universam mathematicam disciplinam principium eruditionis tradentium libri IIII a F.B....cunctis mendis expurgati: scholiis et figuris, que in greco codice omnes desiderabantur aucti: primum iam Romane lingue venustate donati...*, Patavii 1560, p. 37, *Procli Diadochi in primum Euclidis Elementorum librum commentarii,* rec. G. Friedlein, Leipzig, 1873 [facs. reprint Hildesheim: Georg Olms Verlagsbuchhandlung; 1967], p. 63

Another anecdote, reported in Clavius's *Sphaera*, carries the same moral, while investing it with more contemporary relevance to a sixteenth century readership:

> We should not overlook that which happened not many years ago, when the leader of the army of the King of Spain snatched away the whole army of Christians from imminent death with the help of this divine discipline on the island of Jamaica. When the entire Spanish army was in the most extreme danger of death, and the leader could not find any way to procure food from the Jamaicans (for the Barbarians hoped to vanquish the Christian army easily without weapons in this way) he ordered that it should be announced to the leaders of the Jamaicans that unless they provided all necessary sustenance to himself and his army, they would suffer many terrible evils. They would see the moon to be darkened not long afterwards to bear witness to this fact. As he was excellently versed in astronomy, he knew that the moon was about to be eclipsed. At first the Barbarians made light of the commands and threats of the Christian general. But, when they perceived the moon to be eclipsed at the time at which he had stated, and did not understand the cause of this matter, they gave complete faith to the words he had uttered before, provided the Christians with abundant provisions and rushed to fall at the feet of the same General and the rest of the army, so that they forgot themselves and were left in a terrible state of need.[35]

Mathematical expertise, whether displayed to a King or to foolish natives, invested the expert with extraordinary credibility.

Ridicule and public mathematics

The dispute over the status of mathematical knowledge between Clavius and Pereira coincided with Clavius's efforts to secure the position of mathematics in the Jesuit educational system. Despite Balthasar Torres's efforts to give mathematics a respectable place in the curriculum of the *Collegio Romano*, including a suggestion that mathematics

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[35]Christoph Clavius, *In Sphaeram Ioannis de Sacro Bosco Commentarius*, Romae: Apud Victorium Helianum, 1570, pp. 11-12: "Neque vero praetereundum est, quod non ita multos ante annos Ductor quidam exercitus regis Hispaniarum apud Iamaicam insulam totum exercitum Christianorum ab imminente morte huius divinae disciplinae auxilio eripuit. Cum enim universus Hispaniorum exercitus in ultimo iam vitae periculo esset constitutus, neque Dux a Iamaicensibus alimenta ullo posset modo impetrare, (Hac enim ratione sperabant Barbari exercitum Christianorum facile sine armis posse expugnari) rectoribus Iamaicensium nunciari iubet, ni sibi, suisque omnibus necessaria ad victum subministrent, plurima illis ac suprema mala imminere: In cuius rei testimonium non multo post Lunam eos obscuratam esse visuros, quam quidem ipse in Astronomia eximie versatus iam iam defecturam cognoscebat. Contempserunt quidem primo Barbari iussa Ducis Christiani, ac minas: At cum ad constitutum ab ipso tempus Lunam deficere sensim conspicerent, neque huius rei causam intelligerent, illius tam verbis primum fidem praebentes et commeatum Christianis affatim subministrarunt, et ad ipsius Ducis, caeterorumque militum pedes provoluti, uti sibi ignoscerent, obnixe efflagitarunt"

should be taught alongside philosophy for the entire length of the philosophy course[36], the mathematical disciplines were still held in a certain amount of disrepute within the Collegio Romano on Clavius's arrival. During the Roman Provincial Congregation of 1576 the protest was made, possibly by Clavius himself, that "one should beware that philosophy professors do not publicly ridicule [the mathematical disciplines] in front of their pupils."[37] The *Modus quo disciplinae mathematicae in scholis Societatis possent promoveri* which Clavius prepared for Aquaviva in 1582 attacked the low esteem in which mathematics was held by earlier Jesuits, and warned philosophers that errors in philosophy can easily result from ignorance of mathematics, which could prove damaging to the literary reputation of the Society[38]. In this document Clavius furthered the claims made in the *Prolegomena* to his *In Euclidis Elementa*, arguing that mathematics was a science, and a part of philosophy, as well as being useful for the understanding of other parts of philosophy, especially physics:

> For it is agreed amongst the experts that physics cannot be rightly understood without [mathematics]; especially as regards the part dealing with the number and motions of the heavens; of the multitude of intelligences, of the effects of the stars, which depend on the various conjunctions, oppositions and remaining distances between each other, on the division of continuous quantity *in infinitum*, on the flux and reflux of the tides, on winds, comets, rainbows, vapours, and other meteorological matters, on the proportion of motions, qualities, actions, passions and reactions, etc.; of which the *calculatores* have written at length. I omit the infinite examples in Aristotle, Plato and their more famous interpreters, which can in no way be understood without a reasonable knowledge of the mathematical sciences. Indeed, because of their ignorance, some professors of philosophy commit, most frequently, many most terrible errors, and, what is worse, even publish them in their works, some of which it would not be difficult to point out. For this reason, it would be necessary for the professors of philosophy to be at least moderately well versed in mathematics, so that they do not, in similar difficulties, bring damage and dishonour to the great reputation which the Society has in literary matters.[39]

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[36]See MP II, pp. 15, 434, CC I.1, p. 61, BAV Barb. Lat. 304.

[37] "Simul est cavendum ne philosophiae professores eas [i.e. *mathematicas disciplinas*] publice coram auditoribus flocci faciant."MP IV p.254, cit. in CC I p.74

[38] See Clavius, *Modus quo disciplinar mathematicae in scholis Societatis possent promoveri*, MP VII, pp. 115-117, on p. 116: " Pari ratione oportet praeceptores philosophiae callere disciplinas mathematicas, saltem mediocriter, ne in similes scopulos magna famae, quam Societas in litteris habet, iactura et dedecore incurrerent". The unpublished 2nd version of the Ratio Studiorum had similarly stressed the relationship between mathematical competence and the dignity of the Church (see MP V p. 177).

[39]Clavius, *Modus* , cit., on p. 116: "Cum tamen apud peritos constet, physicam sine illis recte percipi non posse; praesertim quod ad illam partem attinet, ubi agitur de numero et motu orbium caelestium, de multitudine intelligentiarum, de effectibus astrorum, qui pendent ex variis coniunctionibus, oppositionibus et reliquis distantiis inter sese, de divisione quantitatis continuae in infinitum, de fluxu et refluxu maris, de ventis, de cometis, iride, halone et aliis rebus meteorologicis, de proportione motuum, qualitatum, actionum, passionum et reactionum etc.; de quibus multa scribunt calculatores. Omitto infinita exempla in Aristotele, Platone et

Clavius emphasised the necessity of electing a master of "uncommon erudition and authority"[40] to attract pupils to the mathematical disciplines. To achieve authority, mathematics must be enshrined in the ceremonial culture of the college:

> So that the master may have more authority with the pupils, and the mathematical disciplines themselves may be valued more highly, and the disciples understand their utility and necessity, the master should be invited to the solemn ceremonies at which doctorates are awarded and public disputations are held, even to the extent that, if necessary, he may sometimes propose arguments and assist the disputants. In this way it may be easily achieved that the pupils [...] can persuade themselves that philosophy and the mathematical sciences are conjoined, as they truly are.[41]

Until now, Clavius continued, students have held the mathematical disciplines in contempt and even regarded them as "useless, seeing that the person who teaches them is never convened to the public ceremonies with the other professors"[42]. To correct the situation, Clavius proposed to give a new, public function to mathematics:

> [T]he students will be greatly incited to these studies if each month all of the philosophers gather in a single place, where one of the pupils would give a brief commendation of the mathematical disciplines and would then explain some astronomical or geometrical problem, which would both be fun for the audience and useful for the humanities. Many problems of this kind might be found. Otherwise he might propose some mathematical part of Aristotle or Plato, of which these authors have no small number; or else he could give some new demonstrations of some proposition of Euclid that he had thought of himself. Then those who best solve the proposed problem, or who commit fewest paralogisms (which are not a rare occurence) in inventing new demonstrations, could be praised . In this way it would come about that they would be inflamed to these studies, as they would see

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eorum interpretibus illustrioribus, quae nulla ratione intelligi possunt sine mediocri scientiarum mathematicarum cognitione. Immo, propter earum ignorationem nonnulli philosophiae professores saepissime multos errores, eosque gravissimos, commiserunt, et (quod peius est) scriptis etiam mandarunt; quorum aliquos in medium proferre non esset difficile. Pari ratione oporteret praeceptores philosophiae callere disciplinas mathematicas, saltem mediocriter, ne in similes scopulos magna famae, quam Societas in litteris habet, iactura et dedecore incurrerent".

[40]"Primum, deligendus erit magister eruditione atque auctoritate non vulgari", *Modus*, ed. cit., p.115.

[41]"Ut autem maiorem apud discipulos auctoritatem habeat magister, et disciplinae ipsae mathematicae maiori in pretio sint, ac discipuli earum utilitatem necessitatemque intelligant, invitandus erit magister ad actus solemniores, quibus doctores creantur et disputationes publicae instituuntur; ita ut, si fuerit idoneus, proponat etiam interdum argumenta et argumentantes iuvet. Nam, hac ratione facile fiet, ut discipuli, videntes professorem artium mathematicarum cum reliquis praeceptoribus eiusmodi actibus interesse et interdum etiam disputare, persuadeant sibi coniunctas esse, ut vere sunt, philosophiam scientiasque mathematicas", *Modus*, ed. cit., p. 115.

[42]"[H]actenus discipuli contempsisse videntur fere has scientias hac una adducti ratione, quod putent eas non haberi in pretio; immo, inutiles esse, quandoquidem, qui eas docet, nunquam convocatur ad actus publicos cum caeteris professoribus", ibidem.

> that they might reach this glory; and at the same time they would understand the excellence of these [studies] and would make greater progress in them by this exercise.[43]

Clavius's agenda to raise the status of mathematical practitioners thus relied crucially on an exploitation of the public spaces afforded by the Jesuit college, both in requiring the presence of mathematics professors at thesis defenses and in suggesting regular mathematical performances in the college.

Contests of authority: The Jesuit moon

In the hypothetical meeting between Ignatius Loyola and Lucifer staged by John Donne in *Ignatius his Conclave*, the demon attributes motives of celestial dominion to the deceased, but as yet uncanonized, founder of the Jesuit order:

> [LUCIFER] And since [Galileo] effected so much with his first *Glasses,* that he saw the Moone, in so neere a distance, that hee gave himselfe satisfaction of all, and the least parts in her, when now being growne to more perfection in his Art, he shall have made new Glasses, and they received a hallowing from the *Pope*, he may draw the Moone, like a boate floating upon the water, as neere the earth as he will. And thither (because they ever claime that those imployments of discovery belong to them) shall all the Jesuites bee transferred, and easily unite and reconcile the Lunatique Church to the Romane church; without doubt, after the Jesuites have been there a little while there will soone grow naturally a Hell in that world also: over which you Ignatius shall have dominion, and establish your kingdom and dwelling there. And with the same ease as you passe from the earth to the Moone, you may passe from the Moone to the other starrs, which are also thought to be worlds, & so you may beget and propagate many Hells, & enlarge your Empire, & come nearer unto that high seate, which I left at first.[44]

Only a year after the publication of Galileo's *Sidereus Nuncius*, Donne considered the complex lunar space made amenable to discussion by Galileo's telescopic observations

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[43]"Praeterea, ad haec studia maxime incitabuntur scholastici, si singulis mensibus omnes philosophi in unum aliquem locum convenirent, ubi unus discipulorum habeat brevem commendationem disciplinarum mathematicarum; deinde, cum uno aut altero explicet problema aliquod geometricum vel astronomicum, quod et iucundum esset auditoribus, et utile rebus humanis; qualia problemata plurima reperiri poterunt; vel declaret locum aliquem mathematicum ex Aristotele vel platone, qualia loca apud ipsos non pauca sunt; vel etiam afferat novas demonstrationes quarumdam propositionum Euclidis a se excogitatas. Ubi laudari possent ii, qui meliu problema propositum solvissent, vel pauciores paralogismos, qui non raro occurrunt, commisissent in novisdemonstrationibus inveniendis. Ita enim fieret, ut non parum inflammarentur ad haec studia, cum viderent sibi propositam esse hanc gloriam; et simul intelligerent eorumdem praestantiam, maioresque in illis hac exercitatine facerent progressus", ibid., p. 117.

[44]John Donne, *Ignatius his conclave (1611),* ed. T.S. Healy, Oxford: Clarendon Press; 1969, p. 81.

as a space of colonization, and, in particular, as the future centre of a Jesuit infernal empire. The polemics surrounding the veracity of the tales relayed by Galileo's sidereal messenger, and the subsequent history of lunar mapping largely confirm Donne's prophetic vision. While Galileo attempted to multiply witnesses of the new celestial phenomena by bringing his body and his telescopes to audiences whose high moral standing made further doubt about the existence of the phenomena described in his book increasingly difficult[45], his inability to close disputes surrounding the nature of the lunar surface demonstrate that words were as important as things in validating novel observations in early seventeenth century Europe.

On 12 March 1610, Mark Welser wrote to Clavius from Augsburg, where he occupied the highest position (*Duumviro*) in the local administration[46]. Describing the rumours that had reached him from Padua about the observation of four new planets and many previously unknown fixed stars, the incredulous statesman asked the elderly Jesuit mathematician for confirmation of the observations, fully conscious that "to be slow to believe is the sinew of wisdom (*tarde credere est nervus sapientiae*)"[47]. Clavius eventually wrote back to Welser on 29 January 1611, confirming that "I too was unsure [*sospeso*] for a long time, not believing in those four Medici planets and thinking that this was a hallucination caused by the telescope [*occhiale*]"[48]. However, after many attempted observations the Roman Jesuits had overcome the difficulties and observed the new planets and the phases of Venus. Clavius believed that in time more "monstrosities" surrounding the planets would be observed, and instructed Welser "not to doubt any further about these observations".[49] Clavius's answer fully satisfied

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[45]See Albert van Helden, *Telescopes and authority from Galileo to Cassini*, in Albert van Helden and Thomas L. Hankins, eds., *Instruments*. Philadelphia: Osiris; 1994 (Second Series, Vol. 9): 7-29.

[46]On Welser, see CC I.2, p. 106, G. Gabrieli, *Contributi alla storia della Accademia dei Lincei*, Roma: Accademia Nazionale dei Lincei, 1989, Vol. II, pp. 989-1009.

[47]Welser to Clavius, Augsburg, 12 March 1610, CC VI.1, pp. 147-8.

[48]Clavius to Welser, Rome, 29 January 1611, OG X, pp. 600-1: "Di quello che V.S. mi scrive alli 7 di Gennaro sono ancora io sato gran tempo sospeso non credendo quelli IV Pianeti Medicei pensando che fosse hallucinat[ion]e per l'occhiale causata"

[49]ibid., "Et cosi credo che si scuopriranno di man in mano altre mostrosità intorno gli Pianeti. Et V.S. non dubiti più di q[est]e osservazioni".

Welser, a key ally of Jesuit cultural and political initiatives in the German lands, and replaced his doubts with admiration for the divine handiwork revealed by the new observations.[50] At no point in this exchange did Welser express any interest in attempting to observe the disputed phenomena for himself - his interest clearly lay in "*asseverationi*" - assertions, rather than in *osservazioni*.

Around the same time, Clavius wrote to Galileo to confirm the existence of the Medicean planets and admit that the new instrument "would be of inestimable use, if only it were not so troublesome to operate".[51] The effect of the letter reveals once again that the words of the Jesuit mathematician had extraordinary powers. Although Galileo had been confined to bed through illness, Clavius's letter of confirmation "removed a great part of my illness, by bringing me the benefit of such a testimony to the truth of my new observations"[52]. However, although the letter had convinced some of the incredulous, "the most obstinate persist, and repute Your Reverence's letter either to be a fake, or to have been written purely through courtesy, and seem to expect me to find a way to bring at least one of the four Medicean planets from heaven to earth to give account of their existence and remove these doubts".[53] Paul Guldin, currently a mathematical academician in the Collegio Romano[54], wrote to Johannes Lanz to comment on the healing effect of Clavius's letters on Galileo:

> And so, by this genuine miracle, shall one shortly adopt the illustrious letters of Fr. Clavius in the place of relics? For they have restored health to the sick, and faith to infidels. He wrote that there are still some who, like the Jews, persist obstinately in their

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[50]Welser to Clavius, Augsburg, 11 February 1611, CC VI.1, p. 169: "Hora resta solo di ammirare l'immensa bontà et grandezza d'Iddio, humiliandoci sotto la potente sua mano, che con questo mezo ci fa conoscere quanto poche siano le cose da noi conoscuite a proporzione delle ignorate, eziando tra quelle che dalla speculat[ion]e dell'humano ingegno sarebbon penetrabili".
[51]Clavius to Galileo, Rome, 17 December 1610, OG X, pp. 484-5: "In vero questo instrumento sarebbe di valore inestimabile, se non fosse cosi fastidioso in adoprarlo".
[52]Galileo to Clavius, Florence, 30 December 1610, OG X, pp. 499-502: "mi hà in gran parte sollevato dal male, portandomi il guadagno di un tanto testimonio alla verità delle mie nuove osservazioni, il quale prodotto ha guadagnato alcuno degl'increduli, ma però i più ostonati persistono, et reputano la lettera di V.Ra ò finta o scrittami à compiacenza et insomma aspettano che io trovi modo di far venire almeno uno dei quattro Pianeti Medicei di cielo in terra a dar conto dell'esser loro, et chiarir questi dubbii".
[53]Ibid.
[54]CC I.1, p. 89 n. 85, citing ARSI Rom. 54, f. 259r

> errors, whom he does not think would be converted even if the new planets themselves were called down from the skies[55]

Guldin's joke, coming from a recent Protestant convert (his baptismal name was "Habakkuk") of Jewish origins[56], illustrates just how far Clavius's authority might be taken. In a candid letter to Welser, Galileo elaborated on how he used the observations of Clavius and the other Jesuits in Rome to disseminate belief in Florence through local Jesuit ministry:

> I showed them several times to some of the same Fathers here in Florence, or rather to all of them here and some who were passing through, and they used them in sermons and orations with very gracious conceits.[57]

Clearly unmoved by the death of one of his opponents, the Pisan philosophy professor Giulio Libri, Galileo remarked drily in the same letter that "never having wanted to see them [i.e. the Medicean stars] on the Earth, perhaps he'll see them on the way to heaven"[58].

While closure occured rapidly for the debate surrounding the Medicean stars, accelerated miraculously by Clavius's words of confirmation, the fate of Galileo's lunar observations was radically different. On 19 April 1611 Cardinal Bellarmine wrote to the mathematicians of the Collegio Romano to ask for confirmation of five of Galileo's discoveries, having himself made observations of the moon and Venus through the telescope. One of his queries was whether "the moon has a rough and unequal

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[55]"[G]enuino itaque miraculo claras P[atriis] Clavii litteras quis mox loco relliquiarum habebit? infirmis enim sanitatem reddiderunt, infidelibus fidem. Scribit quosdam paucos Hebreorum instar obstinate adhuc suis erroribus adhaerere, quod e caelo evocatos ipsemet Planetas novos convertere posse non putat", Guldin to Lanz, Rome, 13 February 1611, Dillingen, Studienbibliothek, ms. 2° 247, 220-222, published in August Ziggelaar,*Jesuit astronomy north of the Alps. Four unpublished Jesuit letters, 1611-1620*, in Ugo Baldini, ed., *Christoph Clavius e l'attività scientifica dei Gesuiti nell'età di Galileo*, Rome: Bulzoni; 1995: pp. 101-132, on pp. 117-121.

[56]See Duhr, *Geschichte der Jesuiten in den Ländern deutscher Zunge*, Freiburg: Herdersche Verlagshandlung; 1907-13, Vol. II. 2, pp. 432-3.

[57]"Io gli ho fatti piu volte vedere ad alcuni de' medesimi Padri qui in Firenze, anzi pur a tutti questi che ci sono, et ad altri che ci sono passati, e questi se ne sono serviti in prediche et in orationi con concetti molto graziosi", Galileo to Welser, [Florence], 17 December 1610, quoted in Welser to Clavius, Augsburg, 7 January, 1611, OG XI, p. 14.

[58]"A Pisa è morto il filosofo Libri, acerrimo impugnatore di queste mie ciancie, il quale non le havendo mai voluto veder in terra, le vedrà forse nel passar al cielo", ibid..

surface"[59]. On April 24, four Jesuit mathematicians (Grienberger, Clavius, Odo van Maelcote and Giovanni Paolo Lembo) responded to Bellarmine, fully confirming Galileo's observations on all points except the moon, for which they wrote "One cannot deny the great unevenness of the moon, but it appears to Father Clavius to be more probable that it is not the surface of the moon that is uneven, but rather that the body of the moon is not uniformly dense and that it has some parts that are more dense and others that are more rarified, as is the case with the ordinary stains that one sees with natural sight (*la vista naturale*). Others think that the surface is truly uneven, but until now we are not sufficiently certain on this matter to be able to confirm it without doubt".[60]

Bellarmine forwarded the letter to Galileo, but a copy also fell into the hands of his Aristotelian opponent the Florentine philosopher Ludovico delle Colombe. Delle Colombe wrote to Clavius to express his agreement, and elaborated the hypothesis to suggest that the perfect sphericity of the moon could be sustained if it were supposed that it was encased in transparent crystal.[61]

Cardinal la Joyeuse saw Delle Colombe's letter and had his secretary, Gallanzone Gallanzoni, send it to Galileo for his comments. This provoked a lengthy vitriolic attack of Aristotelian "ad hoc" hypotheses from Galileo, who wrote to the cardinal's secretary that

> The image [*immaginazione*] is pretty; its only fault is that it is neither demonstrated nor demonstrable. Who does not see that this is a purely arbitrary fiction that brings nothing into being and proposes nothing more than simple non-repugnance?[62]

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[59]Bellarmine to the mathematicians of the Collegio Romano, [Roma], 19 April 1611, OG XI, pp. 87-88.

[60] "Alla 4a non si può negare la grande inequalità della Luna; ma pare al P. Clavio più probabile che non sia la superficie inequale, ma più presto che il corpo lunare non sia denso uniformamente, et che habbia parti più dense, et più rare, come sono le macchie ordinarie, che si vedono con la vista naturale. Altri pensano essere veramente inequale la superficie: ma infin hora noi non habbiamo intorno a questo tanta certezza, che lo possiamo affermare indubitamente", Clavius, Grienberger, Maelcote and Lembo to Bellarmine, Rome, 24 April 1611, OG XI, pp. 92-3.

[61]Ludovico delle Colombe to Christoph Clavius, Florence, 27 May 1611, in OG XI pp. 92-3

[62]Galileo to Gallanzone Gallanzoni, Florence, 16 July 1611, OG XI, 141-155, on p. 142

In this very long letter Galileo goes on to say, sarcastically, that one might as well assume that the earth is a perfect sphere, if one understands by "earth" not only "that opaque body where the sun's rays terminate, but also that part of the transparent atmosphere that fills up all of the valleys, and with a height equal to the highest ridges of the mountains surrounds the earth spherically"[63].

Delle Colombe's deployment of Jesuit authority also came in for lengthy criticism from Galileo:

> I don't see such why [Delle Colombe] should be so delighted that the most Reverend Fr. Clavius does not regard the moon as mountainous, as the same father assigns a very different cause to the apparent inequality to Colombe, attributing it to density and rarity. And if it pleases Sig. Colombe that Fr. Clavius disagrees with me, it must displease him to the same degree that the other three Fathers incline to favour my opinion, despite his reluctance to mention any such disgust on his part. And Sig. Colombe does not know how easy it would have been for me to have persuaded Fr. Clavius and convinced him of my opinion while I was in Rome, if his great age and continual indisposition had permitted us to treat these matters and carry out the necessary observations. But it would have been little less than sacrilege to exhaust and pester such an old man, so venerable for his age, doctrine and goodness, with discourses and observations. As he has gained immortal fame through so many illustrious exertions, it will have little effect on his glory for him to have been mistaken on this single matter, and remained with a false opinion that could easily have been refuted.[64]

The absence of a small amount of ink from Clavius necessitated the expenditure of a great deal of ink and ingenuity from Galileo, and even this lengthy rebuttal of Delle Colombe did not succeed in securing Galileo's control of the lunar surface.

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[63]Ibid.

[64]"[I]o non veggo sì grande occasione di rallegrarsi che il molto R. P. Clavio non approvi la montuosità della [luna], poi che il medesimo Padre è altresì molto differente da esso Col. nell'assegnare la causa della apparente inegualità, attribuendola al denso et al raro. Et se il S. Col. ha caro che il P. Clavio dissenta da me, è forza che egli habbia altrettanto discaro che gl'altri tre Padri inclinino a favor della mia opinione, benchè egli di tal suo disgusto non faccia menzione. Et non sa il S. Col. che facil cosa mi saria stata, mentre fui in Roma, il persuadere et ridurre nella mia sentenza il Padre Clavio, se la gravissima età et la sua continua indisposizione havessero tollerato che noi insieme fussimo di queste materie stati in trattamento et fatte le necessarie osservazioni: ma saria stato poco meno che sacrilegio l'affaticare et molestare con discorsi et osservazioni un vecchio, per età, per dottrina et per bontà così venerando, il quale havendosi con tante et sì illustri fatiche guadagnata una fama immortale, poco importa alla sua gloria che egli in questo solo particolare trapassi e resti con opinione falsa et assai facile a convincersi", ibid., on p. 151.

Although much historical attention has been focussed on the images of the moon published in *Sidereus Nuncius*, the analogy between the terrestrial and lunar surface on which Galileo's argument for the reality of lunar mountains was built was chiefly a literary effort[65]. His much-quoted description of the gradual illumination of lunar mountains and valleys as the terminator shadow creeps along the lunar surface, a prime example of the rhetorical trope of *enargaeia* [66], was precisely what was contested by those who questioned the analogy between earth and moon, suggesting that the relationship between lunar mountains and their earthly counterparts might be otherwise, even a distorted mirroring[67]. The ceremonial legitimation that widely greeted Galileo's account of the Medicean stars was not granted to his description of the moon. Even the *Nuncius Sidereus Collegii Romani* oration, recited at the reception held for Galileo in the Collegio Romano in 1611, avoided making a definite pronouncement on the subject:

> If one of you thinks to be able to provide a cause of this aspect in the varied density and rarity of the lunar body, I will not put forward my judgement: it is enough for me, as a messenger, to narrate that which I have seen and received from the heavens concerning the spots [*maculae*] on the moon[68]

The renowned Jesuit orator, Famiano Strada, also composed an oration about the lunar surface which was probably delivered in Rome shortly after the appearance of *Sidereus*

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[65]This is a point that is also made by Winkler and Van Helden. See M. G Winkler and A. Van Helden, *Johannes Hevelius and the Visual Language of Astronomy*, in J. V. Field and F. A. L. James, eds., *Renaissance and Revolution: Humanists, Scholars, Craftsmen and Natural Philosophers in Early Modern Europe,* Cambridge: Cambridge University Press, 1993.

[66]See Carlo Ginzburg, *Montrer et citer: La vérité de l'histoire,* Le debat, 1989; 56: 43-54

[67]See e.g. Grienberger to Galileo, Rome, 22 January 1611, OG XI, pp. 31-35, "Unde cum, narrando, eo Nuncius tuus devolutus fuisset, ubi de illo lumine agitur quod in noviluniis et prope novilunia luna e terris recipit, cogitare coepi, scabrositatis illius quae in luna apparet veram causam esse, non quod re vera partes aliae aliis in luna sint eminentiores vel demissiores, sed quod luna, veluti speculum sphaericum convexum, terrae nobis inaequalitatem repraesentet. Neque enim video, cur, si lumen e terris repercussum ad lunam pervenire possit, non etiam species rerum terrestrium, quarum lumen illud est instar vehiculi, ad eandem lunam perveniant, et si perveniunt, cur a nobis videri non possint: et quod de lumine solis repercusso tu ipse asseris, cur idem de lumine lunae in pleniluniis non asseratur, non video; ita ut, deficiente solis lumine in pleniluniis et prope plenilunia, ipsum lumen lunae, demissum in terras, e terris iterum ad lunam redeat, et vanam terrae faciem, secum deferens, speculo lunari appingat".

[68]"Quod si quis vestrum huius aspectus causam densitatem raritatemque variam corporis lunaris, vel quid simile, afferi posse putet, ego iudicium meum non interpono: mihi enim, utpote Nuncio, quae vidi et e Caelo accepi de Lunae maculis, narrasse sufficiat: vos de rerum consequentiis iudicate", [Odo van Maelcote], *Nuntius Sydereus Collegij Romani* (1611), in OG III pp. 292-298, on p. 295

Nuncius. Rather than accept the existence of lunar mountains, Strada followed Clavius and advocated a gem-like moon of variable density. "Those who are of a contrary opinion", Strada admonished his audience, "may either suffer themselves to be corrected or accept that we, along with antiquity, do not err who measure ancient and solid truth with new and glassy eyes"[69]. Galileo's interpretation fared no better in verse. Lorenzo Salvi's *Stanze Sopra le Stelle*, prefaced by a dedication written by one of Clavius's academicians, Vincenzo Figliucci, left the moon question open, while advancing the Clavian explanation, in Tuscan dialect, as the most probable. After describing the various current opinions concerning the lunar phenomena, Selvi concludes that

> Ma più stimar si dee conforme al vero
> Ciò che sempre creduto hanno i più dotti.
> Ch'in cotal corpo impuro, e non sincero
> Sian veramente i rai del Sole indotti,
> Onde poi non rimandi il lume intiero,
> Ma siano i suoi splendor difformi, e rotti.
> E come il denso fà splendor più chiaro,
> Cosi oscuro lo fa quel ch'è più raro. [70]

(One should rather judge as conforming to the truth that which the most learned people have always believed: That the rays of the sun are truly absorbed in such an impure and insincere body, and the full light is not returned from there, but its splendours are distorted and broken up. And as the dense [part] brightens its splendours, so the rare [part] darkens them)

The lunar disc remained a space of conflict between Galileo and the Jesuits in a *Problema* presented in Mantua in 1611. The *Problema*, recently established to be the work of Mario Bettini[71], concerned the height of lunar mountains and was recited on three separate occasions. It was recited publicly in the Church of the Holy Trinity, on

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[69]"Quod si ita sit patiantur qui contra sentiunt, aut se corrigi malle aut nos cum antiquitate non errare, quam veritatem priscam ac solidam novis ac vitreis oculis metiri", APUG 1092 ff 57r-59v, on f. 58r

[70]Lorenzo Salvi, *Stanze sopra le stelle, e Macchie Solari, Scoperte col nuovo Occhiale, con una breve dichiaratione Dedicate all'Illustriss. & Reverendiss. Sig. Card. Aldobrandino, Camarlengo di Santa Chiesa da Flaminio Figliucci.* Roma: Mascardi; 1615, Stanza XLII, p. 19. Ugo Baldini and Antonio Favaro both suggest that Flaminio Figliucci may be identifiable with Vincenzo Figliucci. See CC I. 2, p. 41, OG XII, pp. 209-10, XX, p. 441. The dedication identifies Salvi as the author of the poems.

[71]Denise Aricò, *"In doctrinis glorificate Dominum". Alcuni aspetti della ricezione di Clavio nella produzione scientifica di Mario Bettini* in Ugo Baldini, ed., *Christoph Clavius e l'attività scientifica dei Gesuiti nell'età di Galileo*, cit., pp. 189-208, on pp. 191-198; idem., *Scienza, teatro e spiritualità barocca. Il gesuita Mario Bettini*. Bologna: CLUEB; 1996, pp. 211-17.

the occasion of the Provincial Congregation organised by the Jesuits in an attempt to recover a foothold in the Venetian Republic, a meeting eventually broken up violently by suspicious locals[72]. It was also recited in the *Aula* of the Jesuit college in Mantua, in the presence of the Duke of Mantua, and, finally, *in cubiculo*, before Cardinal Ferdinando Gonzaga[73]. Mimicking Galileo's gift of the satellites of Jupiter to the Medici dynasty, Bettini proferred "not the golden mountains of Persia, but the silver mountains of the moon"[74] to the Gonzaga family, and offered the Gonzaga eagle the silver lunar orb as a resting place where it could reside "like a queen"[75]. Far from denying the existence of the lunar mountains described by Galileo, Bettini proclaimed "I affirm, thus that mountains are found in the globe of the moon that are far higher than those that have ever been seen by any mortal on earth"[76]. The mountains, Bettini continues, are "*vera[e] ac nullo modo ficta[e]*"[77]. The method used to calculate the height of the mountains, by measuring the maximum distance of illuminated peaks from the terminator shadow, and doing a little trigonometry, is exactly the same as that used by Galileo, as are the estimated values for the lunar diameter, the maximum distance of peaks from the terminator, and the calculated height of lunar mountains of more than four *milliae italicae*. Despite this similarity the moon was to be removed from Galileo's Medici patrons and offered to the Duke of Mantua. "But we pray to God, maker and moderator of all kingdoms, for you, most serene prince", Bettini claimed, suggesting a

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[72]Antonio Favaro, *Intorno al problema di Mantova sull'altezza dei monti lunar,* in *Atti e Memorie della R. Accademia di scienze, lettere ed arti in Padova*, CCXCIII (1891-2), Padova, 1893, pp. 41-3.

[73][Mario Bettini],*De lunarium montium altitudine Problema mathematicum ter habitum Manuae, in templo Sanctissimae Trinitatis, in nostra aula coram serenissimo duce et in cubiculo coram illustrissimo Cardinali Gonzaga*, OG III, pp. 301-7.

[74]"Montes vobis, non aureos quidem illos Persarum, ut est in proverbio, sed argenteos in Luna pollicemur", ibid., p. 302

[75]"Nos igitur non immerito, cum alii Mediceis Pilis, felici consanguinitatis foedere cum Gonzaga Aquila coniunctis, novos planetas dedicarint, nos etiam novam hanc Lunam excepimus, quam eidem Aquilae consecraremus; ut nec nova Pilis Astra, nec novus Aquilae orbis argenteus, desit, cui reginae instar insideat", ibid., loc. cit..

[76]Even in some recent studies, Galileo's displeasure at the *Problema Mantovano* is sometimes explained by the supposed denial of existence of lunar mountains in the *Problema*. See e.g. Giovanni Baffetti, *Retorica e Scienza: Cultura gesuitica e seicento italiano*, Bologna: CLUEB, 1997, p. 132, n. 138, which describes the *Problema* as "uno scritto [...] nel quale veniva ribadita contro le osservazioni galileiane, l'opinione tradizionale dell'assenza di montuosità sulla Luna, e della sua perfetta levigatezza".

[77]Bettini, *De lunarium montium altitudine Problema* , cit., p. 303.

political analogy with the Turkish conflict, "that he might oppose your eagle with its wings expanded in authority like a mighty fortress to the Ottoman [crescent] moon, and fill the whole of its orb"[78]. Bettini's justification for this abduction is neither disagreement with Galileo's calculation nor with his result, but the claim that "under Galileo's demonstration hides a twisted serpent of falsehood"[79]. Amongst early seventeenth century mathematicians, the vocabulary of the twisted serpent is generally an allusion to a paralogism - a syllogism which is fallacious because a part of the conclusion is already implicitly contained in the premises. Rather than claiming to have measured the lunar diameter to be approximately 2000 *milliariae Italicae*, in Bettini's *Problema*, this value is assumed.[80] Why? Because if one claimed to measure the observed diameter, prior to the calculation, one would also be including any protruberances present on the edge of the lunar disc. Thus one would effectively be attempting to calculate the length by which the lunar mountains protruded above a surface which included them already. Grienberger wrote to Giuseppe Biancani, whom he took to be the author of the problem to complain that, as far as he and Galileo could see, this was mere pedantry, and a slight difference in the adopted value of the lunar diameter would make little difference to the calculation.

> He is sorry, and I too am sincerely sorry, not so much for what was said, but for the fact that it was said in such an eminent gathering of Princes[81]

Grienberger continued to elaborate on proper mathematical etiquette:

> I beseech your Reverence to examine what I have said with good spirit and, if possible, to treat His Lordship Galileo as it is proper to treat a mathematician. I know that not

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[78]"Tibi vero, serenissime Princeps, a regnorum omnium auctore ac moderatore Deo precamur, ut Aquilam tuam, expansis alis imperii, tanquam fortissimum propugnaculum Othomanicae Lunae opponat, totum ne compleat orbem", ibid., p. 307.
[79]"[S]tatim enim corollarii loco efficiemus, ut appareat, sub Galilei demonstratione tortuosum fallaciae anguem latitare", ibid., p. 305.
[80]"Assumimus etiam lunaris sphaerae diametrum bis mille italicis milliaribus protendi, ex certiori doctissimorum astronomorum ratione et sententia", ibid., loc. cit..
[81]"Dolet, et ego ipsi sincere condoleo, aliqua non tam esse dicta, quam esse dicta in tam praeclaro Principum Virorum consessu", Grienberger to Biancani, Rome, 4 June 1611, APUG 534, f. 87r, published in Baldini, *Legem impone subactis*, cit., pp. 227-8.

> everything that he says is *de fide*, but I see, on the other hand, that he has not said anything until now that is so absurd that it could not be excused rather than reprehended in public.[82]

The powerful space for the public legitimation of novelty provided by the *Problemata*, largely pioneered by Grienberger himself, as discussed in the following chapter, was open to potentially dangerous misuse.

The natural epilogue to the contest between Galileo and the Jesuits for control over the lunar surface is the system of lunar nomenclature proposed in Giambattista Riccioli's 1651 *Almagestum Novum*, and eventually adopted generally by astronomers with only small amendments and various additions until the present day. Riccioli embedded the names of no less than twenty-two Jesuit mathematicians in the lunar disc, including Biancani, Bettini, Clavius and Grienberger. Unlike most of the names previously proposed for the lunar craters and other features by van Langren and Hevelius, Riccioli's names stuck fast to the moon's surface[83]. By 1651, the question of the reality of lunar mountains and craters had largely passed out of learned discussion. Van Langren's attempt to use the craters as calibrations on a celestial sundial, with a monthly periodicity, in an unsuccesful effort to solve the problem of longitude buried the question of the reality of the craters, in a nice example of what Ian Hacking has called instrumental realism[84]. Shortly before Riccioli and Grimaldi's lunar maps were published, Athanasius Kircher, in his 1646 *Ars Magna Lucis et Umbrae*, argued that the magical projection of textual characters onto the lunar surface lay beyond the powers of even the most capable human optician, despite the mendacious claims to the contrary made by Della Porta and Cornelius Agrippa von Nettesheim[85]. Even if the moon was a

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[82] "Ra. Va. quaeso haec bono animo dicta [bene] consulat et si fieri possit Dominum Galilaeum, ut decet Mathematicum tractet. Scio non omnia quae dicit esse de fide: sed video etiam ex altera parte, non assere [sic, for asserere] adeo absurda ut non potius excusari debeat quam publice reprehendi", ibid.

[83] On lunar nomenclature in the seventeenth century, see especially Scott L. Montgomery, *The Scientific Voice*, New York and London: Guilford Press; 1996, pp. 196-293. See also Zdenek Kopal, *Mapping of the moon. Past and Present.* Dordrecht: Reidel; 1974.

[84] Ian Hacking, *Representing and Intervening: Introductory Topics in the Philosophy of Natural Science*, Cambridge: Cambridge University Press; 1983.

[85] Athanasius Kircher, *Ars Magna lucis et umbrae*, Romae: Ludovico Grignani; 1646, Liber X, pp. 908-909, *Cryptologia Nova*, Caput I. *Utrum in Lunari disco aliquid legendum exhiberi*

mirror, as some had maintained, Kircher argued, it was a convex mirror, and anyone with the most basic knowledge of catoptrics knew that a reflection in a convex mirror was diminished in size, rendering any letters projected from earth vanishingly minuscule[86]. The successful Jesuit "lunar mission" led by Riccioli and Grimaldi in Bologna demonstrated, nonetheless, that the impossibility of physical projection might not prevent the lunar surface from bearing a highly readable text.

The rationale behind Riccioli's lunar nomenclature is described at length in the *Almagestum Novum*:

> I have not, then, derived the nomenclature of the parts of the moon from the geography of our Earth, as Hevelius did, because of the deficiency of the analogy that I have already indicated, but rather from [the names of] people. These are not people of any type, chosen indiscriminately and distributed almost randomly, as can be seen in the full-moon of van Langren, but selected from those who were either astronomers (rather than judicial astrologers [*Astrologi Genethliaci*]), or whose ancient writings or observations were used to derive some piece of astronomical erudition in our *Almagest*. [87]

Riccioli's moon (fig. 5) was a spatial array of astronomical authorities, living and dead, with the sixth, seventh and eighth octants reserved for *recentiores*, placed according to their school and sect, and ludically associated with the different geographical features of the lunar surface. Riccioli was careful to emphasize that this lunar population, with its conspicuous Jesuit delegation, was purely fictitious:

> We declare, however, that we utterly abhor the error of those who have taught either that the moon is inhabited by other men, or that the souls of heroes or even of other mortals trasmigrate into different basins [*receptacula*] of the moon after death, according to their different merits[88]

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possit. Kircher comments thus on Agrippa's account of how Pythagoras used such a technique to send messages to his friends (p. 908): "O impudens mendacium".

[86]ibid., p. 909: "Addo: si Luna speculum foret, id unum e convexorum genere futurum: at quis nescit convexum ex se, & sua natura, tantum abesse, ut maiora reddat obuecta, ut illa potius multo a iusta magnitudine minora reddat, ut in praecedentibus ostensum est? "

[87]"Nomenclaturam porro Lunarium partium non ex telluris nostrae geographia, ut fecit Hevelius, ob defectum analogiae iam indicatum, desumpsi: sed a personis potius, non cuiusuis conditionis, nec promiscue, aut quasi casu distributis, ut cernere est in Langreni plenilunio; sed ex ijs tantum, qui vel Astronomi fuere potius quam Astrologi Genethliaci, vel ex quorum scriptis antiquioribus aut observationibus aliqua eruditio Astronomica in Almagestum nostrum derivata est", G.-B. Riccioli, *Almagestum novum astronomiam veterem novamque complectens,* Bologna: Ex Typographia Haeredis Victorij Benatij; 1651, p. 204.

[88]"Profitemur tamen, nos ab eorum errore prorsus abhorrere, qui finxerunt, aut Lunam ab alijs hominibus incoli, aut heroum vel etiam aliorum mortalium animas post obitum in Lunae diversa receptacula, pro diversus meritis transmigrare", ibid., loc. cit.

The statement was repeated as a slogan on the top of the Grimaldi/Fontana moon-map: "*Nec Homines Lunam incolunt. Nec Animae in Lunam migrant*"[89]. As Donne's satirical remarks suggested, Galileo's earthlike moon was far more inhabitable than the smooth Aristotelian surface that it replaced, leading to a revival in the seventeenth century, amongst both libertines and scholars, of Plutarch's speculations on the existence of lunar citizens[90]. The two worlds were often closely connected. Cyrano de Bergerac's rhapsody *L'autre monde ou les états et les empires de la lune*[91] was composed just after he had taken lessons with Gassendi in Paris while the latter was busy gathering observations of lunar eclipses after directing the almost tangible, three-dimensional engravings of lunar phases carried out by Claude Mellan in 1636. Mellan, by making the moon a realistic globe rather than a flat disk, made it a more plausible site for the inhabited terrestrial paradise discovered there by Cyrano, but simultaneously rendered it less suitable for sign-bearing and textual inscription. Hevelius, to whom Gassendi sent many of his lunar observations, also suggested the presence of living beings on the moon in his *Selenographia*.[92]

Piero Guicciardini wrote from Rome to Curzio Picchena in 1615 that "this is no country in which to come and dispute about the moon or to want to sustain or bring new doctrines in the current century"[93]. Despite Guicciardini's warning, if one did want to find out the acceptable philosophical, astronomical and theological opinions concerning the moon in seventeenth century Europe, the combined efforts of Bettini, Clavius, Grienberger, Grimaldi and Riccioli were designed to ensure that a local Jesuit college

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[89]ibid., facing p. 204.
[90]See Plutarch, *De facie quae in orbe lunae apparet*, 940-944, in Plutarch, *Moralia*, Vol. XII, translated by Harold Cherniss and William C. Helmbold, Cambridge, MA: Harvard University Press; 1957.
[91]Cyrano de Bergerac, *L'Autre Monde; ou Les États et Empires de la lune*, Paris: Éditions Sociales, 1978.
[92]J. Hevelius, *Selenographia sive Lunae Descriptio*, 1647, repr., New York: Johnson Reprint Co., 1967. See Montgomery, op. cit., p. 261.
[93]Guicciardini to Picchena, Rome, 5 December 1615, in OG XII, pp. 206-7, on p. 207: "[Q]uesto non è paese da venire a disputare della luna, né da volere, nel secolo che corre, sostenere né portarci dottrine nuove".

would be the place to which one would address one's queries. The sermons, orations and verses pronounced in Jesuit colleges and churches rehearsed all legitimate poetical and rhetorical connotations of the moon's surface. The iconographic programmes of Jesuit theatrical productions and emblem books exhausted the moon's licit emblematic readings.

Conclusion

The present chapter has aimed to examine the powerful legitimatory resources offered by the distributed network of Jesuit mathematicians pioneered by Clavius in the late sixteenth century. Through Clavius's political efforts, Jesuit colleges became recognised centres of mathematical expertise in seventeenth century Europe. The epistemological agenda of Clavius and his disciples to raise the cognitive status of mathematics, ensuring its status as an Aristotelian science, further increased the authority with which the Jesuit mathematician spoke about novel natural observations and experiments. The central position in this network of credibility was clearly occupied by the *Collegio Romano*. To understand how the institutional dynamics of this space related to the wider network, I would like now to examine the context of mathematical practice in the *Collegio Romano* in some detail, concentrating on the activities of Clavius's less well-known collaborator Christoph Grienberger.

CHAPTER 3

CHRISTOPH GRIENBERGER: MATHEMATICS AND MODESTY IN THE *COLLEGIO ROMANO*

> CENODOXUS: Wakeful and easeless are
> my days and nights, consumed in careful studies
> SELF-LOVE: But time cannot consume what all men's praises render immortal.
> CENODOXUS: Yet how easily such honours can be gained. My life's whole purpose is therefore this: by glorious deeds to ensure that I and all my glory never perish. This die I've cast.
>
> Jakob Bidermann, *Cenodoxus*, I. iii, transl. D. G. Dyer and C. Longrigg, Edinburgh, 1975, p. 47

Modesty

In 1609 Jakob Bidermann's "Comico-Tragedy" *Cenodoxus*, *or the Doctor of Paris* was performed on the stage of the Jesuit college in Munich. The play, first produced seven years earlier in Augsburg, deals with the story of a Parisian scholar who, despite maintaining an ascetic public demeanour, privately prided himself on his unparalleled erudition. In Bidermann's graphic account, based loosely around the legend of St Bruno, the eleventh-century founder of the Carthusian order, Cenodoxus, recast as a Renaissance humanist, is finally condemned to eternal torment for the sin of kenodoxia or vaingloriousness[1]. The Munich production of the play provoked a memorable reaction, described in the preface to the first collected edition of Bidermann's dramatic works[2]. At first the audience laughed at the opening comic scenes, but as the play progressed the mood gradually changed to one of astonishment and horror as the spectators realised the enormity of the sins portrayed and became aware of the power of hell. By the end of the play, the terrified members of the audience were contemplating their own sins in stunned silence. The impact of the play was immediate.

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[1]The Vulgate translates □□□□□□□□ as "*inanis gloriae cupido*" (Gal. 5, 26, Phil. 2,3).
[2]Jakob Bidermann, *Cenodoxus*, in Bidermann, *Ludi theatrales sacri, sive Opera comica posthuma*, Munich: J. W. Schell; 1666, 2 vols. Reprinted (Herausgegeben von Rolf Tarot) Tübingen: Max Niemeyer Verlag; 1967, Band 1, pp. 78-159. On *Cenodoxus*, see also Roland Mayer, *Personata Stoa: Neostoicism and Senecan Tragedy*. Journal of the Warburg and Courtauld Institutes, 1994; 57: 151-174, on p. 166.

Fourteen members of the audience went into retreat to perform the *Spiritual Exercises* of St Ignatius, just as in the play Bruno retreated into the wilderness to found his monastery and lead a life of spiritual contemplation. The actor who played Cenodoxus himself then joined a Jesuit novitiate, and passed the rest of his life in the religious modesty of the Society of Jesus.[3]

It is difficult to find a more poignant example of the way the Jesuit order in general, and the Jesuit spiritual teachings embodied in the *Spiritual Exercises* in particular, were perceived amongst the ruling elites of early modern Europe as constituting a powerful antidote to pride, *superbia*, or vaingloriousness. Ignatius himself, following Gregory the Great and Thomas Aquinas, frequently emphasized the interdependence of modesty and obedience in his writings, arguing that disobedience, the ultimate enemy to the social fabric of the Jesuit order that he had founded, was an inevitable consequence of vaingloriousness.[4] The *Rules of the Society of Jesus*, first published in 1582 as a guide to the different functions and modes of social behaviour of Jesuits, contained a series of *Rules on Modesty* due to Ignatius. These rules, originally composed around 1555,[5] and well entrenched by the 1580s, really amounted to rules of bodily deportment. Members of the Society, in order to display modesty, humility and religious maturity, had to keep their heads pointing straight forward, with their necks inclined slightly downward. Eyes were to be kept down, especially when talking to others, wrinkling of the nose was to be avoided, walking more quickly than necessary was discouraged, and all gestures were to display humility and move the observer to devotion.[6] Speech too was to display

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[3]Bidermann, *Ludi theatrales*, cit., I, sig. [(†) 8] v - sig. (††)1 r.

[4]For pointers to the more important Ignatian sources, see the excellent introduction to Rolf Tarot's critical edition of *Cenodoxus,* cit., particularly pp. XXI-XXIII.

[5]See Dionysius Fernández Zapico (ed.), *Regulae Societatis Iesu (1540-1556).* Monumenta Historica Societatis Iesu. Rome; 1948. pp. 514- 527.

[6]In a critique of court-based accounts of the development of European civility, Dilwyn Knox situates the Jesuit rules of modesty in the context of a medieval monastic tradition of *disciplina*. See Dilwyn Knox, *Disciplina: The Monastic and clerical origins of European Civility* in John Monfasani and Ronald G. Musto, eds. *Renaissance society and culture: Essays in honour of Eugene F. Rice, Jr.* New York: Italica Press; 1991: 107-135, especially on pp. 126-8.

modesty and edification.[7] Biographical writings about eminent Jesuits, taking their lead from Ribadeneyra's widely read biography of Ignatius[8], laid great emphasis on the qualities of modesty, humility and self-abnegation advocated by the Jesuit *Constitutions* and *Rules*.

Deportment and Scientific Practice

Before the development of societies and institutions exclusively devoted to scientific pursuits in Europe from the 1660s onwards, and the subsequent emergence of codified and tacit forms of professional ethics specific to such institutions, natural philosophers and mathematicians attempting to make novel claims about the natural world were obliged to look outside science for models of acceptable conduct in the prosecution and presentation of their work. Rather than being obliged to acquiesce into a single model of personhood, scientific practitioners were free to make their own creative synthesis from a smorgasbord of religious and courtly models, to name just two of the more obvious options. Steven Shapin has emphasised the extent to which Robert Boyle drew on the social mores of the English gentleman in order to provide a social basis for credibility in the reporting of scientific observations. In a similar vein, Mario Biagioli has argued that Galileo fashioned himself as a natural philosopher by successfully deploying the vocabulary of Medicean dynastic emblematics.[9]

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[7]Unpublished versions extended this rule to the written word, see Zapico, cit., p.526 (*Regularum modestiae complementum* (1555): "In loquendo vel scribendo nulla detur significatio arrogantiae", but the published versions of the *Regulae* restricted their attention to the body.

[8]Pedro Ribadeneira, *Vita Beati Patris Ignatii Loyolae*, Antwerp, 1610. In so far as Ignatius's life story and spiritual disciplining after his injury at the battle of Pamplona came to serve as a model for those entering the order, it is perhaps worth mentioning in the context of self-effacement that Ignatius never allowed his portrait to be painted while General of the Society - future portraits had to rely heavily on sketches made at his deathbed and several death masks. See Thomas M. Lucas (ed.), *Saint, Site and Sacred Strategy: Ignatius, Rome and Jesuit Urbanism,* Vatican City: Biblioteca Apostolica Vaticana; 1990, p. 63 and *Fontes Narrativi de S. Ignatio de Loyola et de Societate Iesu* (Monumenta Historica Societatis Iesu), 4 vols., Rome: Institutum Historicum Societatis Iesu; 1943-1965, Vol. III, pp. 240-1.

[9]Steven Shapin, *A Social History of Truth: Civility and Science in Seventeenth-Century England*, Chicago and London: University of Chicago Press; 1994 , especially Chapter 4, and Mario Biagioli, *Galileo Courtier: The practice of science in the culture of absolutism*, Chicago: University of Chicago Press; 1993. Through a peculiarly reflexive twist, both

Whereas the court environment in which Galileo worked for at least part of his life promoted visibility and authorship -- the attachments of texts, inventions and observations to a proper-name[10] --, the cultural values promoted in the Jesuit order generally emphasised invisibility and self-abnegation, and denied 'authorship' to all but a relative few, sometimes denoted by the term *scriptor* in the catalogues of the Jesuit houses. Individual glory was, in general, to be shirked in favour of the collective glory of the order. In disciplining their adversaries in theological and philosophical disputes, Jesuit authors made frequent use of terms like *jactantia* and *jactatores*, using the inappropriate deportment of opponents to religious or philosophical orthodoxy to discredit their arguments. The playwright Jakob Bidermann himself, after the successes of his theatrical castigations of *superbia,* was brought to Rome to act as General Revisor for Jesuit literary works, where he had the opportunity to police the humility of a large number of learned Jesuit writers in person for almost twenty years[11].

Admittedly many Jesuit mathematicians also worked in a courtly environment. Galileo's opponent in the dispute over sunspots, Christoph Scheiner, is one example[12]. Nonetheless, careers such as Scheiner's manifest the deep tensions between the type of

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Biagioli and Shapin have recently been castigated for intellectual deportment inappropriate to the exalted station of the historian. On Biagioli, see Michael Shank, *Galileo's Day in Court*, Journal for the History of Astronomy, 25 (1994), 236-243, answered in Mario Biagioli, *Playing with the Evidence*, Early Science and Medicine, 1 (1996), 70-105, followed by Shank's lengthy rejoinder, *How shall we practice history? The case of Mario Biagioli's* Galileo Courtier, Early Science and Medicine, 1:1 (1996), 106-150. On Shapin, see Mordechai Feingold, *When Facts Matter*, Isis, 1996, 87: 131-139, Peter Dear's response (Isis, 1996, 87: 505-6), Shapin's response (Isis, 1996, 87: 681-4) and Feingold's rejoinder (Isis, 1996, 87: 684-7).

[10]The work of Roger Chartier, in particular, has provided a renewed critique of the problems related to early modern authorship raised by Foucault's celebrated 1969 essay *Qu'est-ce qu'un auteur?*. See especially Roger Chartier, *Figures of the Author*, in Chartier, *The Order of Books: Readers, Authors, and Libraries in Europe between the Fourteenth and Eighteenth Centuries*, Stanford, CA: Stanford University Press; 1994.

[11]See Jacob Bidermann, *Cenodoxus*, ed. and transl. D.G. Dyer, Edinburgh: Edinburgh University Press, 1975, p. 8.

[12]On Scheiner's troublesome courtly deportment, see Steve Harris, *Les chaires de mathématiques*. in Luce Giard, *Les jésuites à la Renaissance. Système educatif et production du savoir*. Paris: Presses Universitaires de France; 1995: pp. 239-261, and M.J. Gorman, *A Matter of Faith? Christoph Scheiner, Jesuit censorship and the Trial of Galileo.* Perspectives on Science. 1996; 4(3): 283-320.

deportment suitable to a court and the ready-made, modest "personality" provided by the Jesuit prescriptive literature and inculcated through the practice of the *Spiritual Exercises*[13]. Precisely for this reason I would like to look more closely in the present chapter at a Jesuit mathematician who worked almost exclusively within Jesuit-controlled institutions. I believe that the strategies of self-abnegation[14], deployed by the Jesuit mathematician Christoph Grienberger, who availed himself of every opportunity to remove his name from texts written with his pen and optical and astronomical instruments designed by him and built with his own hands, can reveal much about what it was to be both a Jesuit and a skilled mathematical practitioner in the early seventeenth century. At the outset, this appears to be a task of some difficulty, as the 'person' that we would like to understand is a person who manifests himself by disappearing - erasing his tracks in the history of science with remarkable dexterity and even managing to avoid an entry in the *Dictionary of Scientific Biography*. However, through the indiscretions of some of his Jesuit colleagues, through his own epistolary confessions to his senior mathematical colleague, Christoph Clavius, and through the existence of a significant number of anonymous manuscripts that I attribute to Grienberger[15], the the public and private selves of this elusive individual begin to emerge. Where Galileo found a source of legitimation for certain types of mathematical practice in the colourful world of the Medici court in Florence, his exact contemporary Grienberger found his Archimedean point for the upward leverage of the status of mathematics deep within the complex bureaucratic structure of the Jesuit order.

Who was Christoph Grienberger?

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[13]Studies of Ignatian spirituality include David Lonsdale, *Eyes to See, Ears to Hear: An Introduction to Ignatian Spirituality*, London: Darton, Longman & Todd; 1990. For the connections between the development of the Jesuit spiritual programme with the organizational structure of the order see especially John W. O' Malley, *The First Jesuits*, Cambridge MA, Harvard University Press, 1993.

[14]Of course, self-abnegation, or 'self-cancellation', in Greenblatt's terminology, is really just a form of self-fashioning. See Stephen Greenblatt, *Renaissance self-fashioning from More to Shakespeare*, Chicago and London: The University of Chicago Press; 1980.

[15]See Appendix

Bamberga, Bamberger, Banbergiera, Gamberger, Ghambergier, Granberger, Panberger - the list of names used by his contemporaries to refer to Christoph Grienberger goes on and on.[16] Print has a tendency to fix the orthography of proper names, and Grienberger's name was one that, with the exception of a slim book of star-charts and a set of trigonometric tables[17], rarely appeared in print during his life. In approaching the question "Who was Christoph Grienberger?", I do not aim to provide anything like a biography of the sort that Charles Coulston Gillespie might have chosen to include in the DSB[18]. Instead, I would like to look at how people wrote about Grienberger and how Grienberger wrote about himself. I would like to examine Grienberger's own production in terms of texts and instruments, and his moderation of the productions of others, in his work as a revisor of mathematical works written by Jesuits and in his strategies of engagement in epistolary relationships with natural philosophers and mathematicians outside the Jesuit order.[19]

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[16]A cursory examination of the *Edizione Nazionale* of Galileo's *Works* and the Clavius correspondence revealed no less than nineteen current variants. See OG, *s.v.* 'Grienberger' and CC, *passim*.

[17]*Catalogus veteres affixarum Longitudines ac Latitudines conferens cum novis. Imaginum Coelestium Prospectiva duplex. Altera rara Ex Polis mundi, in duobus Hemisphaerijs Aequinoctialibus, per Tabulas Ascensionum Rectarum et Declinationum. Altera nova Ex mundi Centro, in diversis planis globum Caelestem tangentibus, per Tabulas Particulares. Utraque Caelo et accuratioribus Tychonis observationibus quam simillima. Christophori Grienbergeri Oeni Halensis, e Societate Iesu, Calculo ac Delineatione, elaborata*. Romae: Apud Bartholomaeum Zannetum; 1612, and *Euclidis sex primi Elementorum Geometricorum libri, cum parte undecimi, ex majoribus Clavii Comment. in Commodiorem formam contracti, rerumque mathematicarum Christophori Grienbergeri Oenhallensis e Societate Jesu Opusculum primum*. Romae, apud Haeredes Bartholomaei Zanetti, 1629 respectively. A manuscript version of the latter work, is in the Biblioteca Nazionale Centrale in Rome (BNR, Fondo Gesuitico 594 (2723) A manuscript of the second part of the latter work, *Elementa trigonometrica, id est sinus Tangentes Secantes in Partibus Sinus totius 100000. Opusculum Secundum*. Romae, per Haered. Barthol. Zannetti, 1630, containing Muzio Vitelleschi's original letter of approval, is in the Biblioteca Medicea-Laurenziana in Florence (Ms. Ashburnam 1650). For information on later editions of both works see Sommervogel, Vol. III, coll. 1810-1811.

[18]A useful summary biography has already appeared in CC I.2, pp. 55-7. Other information concerning Grienberger may be found in Ugo Baldini, *Astronomia e meccanica: La corrispondenza Grienberger-Burgo sull'idrostatica galileiana*, in Baldini, *Legem*, cit., pp. 183-216 and Baldini, *Dal geocentrismo alfonsino al modello di Brahe. La discussione Grienberger-Biancani*, in Baldini, *Legem*, cit., pp. 217-250.

[19]Apart from the letters published in OG and CC, the codex APUG 534 contains numerous unpublished letters sent to and from Grienberger, a list of which is published in Ugo Baldini, *Legem impone subactis. Studi su filosofia e scienza dei gesuiti in Italia, 1540- 1632*. Rome: Bulzoni; 1992, p. 200. For further details see CC I.2, p. 57.

Christoph Grienberger died on 11 March 1636. Before his death he was in charge of the technical censorship of all mathematical works written by Jesuit authors. Often Grienberger would send detailed calculations and corrections to an author, demanding that they be incorporated before allowing the work to be published. In some cases, as in Gregorius a St. Vincent's attempt to square the circle, Grienberger advised the Jesuit General Muzio Vitelleschi to refuse publication altogether, on the grounds that the errors contained in the proofs would damage the reputation of the Society of Jesus.[20] When Grienberger died, he clearly lost control over the mathematical publications of his fellow Jesuit mathematicians. Perhaps more interestingly, he lost control over his own authorial presence, or rather, absence. A case in point is Mario Bettini's *Apiaria*, an encyclopedic collection of mathematical curiosities[21]. The censorship of the book took place in the mid-1630s, but publication was held up, possibly through a lack of a suitable patron[22]. The book finally appeared in 1645, and unlike other works, which merely incorporated Grienberger's corrections unacknowledged, Bettini takes great pains to highlight the contributions of the late *Revisor*, whom he hails at the outset of his book as having the stature of an "Archimedes of our time", combining "most ingenious practices and wonderful machinery" with "very acute theories"[23]. Later in the work, Bettini confessed that "I have benefited, my Reader, from the mind and industry of the very learned and exceedingly modest man, Grienberger, who, while he would have discovered many marvellous things by himself, preferred to make himself serviceable to

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[20]See Paul P. Bockstaele, *Four Letters from Gregorius a S. Vincentio to Christopher Grienberger.* Janus. 1969; 56: pp. 191-202 and William B. Ashworth Jr, *The Habsburg Circle*. in Bruce T. Moran, ed., *Patronage and Institutions. Science, technology and medicine at the European Court 1500 - 1750*. Rochester, New York: The Boydell Press; 1991: 137 - 167.

[21]Mario Bettini, *Apiaria Universae Philosophiae Mathematicae* Bononiae: Io. Baptistae Ferronij; 1645.

[22]See Stefano Ghisoni to Giannantonio Rocca, Bologna; November 23 1636, "Ed avendolo io sentito molto lamentarsi, che sia in così poca stima la Matematica, dal modo di esagerar questo punto, ho congetturato, che non abbia trovato persona, che faccia la spesa per il suo libro", published in *Lettere d'uomini illustri del secolo XVII a Giannantonio Rocca.* Modena: Società Tipografica; 1785, pp. 62-4.

[23]"Qui nostri aevi alter Archimedes a doctioribus sine controversia est habitus, quippe qui acutissimis theorijs ingeniosissimas praxes, & mirificas machinationes adiungeret." Bettini, *Apiaria Universae Philosophiae Mathematicae* Bononiae: Io. Baptistae Ferronij; 1645, Sig. C2 *recto*.

other people's inventions and other people's praises"[24]. In his *Aerarium*, published three years later, Bettini included a *Scholion Parergicon* eulogising Grienberger, and continuing to compare him to Archimedes, adding that "Grienberger has no greater enemy than his own modesty, by which it has come to pass that his ingenious inventions have been neglected, and he will be consigned to oblivion"[25]. Bettini added, echoing the *Apiaria*, that "It was a remarkable characteristic of [Grienberger] that, following the example of Archimedes, he combined most acute theories with extraordinary practices"[26], and his claims for Grienberger's achievements in designing instruments and machines are closely echoed by other contemporary mathematical authors.[27]

Instruments and Invisibility

> And yet Archimedes possessed such a lofty spirit, so profound a soul, and such a wealth of scientific theory, that although his inventions had won for him a name and fame for superhuman sagacity, he would not consent to leave behind him any treatise on this subject.
>
> Plutarch, *Life of Marcellus*, XVII.3-4

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[24]"Fruerem mi Lector ingenio, & industria doctissimi, ac modestissimi viri Griembergeri, qui cum plura haberet apud se a mirifice inventa, maluit tamen alienis, inventis, & alienis laudibus inservire", Bettini, *Apiaria Universae Philosophiae Mathematicae* Bononiae: Io. Baptistae Ferronij; 1645 Apiarium V, Caput VI, pp. 44-6.

[25]"Sed nihil sibi magis inimicum habuit Griembergerus, quam suam ipsius modestiam, qua factum est ut ingeniosissima sua inventa neglectui, & obliuioni habuerit" Bettini, *Aerarium Philosophiae Mathematicae,*. Bononiae: Io. Baptistae Ferronij; 1648, p. 75. Bettini provides much information on Grienberger's manuscript heritage here that Sommervogel incorrectly ascribes to Gaspar Schott.

[26]"Singulare in eo id fuit, quod Archimedis exemplo acutissimas theorias mirificis praxibus iungebat", Bettini, *Aerarium* , loc. cit.

[27]E.g. Juan Bautista Villalpando, "Is vero in examinandis mechanicis instrumentis tanta est sollertia praeditus [Griembergerus], ut nemini debeat haberi secundus",(J. B. Villalpando, *Apparatus Urbis ac Templie Hierosolymotani*. Rome; 1604, p. 436) and Gaspar Schott, describing an oil-spouting lantern designed by Grienberger, "Sequens Lucerna tametsi vulgaris appareat, suos tamen habet admiratores, quia artificio non caret, & ab ingeniosissimo excogitata constructaque fuit Mathematico. Is fuit P. Christophorus Grünbergerus, Germanus, Clavij in Mathematicis discipulus, & in Romano Collegio quondam illarum scientiarum Professor; qui suis eam manibus (erat enim simul Mechanicus eximius) construxit affabre e ferreis laminis colore obductis, & adhuc asservatur in Kircheriano Museo, & aquâ infusâ exhibet nunc illum effectum, quem oleo repleta exhibere deberet, non sine adventantium admiratione ac voluptate" (G. Schott, *Mechanica hydraulico-pneumatica*. Würzburg: Henricus Pigrin; 1657, p. 290).

In Bettini's *Apiaria*, we see Grienberger's instrumental proficiency forcibly exposed to the public gaze. In composing his corrections to the *Apiaria*, in his role as *Revisor*, Grienberger had noticed that a scenographic instrument described by Bettini could be improved in a way that would make it easier to use and more accurate. The instrument (figs. 2, 3), rather similar to Christoph Scheiner's pantograph (fig. 4)[28], allowed the user to make accurate drawings from life with little effort and less skill. Grienberger wrote to Bettini in 1635 to describe his modifications:

> On experimenting [*tentando*], I discovered that Your Reverence's instrument might be made more easily. I removed the directing rod that moved transversely, until now the part of the instrument that appeared to obstruct its operation. I added *cursores* in my own way, as you will see below, and completed the job by means of four small beams, making a parallelogram. I took care that the line of sight [*radius visualis*] and the line of writing [*radius scriptorius*] would both depart from one of its points, and that both points would exist in a single straight line, namely the axis around which the parallellogram will be rotated continuously.[29]

In addition to providing a lengthy description of the device, arguably at least as different from Bettini's own rude contraption as Scheiner's pantograph, Grienberger sent Bettini two engravings (figs. 2, 3)[30] for inclusion in his book, one showing a schematised form of the instrument accompanied by Grienberger's trademark *cursores*, and the other showing the instrument manipulated by the eyes and hand of an invisible Grienberger (figs. 2, 3). Grienberger's pathological modesty is at work here again. Ever keen to divest himself of any vestige of authorship, he writes to Bettini of the modified scenographic instrument that

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[28]See Christoph Scheiner, *Pantographice seu Ars delineandi res quaslibet per parallelogrammum lineare seu cauum, mechanicum mobile*, Romae; 1631.

[29]"Tentando inueni instrumentum V. R. facilius effici posse. Hastam directoriam, quae movetur in transversum abstuli, atque adeo illam instrumenti partem, quae videbatur operationem remorari. Cursores meo modo, ut inferius videbis, adieci, & quatuor tigillis parallelogrammum constituentibus opus absolui. Curavi ut & radius visualis, & radius scriptorius uterque ex suo puncto egrederentur, & utrumque punctum existeret in una linea recta, nempe in axe, circa quem parallelogrammum perpetuo circunducitur." Bettini, *Apiaria*, cit., Apiarium V, p. 44.

[30]It seems highly plausible that the engravings were made by Grienberger himself, whose published *Catalogus* shows him to have been an extremely accomplished draughtsman, as do the drawings and engravings that accompany several of the *Problemata* discussed later in the present chapter.

> I could have sent this Bettinian Instrument to the Emperor recently, but I did not wish to do this without the permission of Your Reverence. I would rather receive that permission which Your Reverence would bestow if [the instrument] were first published in the *Apiaria*.[31]

Another work in which Grienberger's instrumental manipulations in the *Collegio Romano* lie tantalisingly in the shadows is Christoph Scheiner's 1630 book on sunspots, *Rosa Ursina*.[32] The dichotomy between court and Curia that characterised the work of Scheiner and of many other Jesuit astronomers is eloquently expressed by Daniel Widman's etching of the different techniques for observing sunspots (fig. 7). At the top we see Scheiner in the company of various members of the Orsini household, observing the sun on an ersatz viewing platform, complete with obelisks, on the banks of the Lago di Bracciano, close to the Orsini Castle, which can be seen in the left background. At the bottom we see Scheiner in duplicate, compasses still in hand, making observations from his room in the Jesuit *Domus Professa* in Rome[33]. The instrument used by Scheiner in the lower vignette is the telescope that he claimed to have used to discover sunspots before Galileo observed them in 1611, and suffered from the disadvantage of being difficult to move from a fixed position, thus making protracted observations over any length of time a very awkward business.

To cope with this problem, Grienberger developed a "telescopic heliotrope" or "heliotropic telescope", an instrument (fig. 6) which avoided the difficulties of the other device by being simultaneously mounted on two axes around which it could rotate freely to follow the trajectory of the sun, like the sunflower from which it took its name. Again, Grienberger seems to have been responsible for the engraving of this device

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[31]"Potuissem nuper hoc ipsum Bettinianum instrumentum mittere ad Imperatorem, sed id facere sine licentia Rev. Vestrae nolui. Mallem habere eam licentiam, quam Rev. Vestra daret si quam primum Apiaria in lucem daret", Bettini, *Apiaria*, cit., Apiarium V, Caput VI, pp. 44-6.

[32]Christoph Scheiner, *Rosa ursina, sive, Sol, ex admirando facularum et macularum suarum phaenomeno varius*. Bracciani: Apud Andream Phaeum Typographum Ducalem; 1630.

[33]The relationship between Scheiner and the Orsini household was not so harmonious as this vignette might seem to suggest, as revealed by letters sent by Scheiner to Archduke Leopold of Austria during this time. See Franz Daxecker, *Briefe des Naturwissenschafftlers Christoph Scheiner SJ an Erzherzog Leopold V von österreich Tirol 1620-1632*, Innsbruck: Publikationsstelle der Universität Innsbruck, 1995, pp. 135, 152, 156, 159.

published by Scheiner. Again, Grienberger as machine-operator is invisible, in marked contrast to the multiple representations of Scheiner in the previous figure. Scheiner, ever one to emphasise the collective nature of the scientific enterprise[34], asked Grienberger to provide him with a description of his instrument, but he refused, to Scheiner's surprise:

> And thus this machine is not entangled in as many difficulties as the other one; and additionally [Grienberger's] machine is more convenient, and carried out the work more quickly than that one. For this reason, it will be worthwhile to write a short explanation of its nature, *since the Architect of the Machine himself seemed to be unwilling to furnish this*: despite having later edified many things with his demonstrations, and hastened and urged me to finish the work, [as well as having] helped me most opportunely with similar services that were virtually necessary to me in such a short space of time.[35]

Undoubtedly the polemic between Scheiner and Galileo was part of the reason for Grienberger's attempt to distance himself from the text of Scheiner's work. The rift between Galileo and the Jesuit mathematicians of the *Collegio Romano* that followed Galileo's attacks on Orazio Grassi's public disputation on the comets of 1618 was a source of much distress to Grienberger[36], who could not see any reason for this turnaround.[37] In fact, Galileo's gesture seems to have been the result of a cynical, and

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[34]On Scheiner's "collectivist" approach to natural investigation (apparently cramped somewhat by his unpopularity amongst other Jesuits) see Rivka Feldhay, *Galileo and the Church: Political Inquisition or Critical Dialogue?* Cambridge: Cambridge University Press; 1995, p. 288.

[35]"Itaque Machina haec tot difficultatibus non implicatur, quot illa; & insuper sua expeditius, & in praxi celerius absoluit quam illa. Unde operae precium erit, eius naturam aliquantulum scriptione explicare, siquidem id ipsemet Machinae Architectator visus est praestare noluisse: quamuis postea non pauca suis demonstrationibus egregiè illustrarit, meque festinantem, atque ad finem operis properantem, similibus officijs, mihi in tanta temporis angustia poene necessarijs, peropportune adiuuerit", Christoph Scheiner, *Rosa ursina, sive, Sol, ex admirando facularum et macularum suarum phaenomeno varius*. Bracciani: Apud Andream Phaeum Typographum Ducalem; 1630, p. 348

[36]See C. Grienberger to Ricardo de Burgo, [Rome], [June-July 1619], "Rebus denique Galilaei vellem me non immiscere si possem postquam tam male de Mathematica Collegii Romani est meritus a qua non semel et quidem in praesentia tam bene quam sincere est habitus", published in Baldini, *Legem impone subactis*, cit., pp. 194-5, on p. 195. Surprisingly, before the election of Urban VIII to the Holy See, Federico Cesi made the rather strange suggestion that Galileo's *Il Saggiatore,* a work that was far more critical of the mathematicians of the Collegio Romano, should be dedicated to none other than Grienberger. See Giovanni Ciampoli to Galileo, Rome; 1620 Jul 17 inOG XIII, p. 44 "Il Sig.r Pinc.e Cesi mi ha mandato aperta l'inclusa: vi era una poliza, nella quale adduceva alcune ragione per le quali giudicava bene il dedicar l'opera al P. Bamberger [i.e. Grienberger], e rimette a noi il mandarla, i quali, essendo qua in paese, assolutamente non giudichiamo bene il farlo per non mettere in fastidi quel povero Padre, come certamente sappiamo *ab exemplo* che seguirebbe."

[37]After Galileo's trial, Grienberger is reported to have said that "If Galileo had maintained the affection of the Fathers of this College, he would live gloriously to the world and none of his disgraces would have come about. He would have been able to write freely on any subject,

somewhat shortsighted attempt to cultivate the patronage of Archduke Leopold of Austria, also a patron of Scheiner.[38] Nonetheless, Grienberger's participation in the *Rosa Ursina*, performing observations (not with Scheiner in the *Domus Professa*, but in the *Collegio Romano* only a few hundred yards away) and refining observational instruments is characteristic of the way he chose to present himself in other works. To understand the development of this pattern of effacement of claims to intellectual ownership, I would like to turn to Grienberger's earlier career in the Jesuit order.

Private Lessons

On 15 September 1590, Grienberger, then mathematics teacher and student of theology at the Jesuit College in Vienna, wrote the earliest of his surviving letters to Christoph Clavius in Rome. Although Grienberger, who had spent the ten years since he first entered the Jesuit order in Prague and Olmütz[39], had not yet met Clavius face to face, his letter betrays an unexpected degree of intimacy:

> Why should I not love my teacher? And indeed so much mine that he seems almost to be mine alone. Are you not mine, who are so present to me always, that I began immediately to love you and now for almost the four years for which I have known you have hardly ever placed a foot outside my bedroom? [40]

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even on the motion of the earth etc.". Galileo interpreted this statement as a confirmation of his suspicions that the Jesuits had engineered his downfall, but the material presented here might suggest an alternative interpretation - Grienberger had hoped that together Galileo as 'author' and the Jesuit astronomers as 'expert' corroborators of his observations might produce a reformed cosmology sanctioned by the catholic church. See Galileo to Elio Diodati, Florence; 25 July 1634, in OG XVI, p.117. Grienberger's remarks in his notes for the censorship of Giuseppe Biancani's cosmography (*Sphaera mundi*, Bononiae: Typis Sebastiani Bonomij; 1620) also suggest that Grienberger was in favour of a new cosmography being written by someone outside the order, to replace the outdated commentaries on the Sphere of Sacrobosco: "Laudabile est in primis studium Auctoris, quod potissimum tyronibus in rebus mathematicis prodesse conatur, quibus Cosmographia nova necessaria videtur, eo quod vetus plurimum hoc tempore immutata sit eique non pauca accesserint ornamenta. Sed dubium est expediat necne, *ut id per Nostros fiat*", ARSI FG 655, f. 118r, published in Baldini, *Legem impone subactis*, cit., p. 235 (emphasis added).

[38]See M.J. Gorman, *A Matter of Faith? Christoph Scheiner, Jesuit Censorship and the Trial of Galileo.* Perspectives on Science. 1996; 4(3): 283-320 on p. 312.

[39]See CC I.2, pp. 55-7.

[40] "Quid ni ergo meum amem Praeceptorem? et quidem tam meum, ut mei pene solius esse videatur. An non meus sis, qui tam mihi semper praesens es, ut iam pene quatuor ab annis quibus te nosse unaque statim amare caepi, meo ex cubiculo vix unquam pedem extuleris", Grienberger to Clavius, Vienna, 15 September 1590, in CC II.1, pp. 158-162, on p. 158.

Grienberger is, of course, cohabiting with Clavius's textual body - his commentaries on Euclid's *Elements* and the *Sphere of Sacrobosco* as well as other works[41]. Nonetheless, a short time after this letter was sent, along with the *demonstratiunculae* on spherical trigonometry that Grienberger, like a good pupil, sent to his virtual master[42], Grienberger was summoned to Rome so that the two mathematicians could really live under the same roof[43]. The pattern was to become relatively common - Giuseppe Biancani and Odo van Maelcote were also brought to Rome to assist Clavius (and to be fashioned as mathematicians in his image) after sending unsolicited solutions to celebrated problems or instruments to the famous professor in Rome[44], and many others sent demonstrations hopefully.

In 1595 Clavius went to Naples, leaving Grienberger in charge in Rome. Grienberger wrote to Clavius shortly after his departure:

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[41]Christoph Clavius, *Euclidis Elementorum libri XV. Accessit XVI. de Solidorum Regularium comparatione. Omnes perspicuis demonstrationibus, accuratisque scholiis illustrati*, Rome: Apud Vincentium Accoltum; 1574, Christoph Clavius, *In Sphaeram Ioannis de Sacrobosco Commentarius*, Rome: Apud Victorium Helianum; 1570 (first edn.). See CC I.3 pp. 5-11 for a full bibliography of Clavius's works.

[42]"Nunc quoniam id discipulorum quoque est muneris ut non solum lectionem quisque recitet suam, quod quidem hisce demonstratiunculis, fero licet, facere caepi", Grienberger to Clavius, Wien, 15 September 1590, cit., on p. 158.

[43]Mario Biagioli has recently pointed to the importance of the homosocial bond in the activities of the *Accademia de' Lincei*, but the connection between homosociality and epistolary links, clearly evinced in the Jesuit order well before the creation of the Lincei and stemming from the Ignatian conception of the importance of epistolary relationships to the "union of hearts" in the Society, has yet to receive adequate attention. See M. Biagioli, *Knowledge, Freedom, and Brotherly Love: Homosociality and the Accademia dei Lincei.* Configurations. 1995; 2: 139-166.

[44]Biancani sent Clavius a proposed solution to the problem of measuring longitude at sea. He suggested that a large number of accurate clepsydras could be used to constitute a shipboard clock which, in conjunction with accurate measurements of a particular fixed star, ideally lying close to the equator, could be used to calculate longitudes accurately. The Rector of the Jesuit College of Padua sent an accompanying letter pleading with Clavius to help Biancani, to allow the College to have a mathematics teacher, which it had lacked since Marc' Antonio de Dominis, Biancani's teacher, had become Bishop of Segna. See Biancani to Clavius, Padova, 28 February 1598 in CC IV.1, pp. 34-37. Maelcote sent an astrolabe of his own design, prompting Clavius to suggest his transfer to Rome. See Clavius to Maelcote, Roma, 16 February 1601, in CC IV.1 pp. 124-5 on p. 124 "Si tui Superiores cum P. N. Generali agerent, ut in urbem vocaveris, donec vivo, res mihi esset gratissima".

> Now the Mathematical Museum has put on new clothes, nor does it cry out for anything other than the speedy return of its master. In the meantime it will have me as a custodian. On Monday next I will give my old [room] to two others[45].

The bedroom was a multifunctional space for the Jesuit mathematician. Generally, the rooms of Jesuits were not provided with keys, but, along with the rooms of the Superiors, the Procurator (responsible for the financial affairs of the College), the room of the senior mathematician of the College formed an exception[46]. The added security of a key meant that the mathematics professor could store valuable mathematical instruments in his domestic space, which was often referred to as a mathematical museum, or *musaeum mathematicum*[47]. Later, while in Lisbon, Grienberger would tell Clavius of a valuable clock that he had kept for several months in the privacy of his bedroom[48]. As well as constituting a space for the storage and construction of instruments, the mathematician's bedroom was the focus for the studies carried out by the private mathematical academy of the college[49]. Printed books currently being used by the academy, manuscripts of mathematical works and, perhaps most crucially, the letters sent to successive professors of mathematics in the *Collegio Romano*, were all stored in this space[50]. Whereas the private papers of a Jesuit were generally destroyed after his death unless deemed to be of particular importance[51], the mathematicians of the

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[45]"Iam novam vestem induit musaeum mathematicum nec aliud clamare videtur nisi ut cito redeat patronus. Me interim custodem habebit. Die lunae proximo vetus meum tradam duobus aliis." Grienberger to Clavius (in Naples), Rome, 6 October 1595, in CC III.1, pp. 137-8, on p. 137.

[46]ARSI Rom. 150, I. 36r, cit. in CC III.2, pp. 54-5, note 2.

[47]Such "mathematical museums" were also to be found in other Jesuit colleges, including the college of Prague, where Jakob Johann Wenceslaus Dobrzensky de Nigro Ponte saw a a hydro-magnetic clock-fountain made by Kircher's disciple Valentin Stansel. See J.J.W. Dobrzensky de Nigro Ponte, *Nova, et amaenior de admirando fontium genio (ex abditis naturae claustris, in orbis lucem emanante) philosophia*. Ferrara: Alphonsum, & Io. Baptistam de Marestis; 1657, p. 46.

[48]"Exspecto proximam studiorum interruptionem, ut diligentius perquiram et conscribam fabricam cuiusdam Machinae quam iam ab aliquot mensibus mecum habeo in cubiculo". Grienberger to Clavius (in Rome), Lisbon, 24 March 1601, CC IV.1, pp. 136-9 on p. 137.

[49]On the different levels of mathematical tuition in the *Collegio Romano*, ranging from the private mathematical academy for the training of future teachers to the normal public classes, see CC I.1 59-89.

[50]See CC III.1, p.138.

[51]This practice was formalised in 1636, when Muzio Vitelleschi wrote to Francesco Piccolomini, the Roman Provincial, that the papers of a Jesuit should be examined by the Superiors after his death and only papers of special interest should be preserved. According

college enjoyed the security of a place apart, allowing the correspondence and manuscripts accumulated by successive professors to constitute what Athanasius Kircher and his colleagues were later to use as a private mathematical archive[52].

Humdrum Mathematical Culture

During Clavius's absence in Naples, Grienberger kept him informed with regular bulletins on the vicissitudes of college life. These allude to his own research, the work of the private mathematical academy under his guidance and the normal mathematics classes of the College. Grienberger's letters are punctuated by descriptions of humorous events, such as Fabricio Mordente's pompous display of his beautiful, but imprecise, geometrical compasses to the mathematicians of the college[53] and a rather excessive number of ponderous jokes about Clavius's penchant for Neapolitan pastries[54].

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to Baldini and Napolitani, this was more or less what went on beforehand. See Muzio Vitelleschi to F. Piccolomini, Rome; 9 August 1636, cited in CC I.1, p. 30.

[52] Athanasius Kircher, *Magnes, sive de arte magnetica opus tripartitum*, Romae: Ex Typographia Ludovici Grignani, 1641, Lib. II, Cap. II, p. 431, "[P]artim è literis ab ijs, qui iter in Indias susceperant, vel oretenus ab ijs, qui inde peregrini Romam advenerant; partim ex literarum Mathematicarum è diversis orbis terrae partibus ad *Clavium, Grimbergerum, aliosque Romanos Societatis IESU Mathematicos praedecessores meos datarum, quod penes me est, Archivio*; multas sanè, circa declinationes Magneticas haud spernendas observationes collegi", Gaspar Schott, *Mechanica Hydraulica-Pneumatica*, Würzburg: Pigrin, 1657, pp. 300 and, esp., 339: "In Manuscriptis doctissimi viri P. Christophori Grünbergeri, olim in Romano Collegio Mathematicae Professoris, quae in *Archivio Clavij & Grünbergeri* reperi, haec habentur verba circa praesentem Bettini Machinam, & de motu perpetuo opinionem..." [emphasis added].

[53] Grienberger dismisses the compass, celebrated by Giordano Bruno in two poems, as a pretty plaything: "Nempe in rebus exactioribus esse inutile instrumentum at in apparentia et operatione vulgari pulchrum simul et iucundum immo quod multum faciat mirari spectantes", Grienberger to Clavius (in Naples), Rome, 23 February 1596, CC III.1, pp. 161-9, on p.164.

[54] E.g. "O felices barattolas, o dulces mustacciulos. eoque feliciores quo minus deficient", Grienberger to Clavius (in Naples), Rome, 27 October 1595, in CC III.1, pp. 139-142 on p. 139, "Saltem optarem, ut ne Roma una cum Clavio abisse videatur Mathematica, et Neapolim veluti in novam Coloniam transmigrasse. Quam spero redituram propediem ubi nimia quae illic est dulcedo nauseam attulerit. Quod si ita dulcedo delectat, ut eius satietas sit nulla, saltem meminerit extra patriam se vicere...". Clavius's gluttony was later lampooned by Joseph Scaliger: "Clavius qu'on m'avoit dit estre un grand personnage & que i'ay trop loué, est une beste. Monsieur Dabin m'a dit qu'il luy faut tous les matins un morceau de jambon & un verre de vin Grec. C'est un gros ventre d'Aleman...", Joseph Scaliger, *Scaligerana. Editio altera. ad verum exemplar restituta*, Coloniae Agrippinae: Apud Gerbrandum Scagen; 1667 p. 51 (*s.v.* 'Clavius').

On 12 January 1596 Grienberger told Clavius of a possible addition to his other duties:

> I fear that perhaps I may have to teach privately to a certain Count whose name escapes me. But I hear that he has studied little else, and it appears to me that he is rather young, not to say a boy, so I hope for little profit, even on my side, as *I do not know how to deal with that type of person correctly*.[55]

Shortly afterwards, Grienberger's fears came true, making unfair demands on both his time and his character:

> I do not have much free time, apart from in the mornings. For after lunch all is taken up by the class and the academies, of which there is the domestic one, as you know, and another at the Gate, to which Count St. George, as he's known, comes, a boy with a reasonable mind, together with a certain other [boy] of around the same age, called Orazio, from Perugia, also of good family. Both of these asked the Fr. General if I could lecture them privately. Your Rev. will wonder that I am suitable for this task, as it should really require not a German but a Tuscan, who would be more affable than me. But seeing that it has pleased them thus I hope that they will have patience with me.[56]

Grienberger, unlike his more famous Tuscan contemporary Galileo,was clearly no courtier, and elsewhere diagnosed himself as having a particularly frigid nature, when speculating that Clavius might be prolonging his stay in Naples because Grienberger was occupying his bedroom:

> But is [Clavius] perhaps excluded from his bedroom? On the contrary, it is so ready that it would invite him him there freely even against his will. For I will easily find another one

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[55]"Vereor me fortassis privitam debeam legere cuidam Comiti cuius nomen excidit. Sed ut audio parum aliis studuit, et ut mihi videtur satis est iuvenis ne dicam puer unde parvum spero profectum etiam ex parte mea qui cum eiusmodi hominibus digne tractare nescio", Grienberger to Clavius (in Naples), Rome, 12 January 1596, CC III.1, pp. 146-50.

[56]"Non habeo multum temporis vacui, praeter tempus matutinum. Nam a prandio totum sibi Schola et Academiae vendicant, quarum una domestica ut novit altera est ad Portam, ad quam convenit Comes Sancti Georgi ut vocant puer non mali ingenii. et quidam alius eiusdem fere aetatis Horatius nomine, Perusinus et ipse bonae familiae, quorum uterque apud R.P. Generalem procurarunt ut eis privatim legerem. Cogitet T. Ra. quam sim aptus ad hoc officium, quod non Todescum sed Tuscanum, meque affabiliorem requireret. Sed quoniam eis ita placuit spero mecum habebunt patientiam", Grienberger to Clavius (in Naples), Rome, 23 March 1596, in CC III.1, pp.170-3, on p. 170. It is worth mentioning that it is just possible that "Horatius" may have been the young Orazio Grassi (though he came from Savona rather than Perugia), who joined the Jesuit Novitiate at S. Andrea al Quirinale in 1600 at the age of eighteen.

> that is equally cold, unless perhaps all rooms are cold that are occupied by exceedingly cold [*frigidissimus*] me.[57]

Despite pandering on occasions to a cardinal's desire for a sundial[58], or to the wishes of young aristocrats to have private tuition, Grienberger's concerns lay more with the well-being of his young disciples in the mathematical academy, bound to him by a common love of mathematics, than with courtly aspirations.

> Unless the Superiors change their plans, I believe that I will be freed from the ordinary domestic academy. [...] The other private academy is creeping forward slowly [in the study] of Clocks. Out of the three pupils, one (Janos Nagy, of course) as he was trying impetuosly to go up two steps at a time four or five days ago, almost suffocated on his catharr. However, Nature won, and made herself a way forcibly, but not without blood, as together with the phlegm he vomited up no small quantity of blood.[59]

The impetuous mathematician clearly pays a price. Grienberger went to visit Nagy in the college infirmary, where he found two other indisposed mathematical practitioners:

> As I was visiting Nagy today, I found Fr. Villalpando and Fr. Mario (the one who saluted you in Naples when you were in your sedan chair) in the same place [i.e. the infirmary]. Reading your letter they rejoiced to hear of your good health, and indeed we sensed some unknown fragrance from your letter, and some unknown pleasant odour, but without a taste.[60]

Although the convalescent mathematicians might have detected the smell of the Neapolitan sweetmeats that Clavius hoarded in his bedroom in Naples, imbibed by his

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[57]"Sed exclusus est forte [Clavius] cubiculo? immo vero ita aptum est ut vel nolentem invitet. eodem libenter. facile enim ut puto aliud inveniam quod aeque sit frigidum, nisi forte omnia sint frigida in quibus ego frigidissimus inhabito". Grienberger to Clavius (in Naples, Rome, 24 November 1595, in CC III.1, pp. 142-145 on p. 143

[58]Grienberger to Clavius (in Naples), Rome, 26 January 1596, CC III.1, pp. 151-2: "Nunc parum quiescere cogor, quod mihi in cubiculum allatus sit lapis ut in eo describam horologia pro Cardinali Lanceloto".

[59]"Si superiores non mutent consilium credo me liberum fore ab Academia domestica ordinaria. [...] Altera vero academia privata de Horologiis sensim proprepit. e tribus unus nempe Ioannes Nagius cum ante quatuor vel quinque dies impetuosius binos simul gradus ascendere conaretur, defluente catharro vix non suffucatus est. Vicit tamen natura, viamque sibi fecit vi, sed non sine sanguine, nam una cum phlegmate non parum sanguinis eiecit", Grienberger to Clavius (in Naples), Rome, 23 March 1596, in CC III.1, pp. 170-3, on pp. 170-1.

[60]"Cum hodie visitarem Nagium reperi ibidem tum P. Villalpandum tum P. Marium eum quem dum iret Neapolim T. Ra. salutavit in lectica, qui legentes T. R.ae literas laetati sunt de bona valetudine, etenim vero sensimus nescio quam fragrantiam ex ipsis literis, bonique nescio quid odoris sed sine gustu." Grienberger to Clavius (in Naples), Rome, 23 March 1596, in CC III.1, pp. 170-3, on p. 172

writing paper, Grienberger is suggesting with lumbering jocularity that the elderly mathematician had kept the taste of the pastries for himself.[61]

Public mathematics in the *Collegio Romano*: The *Problemata*

> What gain is to be had from disputations, which reduce everything to the musicians, party-givers (*festaroli*) and printers? Who cannot see that they are altercations in which, as the ancient poet [Persius] said so well, truth is lost instead of found, and that on these occasions one can only prove one's ready cheekiness and sarcasm? And that by making a great show and expending thousands of conclusions, one ends up without having concluded a single thing?
>
> Federico Cesi, *Del natural desiderio di sapere* (1616)

Shortly after Clavius left Rome for Naples, Grienberger castigated him for suggesting to the Rector that Grienberger might give a public oration to mark the commencement of studies in the *Collegio*:

> I do not know what Your Reverence expected when you promised our Rev. Fr. Rector that I would give an oration [*Praefatio*], for I happened to hear this from him at least twice, in the presence of others. *For you know extremely well that, to me, that has always seemed an extremely difficult task*. Certainly, if they expected an oration they did not get one, but instead I explained the dimension of the circle from Archimedes so slowly that it could not be completed in half an hour.[62]

Grienberger did not enjoy speaking in public. No great surprise here, but what might appear initially to represent something of a paradox is a statement made in Mario Bettini's *Aerarium*, when concluding his eulogy of Grienberger and "correcting" Giuseppe Biancani's entry on Grienberger in his Chronology of Illustrious

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[61]ibid., loc. cit. : "Scilicet Clavius Gustum servat sibi nobisque mittit odorem, ut hinc conclusimus quam omnia plana sint in cubiculo Clavii cum etiam chartae dulcem illum odorem hauriant et Romam usque deferant".

[62]"Nescio quo attestante Ro. Patri nostro Rectori T. R.a promiserit me facturum Praefationem, bis enim ut minimum et quidem coram aliis id ex eo audire me, contigit, cum optime noverit quam mihi id muneris, visum sit semper difficillimum. certe si Praefationem expectarunt eam non habuerunt, sed eius loco Dimensionem circuli ex Archimede ita fuse explicatam ut dimidia hora absolvi non potuerit....", Grienberger to Christoph Clavius (in Naples). Rome; 24 November 1595, CC. III.1, pp. 142-6, on p. 143.

Mathematicians, appended to his 1615 *Aristotelis loca mathematica*.[63] Listing Grienberger's extant manuscript works, Bettini writes:

> There are many optical and mechanical [*machinaria*] experiments present in our Roman College that were once exhibited to the eyes and admiration of princely men visiting that place.[64]

To understand how Grienberger's modesty and distaste for public speaking might be reconciled with his authorship of a large number of experimental problems presented publicly to the applause of princes visiting the Collegio Romano, I would like to consider the emergence of a highly specific genre - the *Problemata*.

As discussed above, the 1586 first edition of the Jesuit *Ratio Studiorum* had proposed that Clavius should give private lessons in mathematics to eight or ten Jesuits, selected from all the different provinces of the order, in order to furnish the provinces with mathematics teachers[65]. The next published edition of the *Ratio* (1591) suggested that in addition to this private *academia*,

> once or twice a month one of the students should recount [*enarret*] an illustrious [*illustre*] mathematical problem in a large gathering of philosophers and theologians, having first been instructed [*edoctus*], as is proper, by the master.[66]

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[63]Giuseppe Biancani, *De mathematicarum natura dissertatio una cum clarorum mathematicorum chronologia*. Bononiae; 1615 (bound with idem., *Aristotelis loca mathematica*, Bononiae, 1615).

[64] "Extant plurea & optica, & machinaria experimenta in Coll. nostro Romano: quae aliquando Principum virorum illuc inuisentium oculis, & admiratione exhibita sunt", Bettini, *Aerarium*, cit., Def. 10, §3, p. 75

[65]"Professor alter, qui modo P. Clavius esse posset, constituatur, rerum mathematicarum pleniorem doctrinam conferat in triennium, explicetque privatim nostris octo circiter aut decem, qui mediocri saltem sint igenio, nec a mathematicis alieno, et philosophiam audierint; qui ex variis essent convocandi provinciis, unus ex qualibet, si fieri posset [...] Porro ex hac academia eximii prodirent mathematici, qui eam facultatem in omnes provincias, ad quas essent reversuri, disseminarent, et nostrorum tuerentur existimationem, siquando oporteret eos de mathematicis respondere." MP V, p. 110.

[66]"Semel aut iterum in mense auditorum aliquis in magno philosophorum theologorumque conventu illustre aliquod problema mathematicum enarret, prius a magistro, sicut oportet, edoctus", MP V, p. 284. This suggestion was previously made in the unpublished 1586 version of the Ratio Studiorum, MP, V, p. 177.

Some of the surviving mathematical problems presented in the *Collegio Romano* are published in the Appendix. Although these *Problemata* are generally anonymous, a significant amount of evidence in addition to Bettini's attribution, discussed in the notes accompanying each problem, ranging from references in letters, literary style, internal evidence and Grienberger's distinctive handwriting, points to Grienberger as the author of all of these *Problemata*, which range in date from 1591, the year of Grienberger's arrival in Rome, to 1614. As a ceremonial form of culture, such presentations clearly had much in common with the extravagant public defenses of philosophical theses made by aristocratic students in the *Collegio* and so disparaged by Federico Cesi. In the thesis defenses at the *Collegio*, studied in detail by Louise Rice,[67] the script read by the student was generally written by one of the professors, although if the theses (or the odes composed for the occasion) were printed, they were accompanied by the student's name. The same practice seems to have been adopted for the mathematical *Problemata*, as suggested by the "instruction" by the master advocated by the *Ratio Studiorum*. Publication was a rarer matter in the mathematical presentations, but when it happened, it followed the same patterns. The Roman publishers Zannetti and Mascardi, favourites for such philosophical "vanity publications", were also used for the mathematical problems.[68]

Mixed mathematical themes in the *Problemata*

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[67]Louise Rice, *College Art: Prints, Poetry and Music for the Academic Defense at the Collegio Romano*, paper given at the conference *The Jesuits: Culture, Learning, and the Arts, 1540-1773*, May 28 - June 1 1997, Boston College, Chestnut Hill, MA.

[68]Zannetti's close links with the Collegio dated from the extraordinary success of his edition of Bellarmine's 1578 Hebrew grammar. In 1598, the publishing house moved to new premises located adjacent to the *Collegio* to facilitate the collaboration, and when Bartolomeo Zannetti died in 1621 he left all his printing equipment to the Jesuits. Mascardi moved to occupy his premises shortly after this time, taking over a lucrative and spiritually edifying business relationship between College and printing-house. See Saverio Franchi, *Le Impressioni Sceniche. Dizionario bio-bibliografico degli editori e stampatoi Romani e Laziali di testi drammatici e libretti per musica dal 1579 al 1800*. Roma: Edizioni di Storia e Letteratura; 1994, pp. 780-805.

It should perhaps be stressed that the individual modesty that I ascribe to the behavioural patterns of Christoph Grienberger was utterly different from the prescriptions of cognitive humility with regard to the mysteries of the natural world that characterised much theological discourse of the late sixteenth century, as recently discussed by Carlo Ginzburg.[69] Indeed, Grienberger's refusal to accept authorial dignities, and his confessions of bodily weakness[70] coexisted with the flow from his pen of a series of claims for the exalted powers and cognitive capacities of mathematicians with respect to the natural world. Such a combination of individual modesty with elevated claims for the power of a collectivity is a feature that can be found elsewhere in Jesuit culture, perhaps reaching its zenith the 1640 *Image of the First Century of the Society of Jesus* published to mark the centenary of the order[71]. As Marc Fumaroli has shown, the anonymous Jesuit compilers of this work excused its rather immodest claims for the achievements of the Society by attributing these achievements indirectly to Jesus, in whose hands the Society that took his name was merely a passive instrument. This relationship was captured emblematically by a device in which the Society of Jesus was the moon, reflecting the light of the Sun, representing Christ[72]. Another emblem in the same book reinforces the idea of the Society of Jesus as a passive, mechanical device, manipulated by Divine Love to raise the earth towards heaven by means of conversion (fig. 9). The device used is similar to one which forms the topic for one of Grienberger's mathematical *Problemata*, dating from 1603. The problem in question,

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[69]Carlo Ginzburg, *The High and the Low: The theme of forbidden knowledge in the sixteenth and seventeenth centuries* in Ginzburg, *Clues, Myths, and the Historical Method*, Baltimore and London: The Johns Hopkins University Press; 1989 p. 60-76.

[70]In addition to the confessions of bodily inability found in Grienberger's letters to Clavius cited above, see Christoph Grienberger, *Catalogus veteres affixarum Longitudines ac Latitudines,* Romae: B. Zannetti, 1612, *Ad Benevolum Lectorem*: "Quam cum etiam ipse probe perspectam heberem, videremque desiderium meum plurimorum esse; neque spes ulla affulgeret inueniendi ea apud alios quibus levari diuturna nostra sitis posset, *ipse meos imbecilles humeros,* tandem huic oneri utilitate gravissimo submittendos duxi, & aquam quae meae aliorumque siti extinguendae sufficeret, primo DEO dante & expensas faciente, domum detuli, tum foras ductis rivulis ob commune studium, etiam ad irrigandos aliorum hortulos eduxi." [emphasis added]

[71]*Imago Primi Saeculi Societatis Iesu A Provincia Flandro-Belgica eiusdem Societatis Repraesentata*. Antwerp: Balthasar Moretus; 1640.

[72]Marc Fumaroli, *Baroque et Classicisme: L'Imago Primi Saeculi Societatis Jesu (1640) et ses adversaires*. in Fumaroli, *L'Ecole du Silence: Le sentiment des images au XVIIe siècle*. Paris: Flammarion; 1994: 343-365.

later cited by Paul Guldin in his controversial *Physico-mathematical dissertation on the motion of the earth*[73], provides a graphic example of the enormous power over nature which Grienberger ascribed to the collectivity of mathematical practitioners.

Grienberger's speaker intends to demonstrate to his audience that "by means of no more than 24 wheels with toothed axes, the Earth's globe, even if it were made entirely of gold, could be driven away from the centre [of the universe], by the force of only one Talent"[74]. The demonstration, later plagiarized by Gaspar Schott (fig. 22)[75], is preceded by a long passage extolling the virtues of mathematics that is anything but modest.

"The boldness of Mathematicians," Grienberger begins, "has always been great, as has their power, Most Religious Fathers and other most honourable members of the audience; and they possess so much spirit in a small number of people, that there is nothing in the whole universe either cloaked in darkness or buried in difficulties that has been able to escape their ingenuity and that has not been investigated with their machines."[76] Although nobody could doubt that the motions of the heavens had been

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[73]Paul Guldin, *De Centro Gravitatis Trium specierum Quantitatis continuae*, Viennae: Gregorii Gelbhar, pp. 137-148, *Dissertatio Phisico-Mathematica de Motu Terrae,* on p. 137: "Cuius vestigijs insistentes nonnulli ex posteris, *Problema* hoc posuerunt: *Quavis potentia, quodvis pondus movere*. hoc est, Data quavis, etiam minima virtute, datum quodvis pondus, etiam maximum agitare. Et quamvis adhuc lateat, quo id Archimedes instrumento fieri posse, demonstraret; sunt enim qui velint vecte, sunt qui trochlea, sunt etiam qui certa rotarum sese mordentium compositione, sunt denique qui alijs machinis: omnes sane in eo conveniunt, etiamsi daretur Archimedi citra Terram consistendi locus, fore ut nunquam id ad exitum perduceret; tantum materiae, tantum operis, tantum temporis, ea machinarum exstructio, ususque, esset absumptura", emphasis added. Guldin originally delivered this *dissertatio*, which discusses the trepidation of the earth through small shifts in the position of its centre of gravity, while in the Collegio Romano. The text bears similarities to Grienberger's *Problemata* in style and content, as does the accompanying diagram.

[74]"Dico igitur rotis non amplius 24 et solidem axibus dentatis Globum terrestrem quamuis aureus foret totus, extra centrum propelli posse, uel ab ea potentia, quae Talentum", Problema: Terram auream, Talenti potentia movere, 5 November 1603, APUG Fondo Curia 2052, in Appendix IX.

[75]See Schott, *Magia universalis,* Bamberg: J. M. Schönwetter, 1677[2] (4 vols.), pars III, pp. 219-228, "Machina II: Glossocomum nostrum, quo talenti potentia movetur Terraqua, si aurea foret". Schott makes no mention of Grienberger's authorship of the *problema*, but makes only minor changes to the original. Schott's diagram, almost identical to Grienberger's, is reproduced in William B. Ashworth, Jr., Iconography of a new physics, History and Technology, 4, 1987: 267-297

[76]"Magna fuit semper Mathematicorum audacia, magna uis Patres religiosissimi, caeterique Auditores ornatissimi; et tantus in tam paruo numero animus, nihil ut in hac rerum

translated into the laws of mathematics [*leges Mathematicorum*], someone might still query the dominion of mathematicians over the elementary world. However, "the elements themselves", the author continues, "love to be governed by mathematics as much as they love their own dignities and powers, and prefer to be ornamented by the mathematicians than to be reduced to almost nothing by the natural philosophers". The *Naturales* dress the elements poorly, in the different qualities of heat, cold, wetness and dryness, and imprison them in concentric spheres.

> Why should [the elements] not be miserable, then, being so poorly dressed, confined in prisons and constrained to serve people that treat them so badly. They dig into the earth with ploughs, and utterly disembowel it even to wrench out a handful of gold. They make water wash all the filthiest people; condemn air to the mills and grindstones, and fire to the furnaces. There is no service that is so vile that [the elements] are not subjected to it [...] It should not seem strange, then, if the elements would happily resort to the Mathematicians, who care for their dignity, and whose works often free them from prison, and bring them into the gardens and palaces of kings.[77]

The elements are happier under the dominion (*imperia*) of mathematicians than that of physicists, or natural philosophers. As the passage cited shows, in Grienberger's text, the social and cognitive status of the mathematical disciplines are inextricably entangled, and this is also true of the other mathematical problems. When Grienberger first arrived in the *Collegio Romano* in 1591, he delivered an oration on the mathematical disciplines, much of which was taken up with establishing the nobility of the family made up by the seven mathematical 'sisters': Arithmetic, Geometry, Music, Astronomy, Mechanics, Geodesy, Perspective and Practical Arithmetic (*Supputatrix*)[78]. In the midst of a rather labyrinthine account of the resemblances and quasi-incestuous interrelations between the different 'sisters', he mentions an experiment to show that the study of perspective furnishes the causes of appearances that would otherwise remain a mystery, an

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universitate sit vel tenebris obuolutum vel obrutum difficultatibus, quod eorum ingenia effugere potuerit, quod eorum machinas expertum non sit", ibid.

[77]Quidne igitur misera sint, quae ita misere uestiuntur, misera quae carceribus cohibentur miserrima quae etiam illis ipsis seruire coguntur, a quibus tam male accipiuntur. In terram aratris proscindunt, eamque ut uel pugillum auri extorqueant, penitus euiscerant. Aquam nullis non immunditijs abluendis accommodant; aerem uero ad pistrina et molas, et ignem denique ad coguinas condemnant: nullaque est tam uilis seruitus, quam subire non cogantur. Quare cum talia sint apud Naturales elementa, qualia uidimus, nouum uideri non debet, si apud Mathematicos libenter diuersentur, quibus eorum dignitas curae est, et quorum opera saepius carceribus exuuntur, atque in Regum hortos ac palatia introducuntur", ibid.

[78]See *Praefatio*, [November 1591], APUG Fondo Curia 2052, in Appendix I below.

experiment that is taken up and performed by the narrator of the following *Problema*.[79] The classical *topos* for discussions of mathematical power is the role of the war machines designed by Archimedes in the siege of Syracuse, and this event is cited repeatedly in many of Grienberger's *Problemata*. Mathematical wonders, however, need not be limited to the military domain, and Grienberger also describes a trick-picture, possibly an anamorphosis, which he had heard of, in which a forest landscape seen from one position is transformed into a picture of the Emperor with his brother when one looks through a specially constructed hole.[80] As well as being an ancestral mathematical powermonger, Archimedes also provided a source for the credibility of the early-modern mathematical practitioner, and Grienberger makes much of the story that Hieron, King of Syracuse, ordered that everything Archimedes said should be believed.[81]

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[79]See *Fieri posse [...] in aliqua mensa lumine*, APUG Fondo Curia 2052, in Appendix II.

[80] "Hac qui callent Pictores mirabilia omnino efficiunt opera, inter quae non immerito forsan tabella etiam illa extitent, quam ego quidem ipse non vidi, certo tamen exstare ab ijs qui viderunt accepi, estque talis, ut illi qui tam intuentur e directo nihil omnino praeter ferat silvas et alia eiusmodi videant, qui vero eandem ex latere inspiciunt per deformitatum quoddam foramen, ipsum cernant cum Fratro Imperatorem integerrime depictum. Aliud de scenographia quoque adferrem exemplum, nisi ad reliqua adeoque ad finem properarem", in *Praefatio*, [November 1591], APUG Fondo Curia 2052, Appendix I below.

[81] "In omnibus hisce vel maxime excelluit Archimedes. [...] Per mirabilia vero opera quae efficit illud tandem ab Hierone Rege privilegium est consequutus, ut quidquid tandem affirmaret omnino sibi fides haberetur", ibid. See also the introductions to Appendix I and Appendix II.

Knowing the world through mathematics

> He handed the world over to their disputation, but man could not grasp the work which God made from the beginning up to the end
>
> Ecclesiastes 3:11
> (Quoted in P. A. Foscarini, *Lettera sopra l'opinione de' Pittagorici e del Copernico*. Naples: Lazzaro Scoriggio; 1615)

Describing the audience of his 1595 oration to mark the beginning of studies to Clavius, Grienberger wrote that

> Our Reverend Father General was there, unexpectedly, along with several other unexpected people, and he seemed to apprehend the matter with some delight, as I understood afterwards from Father Pereira, who complained to me because I didn't invite him.[82]

Pereira was unhappy not to be invited to hear Grienberger's discourse (one of the very few public speeches that he seems to have given in person), and indeed the statements about mathematics made at the beginning of the 1595 oration were little short of anathema to Pereira's perception of the cognitive impotence of the mathematical disciplines, discussed above:

> You know that the whole of Philosophy is divided chiefly into three kinds of Sciences: Natural, Mathematical and that divine one that is called Metaphysical. The first one verifies for itself things immersed in matter, that is, abstracted neither from reality nor from reason. The last one assumes as its objects things that are utterly alien to matter. Even if the other two might seem to have all things distributed between them, the middle one, however (which, even by virtue of being the middle one can be said to be more excellent than the others), finds that in [treating] the same matters it ascribes them to itself in such a way that in its object it nevertheless in no way defrauds the other [sciences]. [83]

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[82]"Interfuit R.dus Pater noster Generalis cum nonnullis aliis inexpectatus, visusque est rem aprehendisse non sine delectatione, ut ex P. Perierio postea intellexi, qui mecum conquestus fuit quod non invitassem" Grienberger to Clavius (in Naples), Rome; 24 November 1595, in CC III.1, pp. 142-146.

[83]"Nostis Philosophiam universam, in tria potissimum, distinctam esse Scientiarum genera, Naturalem, Mathematicam, et divinam illam quam vocant methaphysicam. Prior illa res sibi in materia immersas, id est nec re nec ratione abstractas verificat; posterior res a materia prorsus alienos, suo sibi pro obiecti assumit: at vero media illa (quae vel ob hoc quod media est caeteris dici potest esse praestantior) etsi iam reliquae duae res inter se universas distribuisse videantur, inuenit tamen quod in ijsdem rebus ita sibi proprium adscribat, ut suo nihilominus obiecto caeteras nequaquam defraudet", [*Problema. De Dimensione Circuli*], [27 October - 24 November 1595?], APUG Fondo Curia 2052, in Appendix IV.

Although mathematics considered quantity abstracted from any specific material incarnation, such abstraction rendered mathematical truths universal in their application, rather than inapplicable to the natural world as Pereira and others wished to suggest. The theme, later to be central to Giuseppe Biancani's *De mathematicarum natura dissertatio* (1615)[84] recurs frequently in the other *Problemata*, which Biancani may have had the opportunity to read during his time as one of the academicians in the *Collegio Romano*[85]. Mathematical conclusions made about quantity in general were applicable to any physical quantity, including motion; and Grienberger completes his oration with the suggestion that the possibility of incommensurable lengths implied the possibility of real incommensurable motions. The other *Problemata* put the application of mathematics to natural motions into action, and include one dealing with the motion of a weight attached to a rod, influenced by the medieval *calculatores* and Tartaglia, and another on the reality of the motions of the heavens described by astronomers.[86] In the latter, Grienberger, furthering an argument put forward in Clavius's *Commentary on the Sphere of Sacrobosco*, considers the motion of an ant on a moving table, to demonstrate, against the views of Pereira and the other "homocentrists",[87] that a single body, could possess two real motions simultaneously without involving a contradiction. This allowed Grienberger to argue for the reality of the convoluted motions ascribed to the planets by astronomers, although he avoids confronting the vexed question of the Aristotelian distinction between natural and violent motion. As geometry pervades Grienberger's depiction of the natural world, so it inhabits the artificial domain of

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[84]Giuseppe Biancani, *De mathematicarum natura dissertatio una cum clarorum mathematicorum chronologia*. Bononiae; 1615 (bound with idem., *Aristotelis loca mathematica*, 1615), English translation in Paolo Mancosu, *Philosophy of Mathematics and Mathematical Practice in the Seventeenth Century*, New York, Oxford, Oxford University Press, 1996, pp. 178-212

[85]Biancani is recorded as an academician in 1599-1600 (ARSI, Rom. 54 ff. 2v, 12v, 77r, cit. in CC I.2 pp. 18-19).

[86]Grienberger, *Problema Mechanicum Circa motus ponderum*, [January 1596?], APUG Fondo Curia 2052 (Appendix VI), idem., *Problema Circa motus caelorum*, APUG Fondo Curia 2052 (Appendix V).

[87]On Clavius's response to homocentric astronomy see James M. Lattis, *Between Copernicus and Galileo: Christoph Clavius and the collapse of Ptolemaic cosmology*. Chicago and London: University of Chicago Press; 1994, pp. 87-94.

buildings and other institutions necessary to civic life. In one *Problema*, Grienberger writes that

> Without doubt that Bolognese structure [i.e. the Torre degli Asinelli in Bologna] had an outstanding mathematician as its architect [*delineator*] by whose vigilance Geometry has come to inhabit that tower.[88]

Another problem was prompted by the disagreement between a group of Spanish sailors and a group of Portuguese sailors who arrived simultaneously in Lisbon, having circumnavigated the world in opposite directions, and unable to decide which day was Sunday,[89] and indeed the Gregorian Calendar, co-authored by Clavius, is an obvious example of an enormous mathematical artifice of a religious and civic nature.

Performing physico-mathematics - Bodies Floating in Water

> [L]ast Wednesday I went to hear the *Problema* recited by Sig. Bardi in the College of the Gesù, and I particularly delighted in seeing Your Lordship's opinion favoured and defended to great applause, as well as the experiments which were then carried out by Fr. Christoph Grienberger in the presence of everybody, after he had brought all of the instruments that you see in the enclosed figure into the room where the *Problema* was recited. Although there were some Peripatetics who shook their heads, with all of this everything was made clear by the end.
>
> Francesco Stelluti to Galileo, Rome, 28 June 1614

On February 5th 1612, Christoph Grienberger interrupted a letter that he was writing to Galileo to report the news of Clavius's death in "real time":

> While I pause from writing for a moment, behold here is someone who rushes to announce that our Clavius is about to be given his Travelling money, which he accepted this very

[88]"Habuit proculdubio et Bononiensis illa structura sui delineatorem insignem mathematicum, cuius vigilantia id effectum est, ut Geometria turrim illam inhabitaret", Grienberger,*Problema Datis excessibus quibus diameter Quadrati aut figurae*, APUG Fondo Curia 2052, Appendix VII.
[89]*De errore qui in denominandis numerandisque diebus in Indicae navigatione committitur*, APUG Fondo Curia 2052, Appendix VIII.

> evening at the first hour of the night. So do not be surprised that I break off this letter in a rather untimely fashion - such news does not allow me to linger any longer on these matters. You will learn more from the bearer of the letter, Father Odo van Maelcote, who, by returning to Flanders has shackled me once more to the mathematics classes.[90]

Grienberger's relationship with Galileo had been strengthening steadily since 1611, as the physical powers of his senior colleague Clavius decreased. The *Ad benevolum lectorem* introducing Grienberger's 1612 star-charts eulogises Galileo's telescopic observations in highly charged language. The decline of Clavius brought the Austrian and the Tuscan ever closer; and after Galileo's triumphal visit to the *Collegio Romano* Grienberger spoke eagerly to Galileo of future reunions of the aging Clavian telescope of the *Collegio* with Galileo's instrument.[91] Galileo's anger at the criticism of his opinions on the heights of lunar mountains by a Jesuit in Mantua led him to write a long letter to Grienberger to defend his position in detail.[92] Replying on the "anniversary of the death of our most beloved Clavius", Grienberger displayed a prudence that brings into relief the boundary of the corporate culture within which he carried out his work:

> Do not be surprised that I am silent about your [letter]: I do not have the same liberty as you do.[93]

To have entered the dispute on Galileo's side would have constituted a breach of discipline for Grienberger, and would have been incompatible with his institutionalised *modus procedendi*. Instead, as ever, he breaks his silence through the words of others. A young former pupil of Galileo's studying in the *Collegio Romano*, Giovanni Bardi, wrote to him to describe a meeting with Grienberger:

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[90] "Dum hic paulisper scribendo subsisto, ecce accurrit qui Clavio nostro dandum Viaticum nunciat, quod etiam hoc vespere, prima noctis hora, accepit. Ne igitur mirere quod intempestivius literas abrumpo: diutius his immorari tanta novitas non sinit. Disces plura ex harum latore, qui est P. Odo Malcotius, qui, Flandriam repetens, scholae mathematicae me iterum alligavit", Grienberger to Galileo, Rome, 5 February 1612, in OG XI, 272-4, on p. 273

[91] "Salutant Dominationem tuam omnes quos toties in Collegio Romano salutavit, et saluto in primis ego, meque D. tuae commendo; et se commendat etiam perspicillum Clavianum, expectatque avide sociari cum Galilaico. Mihi Clavianum sensim consenescere videtur cum Clavio." Grienberger to Galileo, Roma; 24 June 1611, in OG XI, pp. 130-1.

[92] Galileo to Grienberger, Firenze; 1 September 1611, in OG XI, pp. 178-203.

[93] "Neque mirere quod de tuis sileam: non est mihi eadem quae tibi libertas", Grienberger to Galileo, Rome; 5 February 1613 in OG XI, pp. 479-80.

> I visited Father Grienberger on behalf of Your Lordship and saluted him in your name. He returns your salutations doubled. I asked him for his opinion on that book [i.e. Galileo's *Sunspot letters*] which he had already seen and he said that he thought very well of it, and that on this subject, as on the other matter of things that float on water, he was of [the opinion] of Your Lordship.[94]

Galileo had spent much of 1612 embroiled in a dispute with a group of Florentine Aristotelians led by Ludovico delle Colombe about the cause of flotation of flattened bodies having a specific gravity greater than that of water. Di Grazia's claim that ice was condensed water was attacked by Galileo, who pointed out that if ice was condensed water then it would sink, as is patently contrary to experience. Di Grazia replied that ice floated because of its flat shape, and a dispute quickly flared up about the true cause of the flotation of bodies[95]. Ludovico delle Colombe, another prominent Florentine Aristotelian, joined the debate, and began performing experiments in public with chips of ebony to demonstrate that, in this case, shape, not heaviness, was the cause of flotation.

Clearly this was a philosophical debate, as it concerned causes, and a remark that Galileo made in a 1612 manuscript treatise intended to answer his critics displays his consonance with the positions expressed by his Jesuit contemporaries on the uses of mathematical arguments in philosophy:

> Here I expect a terrible rebuke from one of my adversaries, and I can almost hear him shouting in my ears that it is one thing to deal with matters physically, and quite another to do so mathematically, and that geometers should stick to their fantasies and not get entangled in philosophical matters - as if truth could ever be more than one; as if geometry up to our time had prejudiced the acquisition of true philosophy; as if it were impossible to be a geometer as well as a philosopher - and we must infer as a necessary consequence that anyone who knows geometry cannot know physics and cannot reason about and deal with physical matters physically! [...] Let my adversaries see whether I treat the matter in the

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[94]"Visitai il Padre Gamberger da parte di V.S. et insieme lo salutai in nome suo, il quale rende a V.S. duplicati saluti. Io li domandai quello che gli pareva di questo libro, che già lui haveva visto; e mi disse molto bene, e che in moltissime cose, tanto di questo come di quell'altro delle cose chi stanno sull'acqua, era da quella di V.S."Giovanni Bardi to Galileo, Rome; 24 May 1613, in OG XI, pp. 512-513.

[95]On the debate about the *Gallegianti*, see especially Stillman Drake. "The Dispute over Bodies in water", *Galileo Studies* , Ann Arbor: University of Michigan Press; 1970, pp.159-176, Mario Biagioli *Galileo Courtier: The practice of science in the culture of absolutism.* Chicago: University of Chicago Press; 1993, Ch.3, pp.159-209 and Francesco de Ceglia, *Reazioni romane: L'draulica galileiana negli scritti di Giovanni Bardi e Giuseppe Biancani*, Bari: Laterza, 1997.

> same terms as Aristotle, and whether he himself does not, where necessary, introduce geometric demonstrations. And then let them have the kindness to desist from their bitter enmity towards geometry - to my astonishment indeed, since I had not thought anyone could be an enemy to a total stranger[96]

Galileo's *Discorso intorno alle cose che stanno in sù l'acqua* was published in 1612[97], and attempted to explain the flotation of ebony chips in terms of a dip in the surface of the water, leading the the combined weight of ebony and air to be less than that of water. The controversy continued with the appearance of an anonymous work entitled *Considerazioni sopra il Discorso del Sig. Galileo Galileo intorno alle cose, che stanno in sù l'Acqua, o che in quella si muovono...fatte...da Accademico Incognito*[98], a work which made Galileo furious and led him to write the following marginal note: "If Bardi writes, one could say that in asking me some of his doubts, befitting to his age, i.e. puerile, the answers that he required would be fully sufficient for the Considerations of the Academician."[99]

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[96]"Qua io m'aspetto un rabbuffo terribile da qualcuno de gli avversarii; e già parmi di sentire intonar negli orecchi che altro è il trattar le cose fisicamente ed altro matematicamente, e che i geometri doveriano restar tra le lor girandole, e non affratellarsi con le materie filosofiche, le cui verità sono diverse dalle verità matematiche; quasi che il vero possa esser più di uno; quasi che la geometria a i nostri tempi progiudichi all'aqquisto della vera filosofia, quasi che sia impossibile esser geometra e filosofo, sì che per necessaria conseguenz[a] si inefrisca che chi sa geometria non possa saper fisica, nè possa discorrere e trattar delle materie fisiche fisicamente. Conseguenze non meno sciocche di quella di un tale medico fisico, che spinto da un poco di livore, diceva che il medico Aqquapendente, essendo grande anatomista e chirurgo, doveva contentarsi di star tra i suoi ferri ed unguenti, senza volersi ingerire nelle cure fisiche, come se la cognizione di chirurgia destruggesse e fosse contraria alla fisica... Vegghino gli avversarii se io tratto le materie con i medesimi termini che Aristotile, e se egli medesimo, dove è necessario, introduce terminici della geometria, non senza mia grandissima meraviglia, il quale credevo che non si potesse esser nimico di persona non conosciuta", OG IV p.49 [Diversi fragmenti attenti al trattato delle cose che stanno su l'acqua] translated by Stillman Drake.

[97]Despite the Archimedean conclusions of this work, Galileo's attempts to produce an Archimedean demonstration foundered, due to his assumption that the volume of the liquid displaced is equal to the submerged bulk of the body. To be consistent with Archimedes, he should have assumed that the volume of liquid displaced is equal to the bulk of the body below the original level of the liquid. This slip meant that Galileo ended up using the method of the Pseudo-Aristotelian mechanical problems. See William R.Shea, *Galileo's discourse on floating bodies: Archimedean and Aristotelian elements*, Actes du XIIe Congrès International d'Histoire des Sciences, 1968, Paris: Blanchard;1971, IV, pp. 149-153.

[98]*Considerazioni sopra il Discorso del Sig. Galileo Galileo intorno alle cose, che stanno in sù l'Acqua, o che in quella si muovono...fatte...da Accademico Incognito*. Pisa, Gio. Battista Boschetti, e Giovanni Fontani, 1612.

[99]"se scrive il Bardi, si potrà dire che nel domandarmi alcuni suoi dubbi conformi alla sua età, cioè puerili, gli è occorso sentire risposte tali, che benissimo possono satisfare alle Considerazioni dell'Accademico." OG IV p.195

This is the first evidence of the existence of a relationship between Galileo and the young Florentine Jesuit Giovanni Bardi[100], who was taught mathematics by Galileo before entering the Order. Despite Galileo's disdain, Bardi was a zealous supporter of his teacher, and, like Giuseppe Biancani in Parma, was keen to demonstrate Jesuit solidarity with Galileo's anti-Aristotelian position[101].

In 1613, Galileo's position on the *Gallegianti* was being discussed in earnest by the students of the Collegio Romano. Bardi complains to Galileo in a letter of 24th May 1613 that, although Grienberger was very much in agreement with the Archimedean conclusions of the *Discorso*, and students with only half a year of philosophy were pronouncing ridiculous judgements on the work, the remaining professors were not yet discussing it. [102]

A year later, Bardi was selected to recite a public *Problem* in the Collegio Romano. Grienberger asked him what topic he would like to consider, and he chose to address the controversial question of floating bodies. Grienberger wrote a *Problem On things that float in water*, adopting Bardi's voice and describing Galileo as "*meus olim praeceptor*". To Galileo's experiments, Grienberger added a further two hydrostatic wonders derived from Simon Stevin's *De Beghinselen des Waterwichts*. The Problem was recited in the presence of Federico Cesi, and other members of the Accademia de' Lincei, accompanied by "*dipinte e stampate*", and the Lincei reported back to Galileo of their delight in seeing

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[100]Little is known about Giovanni Bardi. He was born in Florence on 20 May 1594 (ASF, Fondo Ceramelli Papiani 389: Tav. VIIIa suggests April 1594, but ARSI Rom. 56 ff. 177r, 296v give the date of 20 May), making him just twenty years old when he gave the lecture on floating bodies, perhaps explaining the disparaging remark made by Galileo about Bardi in his manuscript comments on the 1612 *Considerazione del Accademico Incognito*. No further documentation has been found for Bardi's instruction by Galileo. Bardi professed the four vows on 31/7/1634 in Florence (ARSI Ital. 9, ff.200r-v). I have been unable to find any further indication of continued experimental activities in the Florentine college of San Giovannino. For additional biographical details, see Mario Biagioli, *Galileo Courtier*, Chicago: University of Chicago Press; 1993 p. 296 note 93. Bardi died on 14 June 1635 (ARSI Hist. Soc. 43, f.11r)

[101]Biancani's *Brevis tractatio de iis quae moventur in aqua, unde caput ultimum de caelo explicabitur*. (ARSI F.G.662, ff.168r-176v.) was not permitted to be published on the grounds that 1) it was contrary to Aristotle and 2) it was merely a reiteration of Galileo's treatise. G. Camerota's censure of the work is in ARSI FG 662 f.166r (published in U. Baldini "Legem impone subactis" (cit.) p.232)

[102]Bardi to Galileo , Rome 24th May 1613 OG XII, pp. 512-513

such a good "Jesuitical" demonstration towards him. The diagram exhibited during Bardi's recital, almost certainly drawn by Grienberger (fig. 12), displays a host of experimental *putti* performing and considering the disputed experiments. As Francesco Stelluti informed Galileo, during the recital, the anti-Aristotelian experiments were "made in the presence of everybody by Father Christoph Grienberger, after he had brought all of the instruments which you can see in the enclosed picture into the room where the *Problem* was recited"[103], and the Rubenesque *putti*[104] drawn by Grienberger with such care would thus seem to represent his ultimate act of iconographic self-effacement - Grienberger's only surviving self-portrait, one might say. This would seem perhaps a good point at which to leave our modest Jesuit mathematical practitioner: silently performing hydrostatic experiments in the *Aula Magna* of the *Collegio Romano* while his "puerile"[105] Florentine student Giovanni Bardi recites his text aloud to the assembled aristocratic public.

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[103]Francesco Stelluti to Galileo, Rome, 28 June 1614, in OG XII

[104]The use of *putti* to perform experiments is traceable to Rubens' illustrations to Aguilonius' 1613 *Opticorum Liber Sex* (see fig. 23). The putti in the diagram accompanying Bardi's presentation also bear a strong resemblance to the putti carrying the gospels in Raphael's *Disputa* in the Stanza della Segnatura. Another of Grienberger's diagrams, accompanying the 1604 *Problema De Stellis Novis*, (fig. 11) resembles Raphael's allegory of astronomy in the same room.

[105]The term of abuse is due to Galileo: "se scrive il Bardi, si potrà dire che nel domandarmi alcuni suoi dubbi conformi alla sua età, *cioè puerili*, gli è occorso sentire risposte tali, che benissimo possono satisfare alle Considerazioni dell'Accademico", OG IV, p.195.

CHAPTER 4

THE USES OF CORRESPONDENCE

Introduction

While previous chapters of this thesis have placed emphasis on the Jesuit college, as providing both public and private spaces for certain kinds of mathematical practices, this chapter will be concerned with epistolary networks and their role in Jesuit investigations of nature. The tension that will be explored here is the tension between *urbs* and *orbis* -- localist and globalist approaches to extracting numerical knowledge from the natural world. I will explore this tension through an examination of the dispute between Athanasius Kircher and Giambattista Riccioli over the reform of geographical knowledge.

Correspondence in the Society of Jesus

On 25 July 1547, Juan de Polanco, who had just assumed the post of secretary to Ignatius Loyola[1], wrote a circular letter addressed to each of the members of the Society of Jesus in which he outlined the various functions of frequent correspondence amongst the members of the order.

> Although we do not know one another by sight, for a long time our Redeemer and Lord Jesus Christ, who reinforces the link of common charity that unites us together like members of his body, has joined me closely to Your Reverence [...] There is thus no reason for me to find anything strange about writing to Your Reverence[2]

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[1]On Polanco and his role as secretary see O' Malley, *The First Jesuits*, cit., 9-11 and André Ravier, *La Compagnie de Jésus sous le gouvernement d'Ignace de Loyola (1541-1556): D'après ;es Chroniques de J.-A. de Polanco*, Paris: Desclée de Brouwer, 1990.

[2]"Aunque de vista no aya conocimiento de una parte ni de otra, mucho tiempo ha que me tiene estrchamente juntado con V.R. Jesu X.o nuestro redentor y señor, apretando el vinculo de la charidad comùn, con que nos une en sì mesmo, como miembros de su cuerpo [...] Y así no será razón que yo me tenga nada por estraño [...] para scrivir á V.R.", Juan de Polanco to the whole Society of Jesus, Rome 27 July 1547, in Monumenta Ignatiana, Series Prima, Sancti Ignatii de

Polanco continued his letter to outline the immense importance of frequent letter-writing between Jesuits. Merchants, well-practised in the epistolary art for their own "miserable interests" were putting the early Jesuits, driven by far more pious goals, to shame[3]. Polanco provides a list of no less than twenty benefits achieved through the frequent exchange of letters between Rome and the periphery. As well enhancing the unity of the Society, nurturing mutual love between its members and increasing their humility by keeping them punctually informed of the worthy deeds of their confrères, letter-writing would aid the growth of the good reputation of the Society and increase the efficiency of its government.[4] Polanco noted that Jesuits in the provinces were being asked to perform a far less onerous task than the bureaucrats of the Roman centre of the order, who "occupy ourselves willingly with this task of writing, which is our principal, and almost exclusive activity".[5] While those on the periphery need only write to give account of themselves to those in Rome, the latter were obliged to satisfy the needs of all of the far-flung places where the Jesuits were stationed. A brief set of rules for correspondence between Rome and the periphery was attached to Polanco's letter, and instructed Jesuits on the practicalities of sending and receiving letters, by means of travelling clerics or merchants, and keeping them from falling into the wrong hands.[6]

Polanco's letter illustrates the immense importance invested in letter-writing in the early years of the Society of Jesus. Polanco's model of epistolary exchange, moreover, is

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Loyola Epistolae et Instructiones, Vol. 1 (Madrid: Gabriel Lopez del Horno; 1903), pp. 536-541, (translated into French in *Ignace de Loyola: Écrits*, traduits et présentés sous la direction de Maurice Giuliani, S.J. Paris: Desclée de Brouwer; 1991, 707-711).

[3]"Y cierto que me pareçe que los mercaderes y otros negociadores del mundo nos hazen en esta parte gran vergüença, que sobre sus intereses míseros tan solícitamente y con tanto concierto se cartean y scriben sus libros por dar mejor recaudo á sus nonadas", ibid.

[4]ibid.

[5]"Y cierto los de fuera haránlo con muy mayor facilidad que los de Roma; porque, donde el que está fuera sólo ha de dar aviso de sí, acá es menester satisfazer á todas aquellas partes donde está la Compañía derramada, scribiendo en cada parte, no sólo lo que acá passa, sino lo que en todas partes. Y pues acá por los fines dichos nos occupamos de buena voluntad tres ó quatro en esto del escribir, como en principal y quasi solo exercitio, devía V.R. no tener por mucho gastar un poco de tiempo y travajo en esta parte tan neçessario", ibid., on p. 540.

[6]Juan de Polanco, *Reglas que deven observar acerca del escribir los de la Compañia que están esparzidos fuera de Roma*, in *Monumenta Ignatiana*, part 1, vol. 1, cit., pp. 542-549.

emphatically centralised in Rome. During the years that followed, practices of letter-writing were gradually refined to deal with the immense expansion of the Society, but centralised correspondence remained at the core of the Jesuit apostolate. One might even say that in the Jesuit order, correspondence substituted the collective prayer of the cloistered medieval orders as the primary expression of the*opus divinum* and the ultimate bond between the globally distributed members of the *corpus christi*, as the order frequently described itself. All aspects of the Jesuit ministry, from the construction of new churches and colleges to the elaboration of the educational structure published in the *Ratio Studiorum* were carried out through the accumulation and evaluation of letters, reports and projects in Rome[7].

Previous chapters of this thesis have suggested that Society of Jesus provided unique conditions for the establishment of a globally distributed network of disciplined observers of the natural world, united by a common body of training. The types of practices involved in performing and disseminating observations and experiments between remote stations developed by the Jesuits were to remain a pervasive, though often tacit, model for scientific societies and correspondence networks.

In his synthesis of recent scholarship on the Counter-reformation, John Bossy has argued that "The disciplinary significance of the Council of Trent and of two centuries of activity on the part of the Catholic hierarchy lay in their determination that [...] the code of parochial observance should be made watertight and universally enforced. This did not require much new legislation, but called for *a decidedly new attitude to old legislation*"[8]. My wish here is to import Bossy's useful distinction into a scientific

[7]For architectural projects see J. Vallery-Radot, *Le recueil de plans d'édifices de la Compagnie de Jésus conservé à la Bibliothèque Nationale de Paris*. Rome: Institutum Historicum Societatis Iesu; 1960, especially pp. 6*-18*. For the development of the *Ratio studiorum*, in addition to the texts contained in MP V, VI and VII, see also the new French translation and critical edition *Ratio studiorum: [version de 1599],* édition bilingue latin-français; presentée par Adrien Démoustier et Dominique Julia. Paris: Belin; 1997.
[8]John Bossy,*The Counter-Reformation and the People of Catholic Europe*. Past and Present. 1970 May; 47: pp. 51-70, on p. 53, emphasis added.

context. In understanding what was new about scientific practice during the period of the Counter-reformation, many studies have focussed on "new legislation" -- new theories of the natural world and their exponents. The Jesuit case, however, encourages to look more closely at the emergence of new, disciplined observational habits -- the processes whereby a community of distant informants on natural phenomena can be mobilised to conduct careful observations and communicate them to each other.

The importance of new techniques of precision-measurement in astronomy and, later, other forms of natural investigation during the sixteenth and seventeenth centuries has traditionally been associated with the figure of Tycho Brahe. Tycho's project, which later served as an explicit model for Jesuits such as Riccioli, was irretrievably attached to a single site - his extraordinary observatory-complex at Uraniborg[9]. The recruitment of a spatially distributed network of observers, characteristic of the geographical project of Athanasius Kircher, on the other hand, problematised the establishment of a shared basis of training and hardware.

How do distant individuals learn to share practices of observation? How do you establish a common language for the reporting of observations? These are questions which motivate the present chapter. They are also voiced more or less explicitly by the Jesuit mathematicians I consider.

Despite the practical problems involved in co-ordinating practices of measurement on a global scale, disciplined practices of observation found renewed legitimation in the post-Tridentine Catholic church. Time-keeping, both in the long and short term, acquired ever greater importance after the Reformation, initially in response to the incorporation of time-limits on preaching by Protestant reformers, and soon marked by the entry of mechanical clocks and chancel sandglasses into the monastic cell and the scholarly

[9]Victor E. Thoren, *The Lord of Uraniborg: A Biography of Tycho Brahe*, Cambridge - New York: Cambridge University Press, 1990 and also Owen Hannaway, *Laboratory Design and the aim of science: Andreas Libavius versus Tycho Brahe.* Isis. 1986; 77: 585-610.

study, spaces that were synthesized in the Jesuit *cubiculum*.[10] The temporal divisions of Ignatius's *Spiritual Exercises* constituted an important example of the increased time-consciousness of sixteenth century spirituality. By the mid-seventeenth century, a necrology listing the virtues of a deceased Jesuit physics professor could proclaim that "He was extremely precise in filling the whole hour with his oration, and when he had to interrupt it for some reason, he kept a powder clock which he did not allow to run during the interruption. He then took up the oration again, timing it with the clock".[11] The Gregorian reform of the calendar was a conspicuous expression of this renewed concern with time-measurement in the Roman clergy, a concern that problematises Jacques Le Goff's perceived irreversible transition from "Church's time" to "merchants' time" in the later middle ages.[12] Calendar reform also provided renewed legitimation for astronomical and mathematical practices within the Catholic church, as suggested in Chapter 1. Copernicus's *De Revolutionibus* was allowed to remain in circulation by the Congregation of the Index, once the more offensive passages had been deleted, primarily on the grounds of its importance for the measurements of solar year used in the new calendar[13], and one of the chief justifications for the presence of mathematics in the Jesuit *Ratio Studiorum* was the importance of accurate time measurements for ecclesiastical laws and customs[14]. The procedure adopted in accumulating, archiving and

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[10]Gerhard Dohrn - van Rossum, *History of the Hour: Clocks and Modern Temporal Orders*, transl. by Thomas Dunlap, Chicago and London: University of Chicago Press; 1996, especially pp. 260-287.

[11]ARSI 188 II, f. 308r (*Alcune virtù del R.P. Giacomo Lampugnano morto in Tivoli, 9 Novembre 1654*): "Nel compire l'hora intiera d'oratione era essatissimo, e quando per qualche accidente la doveva interrompere, teneva un'horologio di polvere, il quale non faceva scorrere, durante l'occupatione e poi la ripigliava con la misura d'horologio".

[12]Jacques Le Goff, *Time, Work and Culture in the Middle Ages*, Chicago: University of Chicago Press, 1980.

[13]See BAV, Barb. Lat. 3151 ff.58r-61v, *De emendatione sex libr. Nicola Copernic. De Revolutionibus*, on f. 58r: "For [measurements] of time, very much needed by the Christian people both for the celebration of divine solemnities and for the carrying out of business, derive from the calculations of Astronomers especially of the sun and the moon and the precession of the equinoxes, as is clear from the corrections carried out to the year during the happy reign of Gregory XIII". An English translation of this document is published in Owen Gingerich, *The Censorship of Copernicus' De Revolutionibus.* Annali dell'Istituto e Museo di Storia della Scienza di Firenze. 1981; Anno VI: 45-61.

[14]See MP V p.109: "Illae [i.e. mathematicae] namque suppeditant atque exponunt [...] theologis praecipuas divini opificii partes; iuri et consuetudini ecclesiasticae accuratas temporum supputationes. [...] Romae quoque, si unum aut pene alterum demas, vix ullus reliquus

processing the observations made by foreign mathematicians in Rome[15] also set an important precedent, as a model of papally-sanctioned, collective investigation of the natural world, a precedent that was to have significance for Athanasius Kircher's geographical project.

The Jesuit geographical project

In his *Magnes, sive de Arte Magnetica*, published in 1641, Athanasius Kircher (fig. 24) outlined his proposal for a *Magnetic Geography* that would be magnetic in two respects - both in seeking magnetic solutions to geographical and navigational problems and in drawing the observations performed by mathematicians, navigators and missionaries throughout the world together in Rome, as if by some occult force of attraction[16]. Kircher likened his project to calendar reform, suggesting that a similar initiative might allow geographical knowledge, clearly in disarray, to be reformed, just as the convergence of the authorities of Pope, princes and universities had reformed the temporal order governing religious and civil affairs.[17]

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fiet, qui aut has facultates valeat profiteri, aut Apostolicae Sedi praesto esse, cum de ecclesiasticis temporibus disputatur."

[15]See e.g. the copies present in Clavius's correspondence of letters from Rudolph II to Gregory XIII, Prague, 24 January 1579 (APUG 530 ff. 96r-v, published in CC II.1, 20-21), Ignatius Na'matallah, Patriarch of Antioch to Gregory XIII, , n.p., n.d., (APUG 530 ff. 253r-255v, published in CC II.1, 21-23), Philip II of Spain to Gregory XIII in Rome, Madrid, 13 January 1580 (APUG 530 ff. 21v-22v, published in CC II.1, 23-24).

[16]Athanasius Kircher, *Magnes, sive de arte magnetica opus tripartitum,* Romae: Ex Typographia Ludovici Grignani; 1641, Lib. 2, Pars Quinta. *Geographia Magnetica*.

[17]Kircher, op. cit., □□□□□□ □□ (1654[3] p. 293): "Hos igitur gravissimos errores, cum aliquot ab hinc annis in Gallia, Germania, Belgio viri doctrina, & authoritate praestantes notarent, superiori saeculi Astronomos imitati sunt, qui cum ex motibus Solis, & Lunae plus aequo discrepantibus futurum deprehendissent, ut eo inemendato Paschalis Christianorum Solemnitas contra aperta Concilij Nicaeni decreta successu temporum toto caelo aberrans, prorsus inconvenientem anni faciem monstraret; ut talibus tempestive occurrerent incommodis, Deique Ecclesiam ab huiusmodi exorbitatione vindicarent, unanimi consensu eiu correctionem aggressi sunt, quam & summo tandem totius Reip. Christianae emolumento, Gregorio XIII. Pontifice Sapientissimo imperante, & auctoritate sua eandem confirmante, perfecerunt. Horum itaque exemplo invitati supra memorati viri, ne Reip. Christianae & utilissima, & maxime necessaria Geographia, adhuc post tot saecula, potissimum hoc aevo tot eximijs, atque omnis eruditionis genere praepollentibus viris florente, mutila maneret, & imperfecta, pro cura singulari, & affectu incredibili, quo boni communis promotione tanguntur, animum ad huiusmodi nobilissimae disciplinae instaurationem, serio, constanter, & inexplebili quodam exequendi operis desiderio adiecerunt."

Clearly, like calendar reform, geographical reform could not be carried out by a single individual. Instead, it was seen to require a "unanimous conspiracy of mathematicians".[18] The religious orders were particularly suited to such a task, but most appropriate of all was the Society of Jesus, "distributed throughout the whole globe, provided with men skilled in mathematics and, above all, enjoying a unanimous harmony of minds".[19] Kircher was urged to embark upon the reform of geographical knowledge through the use of Jesuit informants by a number of sources, and especially by the General Muzio Vitelleschi, who ordered him to compose a Geographical Plan" (*Consilium Geographicum*), "a treatise in which I would display the methods and procedures for restoring Geography, and would explain by what means, with which instruments, and in which place, state and time observations might be carried out fruitfully. I would try to show briefly and clearly that this business would not be difficult work for the religious orders"[20]. Kircher's plan for a Jesuit-led global observational imperative would go far beyond mere cartography: "I would also provide instructions for what they should observe about the flux and reflux of the tides, the constitution of lands and promontories, the natures and properties of winds, bodies of water, rivers, animals, plants and minerals, and, finally, about the customs, laws,

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[18]ibid., "Verum cum tantae molis opus haudquaquam unius, aut alterius opera. sed unanimi Mathematicorum conspiratione peragendum esse cernerent. Me itaque primum frequentibus, e diversis partibus, literis ad negotium urgendum; deinde Adm. R.P.N. Generalem ad id exequendum incitantes, tantum laudibile sua importunitate potuerunt, ut ego Consilium Geographicum conscribere iuberer, tractatum videlicet, quo totius Geographiae restaurandae rationes, & modos exhiberem, ut qua vi quibus instrumentis, quibus in locis statis temporibus observationes cum fructu instituendae essent, & quod hoc negotium Religiosorum Ordinum opera haud difficile esset futurum breviter, & dilucide conarer demonstrare.

[19]ibid. "diversorum Ordinum Religiosos, ut in hoc opere ita glorioso operam suam conferrent, praesertim Societatem nostram, quam & per universum orbe diffusam, & viris Mathematicae peritis instructam, & quod caput est, unanimi mentium conspiratione vigentem norant, ad hoc adeo gloriosum institutum omnibus viribus promovendum, sollicitarunt"

[20]ibid., "Me itaque primum frequentibus, e diversis partibus, literis ad negotium urgendum; deinde Adm. R.P.N. Generalem ad id exequendum incitantes, tantum laudibile sua importunitate potuerunt, ut ego Consilium Geographicum conscribere iuberer, tractatum videlicet, quo totius Geograhpiae restaurandae rationes, & modos exhiberem, ut qua vi quibus instrumentis, quibus in locis statis temporibus observationes cum fructu instituendae essent, & quod hoc negotium Religiosorum Ordinum opera haud difficile esset futurum breviter, & dilucide conarer demonstrare".

languages and religious rites of men".[21] Although Jesuit missionaries, from Matteo Ricci to José de Acosta, had been enormously active in accumulating observations of just this kind in the first century of the Society's existence[22], at the beginning of the second century Kircher wished to discipline and coordinate such reports. By doing so he would avail of the mobility, mathematical expertise and self-effacing obedience of his Jesuit colleagues, a human resource generated largely through the political and pedagogical adroitness of Clavius during the last decades of the sixteenth-century. Inscribed into Kircher's larger geographical project was an attempt to resolve the recalcitrant navigational problem of calculating longitude at sea.

Magnetic declination and the problem of longitude

The problem of determining longitude while at sea was of the utmost importance for navigation in the seventeenth century, given the absence of a mechanical clock that could remain reliable during a sea-voyage[23]. A huge number of solutions were proposed after Philip III offered a perpetual pension of 6,000 ducats to anyone who could find a workable method of maritime longitude-determination in 1598. Galileo had proposed using the eclipses of the newly discovered satellites of Jupiter as a "celestial clock" which sailors might consult to determine their position, a project frustrated by the difficulty of making accurate telescopic observations of the Jovian moons aboard a moving ship[24]. Giuseppe Biancani wrote to Clavius to suggest a mechanical solution

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[21]ibid., "multaque alia quae circa fluxum & refluxum maris, terrarum, & promontoriorum constitutionem, item ventorum, aquarum, fluminum, animalium, plantarum, mineralium naturas & proprietates, circa hominum denique mores, instituta, linguas, cultum religionis observari debeant, docerem".

[22]For an analysis of the relationship between travel and data-gathering in Jesuit culture see Steven J. Harris, *Confession-building, long-distance networks, and the organization of Jesuit science.* Early Modern Science and Medicine. 1996; 1(3): 287-318.

[23]There is an enormous literature on the longitude problem, but see especially William J. H. Andrewes, (ed.). *The Quest for Longitude: the Proceedings of the Longitude Symposium*, Harvard University, November 4-6, 1993. Cambridge MA: The Collection of Historical Scientific Instruments; 1996 and S. A. Bedini, *The pulse of time. Galileo Galilei, the determination of longitude, and the pendulum clock*. Florence: Olschki; 1991.

[24]Van Helden, in Andrewes ed., *The Quest for Longitude,* cit..

involving a large number of on-board clepsydras.[25] Oronce Finé, followed by Jean-Baptiste Morin, proposed an immensely complicated method involving the movement of the moon against the background of the fixed stars, of which Kircher later complained that its use required the mathematical ability of a Euclid or a Ptolemy.[26] Van Langren attempted to use the motion of the terminator shadow across the lunar disc as a painfully slow celestial sundial.[27] Kircher approached the problem in a different way, through magnetic variation. The idea of determining longitude by using the deviation of a compass needle from North as determined by the pole star, or by observing the sun at equal intervals before and after noon and taking an average was not original to Kircher, having been suggested by the Neapolitan magus Giambattista della Porta in the late sixteenth century and by mathematicians and navigators in England[28]. What was new to Kircher, however, was an unprecedented attempt to put this idea into practice on a global scale, an attempt only made possible by his position at the heart of the Jesuit network of mobile correspondents.

Acknowledging Kircher's privileged position, Marin Mersenne wrote to Gabriel Naudé in Rome in 1639 to suggest that Kircher should "order some Reverend of the Society in each college, by whatever means possible, to note the variation of the magnet and the height of the pole star accurately. Let him order that one or another lunar eclipse be observed in these same houses and colleges". "If this task were completed", Mersenne continued, "and if the authority of the supreme pontiff would lend itself to this task,

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[25]Giuseppe Biancani to Christoph Clavius, Padova; 28 February 1598, in *Christoph Clavius: Corrispondenza*, ed. by Ugo Baldini and Pier Daniele Napolitani. Pisa: Università di Pisa, Dipartimento di Matematica, Sezione di Didattica e Storia della Matematica; 1992, IV.I: 34-37.

[26]Athanasius Kircher, *Ars Magna lucis et umbrae*. Romae: Ludovico Grignani; 1646, Liber VI. Protei Pars III. Caput VII, p. 552, "Orontius per Lunae meridiaenae, & stellae fixae observationes illam investigat quidem, sed ita laboriosa, ita perplexa, & difficili methodo, ut ad eam non nisi Euclides, aut Ptolemaeus sufficiens esse possit: simili methodo Morinus eam se inuenisse gloriatur".

[27]See Omer Van de Vyver, *Lettres de J.-Ch. della Faille S.I., cosmographe du roi à Madrid, à M. -F. Van Langren, cosmographe du roi à Bruxelles, 1634-1645*. Archivum Historicum Societatis Iesu. 1977; XLVI: 73-183.

[28]See Jim Bennett, *The Divided Circle: A History of Instruments for Astronomy, Navigation and Surveying*, Oxford: Phaidon, Christie's, pp. 53-55.

the result would be that some time under the happy auspices of Urban VIII we would know the magnetic variation of the whole world, the altitudes of the pole star, and the longitudes so long sought after".[29] Mersenne's suggestion is similar in tone to one made some years before by Gassendi, who proposed to Kircher's friend Nicholas Claude Fabri de Peiresc that either Urban VIII or his nephew Cardinal Francesco Barberini should incite missionaries to make accurate eclipse observations to reform the geographical art[30]. Interestingly, Gassendi did not restrict his suggestion to the Jesuits, having made previous use of the observational powers and mathematical expertise of other peripatetic counter-reformation orders such as the Capuchins and the discalced Carmelites, founded in 1568, in collecting reports of eclipses[31]. However, while eclipse observations might allow longitude to be established at a fixed urban location, they were of little use to a lost ship's captain unless his predicament happened to coincide with a lunar eclipse.[32]

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[29]Marin Mersenne, [Treatise on the magnet, 1639?], BL Add. ms. 4279, ff. 145r-146v, in Mersenne, *Correspondance*, VIII, 754-762, on p. 761: "Vide igitur, doctissime Naudee, ut te procurante, impetremus veras cujuslibet urbis magneticas declinationes, quod facile possit Reverendissimus Pater Kirkerus, quem de vi Magnetica meditari scribis, cui veram declinationem Parisiensem jamjam policeor. Jubeat enim Reverendus Societatis, quaqua patet, Collegio, accurate notet Magnetis declinationem, quantaque sit altitudo poli *. Jubeat etiam unam aut alteram eclypsim Lunae in iisdem Collegiis atque domibus observari; ad quod, si fuerit opus, summi Pontificis imperium accedat, ut brevi totius orbis declinationes magneticas, poli altitudines, atque longitudines tamdiu quaesitas, tandem aliquando sub foelicibus Urbani octavi auspiciis cognoscamus".

[30]"Intelligo nempe, si semel Principibus Viris haec placuerint, fore ut tandem nobilissima, utilissimaque Artium Geographia possit instaurari. Vetus iam nihis proter illius deturpationem expostulatio, quod ipsius resitutioni, Viri privati sint impares, & surdi sint nimis, qui rerum potiuntur, quorumque ea res interest praecipue. At si tandem Pontifex Summus, aut saltem magnus ille Nepos in hanc curam incumberet (posset autem facillime per Sacerdotes ac Religiosos, qui in omneis Mundi Regiones mittuntur) Deum immortalem! quanta exinde & utilitas generi humano, & ipsi gloria compararetur? Sane immensam gratiam apud omneis doctos, ac bonos iniret, & re, vel solum inchoata, universam Rempublicam literariam demeretur."Gassendi to Peiresc, n.d., n.p., published in Gassendi, *Epistolae* (Tom. VI of *Opera Omnia,* Lugduni: Sumptibus Laurentii Anisson, 1658), p. 90.

[31]See Gassendi to Diodati, Aix, 23 April 1636, in Gassendi, *Epistolae*, cit., pp. 85-90, on p. 88: "ALEPI in Syria, Observavit P. Caelestinus a S. Liduina, Carmelita discalcetus, una cum P. Michaele Angelo Capucino perito Mathematico. Ille adfuisse sibi scribit varia horologia, ac etiam Telescopium, quo sint duodecim Phases adnotatae".

[32]Before changing to magnetic variation, Kircher also attempted to use Jesuit missionaries to gather measurements of lunar eclipses with the help of a paper *Rota Geographica* which he distributed to correspondents. See Kircher to anonymous Jesuit priest, Rome, 14 October 1636, APUG 561 ff. 83r-84v.

Kircher put Mersenne's proposal into action as part of his geographical project. Having performed numerous observations of the magnetic declination during his own perigrinations through Europe, and armed with the observations collected by his predecessors in the Collegio Romano, he wrote to distinguished mathematicians throughout Europe to solicit their measurements of the magnetic variation of their place of residence. He hoped that in this way they "would all be inspired to perform careful observations to determine this variation and other matters with which our Geographical Plan is concerned".[33] The outcome of this first attempt was disappointing. Kircher had "almost no news at all from the more famous mathematicians"[34], despite his entreaties. This required a change of plan. Taking advantage of a meeting of the Procurators (responsible for the financial affairs of each Province of the Jesuit order) in Rome in November 1639[35], Kircher asked each Procurator to solicit observations of the magnetic declination from the Jesuit mathematicians resident in the different cities of his Province. In addition to sending observations, each mathematicians was to explain in detail exactly what precautions had been taken, and what type of equipment had been used. Unlike the more famous mathematicians, a great number of their Jesuit contemporaries responded immediately[36].

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[33]Kircher, *Magnes* (1641[1], p. 430): "Communicato itaque cum Amicis consilio, una omnium fuit sententia, ut literae ad omnes Mathematicos saltem Europaeos mitterentur, quibus amice ad hanc variationum, uti & aliorum de quibus in nostro Consilio Geographico proprie agitur, omni studio peragendam observationem animarentur"

[34]"Verum cum, si paucos excipias, nullam fere singularem Mathematicorum celebriorum notitiam haberem, visum fuit tandem Societatis nostrae Mathematicis per Provinciarum Procuratores eodem tempore Romae congregatos facta, ad singulos literae datae sunt, quibus ad observationem variationis Magneticae singuli suis in partibus faciendam, quantum fieri posset efficaciter sollicitarentur", ibid.

[35]ARSI Congr. 7 ff. 46r-48v: Acta Congregationis Procuratorum anni 1639, incipit "Die Mercurij 16 nov. ex S. 3i. Form. Congr. Proc. praescripta cum aduenissent Roma multo plures ex PP. Procuratoribus ad hunc Coetum delictis". Two of the Procurators present at this congregation, P. Petrus Cazraeus and P. Nithardus Biberus subsequently corresponded with Kircher directly. See APUG 567 f. 192r (Cazraeus) and APUG 567 ff. 128r, 172r (Biberus)

[36]"[S]ed & aliorum auxiliatricibus, manibus ascitis, egregie peractam, Romam cum omnibus observationis factae circumstantijs & cautelis, transmiserunt; ostenderuntque insigni sanè hac eorum promptitudine, quam in Reip. Lit. bonum sint propensi quamque libenter operam suam in alijs maioris momenti observationibus imposterum sint collaturi", Kircher, *Magnes*, loc. cit..

Kircher published their observations along with those made by others in his *Magnes*. In recognition of the labours of his Jesuit helpers, performing observations of the magnetic variation in places as far apart as Goa, Paris, Macao, Alexandria, Constantinople, and Vilnius, Kircher published their names in a large table (fig. 25) reporting the magnetic declination and the latitude of the place at which the observation was made. Behind this table lies an enormous amount of labour, in the performance of observations in different urban centres, their transmission to Kircher and their tabulation.

Politically, it has been observed that the Jesuit order has a monarchical organizational structure, with great emphasis on obedience to commands issued to the periphery from the Roman centre[37]. Such a structure, to be contrasted with the capitular structure of the older monastic and mendicant orders[38], clearly lends itself extremely well to projects like the measurement of global magnetic variation. One of Kircher's more expert correspondents on magnetic matters, the French Jesuit Jacques Grandamy, made the congruence of absolute power and global observation very explicit when he suggested in a book published four years after Kircher's *Magnes* that kings and princes should order their subjects to measure magnetic variation diligently in the cities of under their rule, and that the General of the Society of Jesus should order his subordinates - Jesuit priests and brothers in different parts of the world - to do the same[39]. Although Kircher

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[37]Adrien Demoustier, *La distinction des fonctions et l'exercice du pouvoir selon les règles de la Compagnie de Jésus* in Luce Giard, ed., *Les jésuites à la Renaissance. Système educatif et production du savoir*, Paris: Presses Universitaires de France; 1995: pp. 3-33.

[38]On this point see John W. O' Malley, *The First Jesuits*, Cambridge, Massachusetts: Harvard University Press; 1993, p. 354 and the revealing comments made by Jeronimo Nadal in his Dialogus II (1562-1565), in *P. Hieronymi Nadal Commentarii de Instituto Societatis Iesu*, ed. Michael Nicolau, S.J. (= *Epistolae et Monumenta P. Hieronymi Nadal*, Tomus V) Romae: apud Monumenta Historica Societatis Iesu, 1962, pp. 601-774, on pp. 764-770 (*De ratione gubernationis*), e.g. p. 767: "[H]abet in ipsum imperium Societas ex ratione aristocratiae. Itaque contemperata quaedam est huius Societatis gubernatio ex aristocratiae imitatione et monarchiae, in qua gubernatione primarias quidem partes gerit aristocratia, autoritate ac potentia; cuius potentiae actum exercet Generalis Praepositus. Is enim nomine Societatis agit, quae agit omnia; neque enim aliter visum est commodius posse ministrari Societatem, sive ad unitatem animorum spectes, sive ad obedientiae perfectionem, sive ad negotiorum expeditionem, sive ad certitudinem consilii, sive ad abigendam ambitionem vel arrogantiam. Breviter: quam alia via non possint, hac saltem perfectissimam politiae rationem imitantur".

[39]Jacques Grandamy, *Nova Demonstratio Immobilitatis Terrae Petita ex Virtute Magnetica. Et quaedam alia ad effectus & leges magneticas, usumque longitudinum & universam Geographiam spectantia, de novo inventa.* Flexiae: Apud Georgium Griveau, Typographym

makes frequent reference to a "Republic of Letters" in his works, both he and Grandamy are clearly conscious that in the world in which they live, the command of an absolute authority, whether secular or clerical, is the most effective way of galvanising observers into action.

The letters sent to Kircher by his Jesuit informants reveal much of what is involved in making a collective experimental enterprise. Joannes Ciermans, writing to Kircher from Louvain, writes in tones redolent of the mathematical homosociality familiar to us from Grienberger's letters to Clavius: "Although the sky here is cold and cloudy, this is not true of my breast, under which something is warm and lives in ready obedience to Your Reverence. To accumulate together in the Father that which you estimate to bring splendour to his name and to that of our Mother, the Society, you will have a strong helper in me if you wish. For we know that it is not for one man to repair [*instaurare*] astronomy and geography, but requires the works of many mathematicians to be gathered together in one."[40] In Lithuania, on the request of the Provincial, Oswald Krüger took time away from his cooking-duties to observe the magnetic declination of Vilnius and two neighbouring towns and wrote to the Polish Provincial to encourage Jesuit mathematicians in the Polish province to do likewise.[41] The letters sent by

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Regium, & Henricae Collegij Societatis IESU; 1645, p. 83: " Quem in modum si qui varias orbis Regiones sive terra, sive mari percurrunt, diligentes essent in observatione verae inclinationis & declinationis magneticae, eademque coniugendâ cum alititudine poli in singulis locis, maxime in nobilissimis portubus, insulis, civitatibus; aut si plures periti conuenirent in eodem studio & diligenti observatione in uno aut pluribus regnis, non dubito quin brevi constaret cerus eorum locorum situs, quem magnetis globius aut acus ad eum usum apte concinnati certisssima designatione notarent. Unde etiam pari facilitate corrigi possent errores navigationum qui in longioribus tempestatibus & obscuritate Coeli contingere solent. Hoc autem praestare prae caeteris possent Reges & Principes imperando subditis ut in nobilissimis sui Regni civitatibus, & ad exteras Provincias navigationibus id diligenter observarent, & Admodum R.P. Generalis Societatis nostrae in eo magnam operam toti orbi Christiano praestaret, si idem iuberet Patres nostros in diversis mundi Regionibus & peregrinationibus annotare".

[40]Ciermans to Kircher, Lovanij 7. Martij 1640, APUG 567 f. 90r: "Quamuis enim hic frigidum nobis, & nebulosum sit coelum, non tamen pectus, sub quo aliquid calet, & vivit in obsequium R.V. paratum. Aggredere in Patre quae ad splendorem nominis sui, Matrisque nostrae Societatis facere existimabis, me, si voles adiutorem habebis strenuum. Scimus enim non unius hominis esse Astronomiam aut Geographiam instaurare sed multorum mathematicorum in unum collatâ esse operâ opus. "

[41]Oswald Krüger to Kircher, Vilnius, 21 July 1639, APUG 567 f. 53r "Scripsit ad R.P. Provincialem nostrum P. Gregorius Cisat nomine RVae inquirendo de acus magneticis, in nostris partibus, declinatione. Hac in re requisitus, significo RVae, me, quantum per culinares

Kircher's magnetic correspondents give a picture of an increasingly fervent exchange of magnetic needles, books, and observations in the early 1640s, continuing well after the appearance of the first edition of Kircher's *Magnes*. A correspondent in Mainz, a city where Kircher had previously taught for several years, though keen to send Kircher his measurements, was unable to be of any use because the marauding Swedish armies had taken every mathematical instrument in the Jesuit college, down to the last pair of compasses[42]. At the other end of the scale, Jacques Grandamy boasted of a new instrument which he had designed to measure both magnetic declination and inclination, or dip, with the utmost accuracy[43]. Others clearly didn't understand what they were supposed to do, and asked Kircher for clarification, while sending observations of questionable meaning. Along with the numerical measurements, Kircher's obedient observers often sent diagrams and other information to make their observational practices as transparent as possible to the "mathematical prince of our Society"[44] in Rome (fig. 26). Occasionally the task of observation was delegated by Kircher's correspondents to their subordinates: "The declination of the magnet from the Meridian, required by Your Reverence, has been investigated by Master Gaspar Schiess, the private mathematical disciple of Fr. Cysat", Jacobus Imhofer wrote to Kircher from Innsbruck on 15 January 1640. "He has used various needles, all of which disagree with each other, some indicating 4, some 6 and some 10 degrees [of declination]. He says that

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occupationes licuit, inuenisse, declinare acum magneticum a meridie in occasum, plus quam tribus gradibus, feci experientiam Vilnae, Nesuisij, et Orsae, quae Vilna orientalior est gradibus 5, Usus sum acu longitudinis sex digitorum: e pro maiore certitudine adhibui plurimas alias ex officinis in Germania magneti tinctas, omnes aequaliter occasum respiciebant. Differentiam declinationibus, in nominatis tribus observationis locis, non notavi. Ego licet ignotus, plurimum RVm rogo, velit mihi mittere partem heliotropij, quod ad motum solis obversum horas indicat, memor doni accepti coram Divina maiestate ero."
"...Scripsi ad P. Provincialem Poloniae ut si qui sint, scientiae huis periti, in Provincia ipsius, ijsdem proponat qui re examinata, pro honore Societatis pute stabunt, ut RV quod summi petij indicabunt."

[42]Henricus Marcellus to Kircher, Mainz, 1 May 1640, APUG 567 f. 213r

[43]Grandamy to Kircher, Touron, 9 May 1640, 557 ff. 400r-401v, on f. 400r "habeo peculiare Instrumentum in ea usu deferens acum subtiliter suspensam quae exactissime Inclinationem cum declinationem demonstrat."

[44]Henricus Marcellus to Kircher, Mainz, 1 May 1640, cit., "Quamuis minoris videantur momenti mea de Magnetica virtute, adversaria, quam ut in Urbem mittantur, *ad Principem Societatis nostrae Mathematicum*; quia tamen iteratis litteris ac sibi grata fori significat, ea mitto, qua subscrivit horis notavi.", my emphasis.

he is waiting for the arrival of Fr. Cysat, who has the best magnets locked-up, and that he will then make observations most diligently and send them to Your Reverence."[45] Jesuits world-wide begged Kircher to turn them into more efficient measurers. "If Your Reverence has some information about this practice", wrote Jacobus Durandus, "I would be most grateful if you could send it to me"[46]. Some sent reflections of a philosophical nature, querying the source of terrestrial magnetism, and Gilbert's suggestion that the earth was a large magnet. Others reported on magnetic magic, particularly Francis Line's magnetic clock composed of globe suspended in water that rotated to indicate the hours of day and night.[47]

A number of correspondents wrote independently to advise Kircher of some anomalous observations recently performed in England. The measurements of magnetic declination performed in Limehouse by William Borough, Edmund Gunter and Henry Gellibrand, successive professors of mathematics in Gresham College, recently founded to provide training in practical mathematics, appeared to show a decrease in magnetic declination between 1580 and 1634[48]. Mersenne, Gassendi, Pierre Bourdin and Jacques Grandamy all reported the same phenomenon to Kircher in their letters and speculated on its

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[45]APUG 567, f. 177r: Jacobus Imhofer to Kircher, Oeniponti, 15 January 1640: "Declinationem magnetis a meridiano, quam requirit R.V.a investigavit Magister Casparus Schiess, discipulus in Mathesi privatum Pis. Cysati. Adhibuit diversas lingulas, quae omnes inter se dissentiebant, aliis 4, aliis 6, aliis 10 gradus indicantibus. Dicit proinde videri sibi expectandum adventum Patris Cysati, qui optimos magnetes conclusos habet, tunc se denuo quam diligentissime observaturum, & ad Vam. Ram. missurum."

[46]APUG 567 f. 202r, Durand to Kircher, 12 March 1640: "si RVa aliquam de hoc praxim habuerit, gratissimum fecerit si dignetur perscribere".

[47]APUG 567 f. 159r, Laurentius Mattenkloth to Kircher, 8 March 1640, APUG 567 f. 24r-v (P. Gregorius a S. Vincentio to Kircher, 8 March 1640) : "Veterius quod addam non habeo nisi particulari aliquod inuentum cuiusdam P. Angli qui a paucis annis globum in aquis medijs aequilibrij beneficio constitutum in girum (beneficio ut aiunt Magnetis) ita circumvoluit ut horas perpetuas diei et noctis ostendat sed iste suo inventiones valde tenax est."

[48]On this episode, see Stephen Pumfrey, *"O tempora, O magnes!" A Sociological Analysis of the Discovery of Secular Magnetic Variation in 1634.* British Journal for the History of Science. 1989; 22: 181-214. The linguistic and cultural gulf separating the vernacular culture of the practical mathematicians of Gresham college from the Latin culture of the *Respublica litteraria* within which Kircher found a home is demonstrated by the length of time it took for Kircher to be informed about Gellibrand's work reporting these observations, *A Discourse Mathematical On the Variation of the Magneticall Needle. Together with its admirable Diminution lately discovered.* London: W. Jones; 1635.

possible causes[49]. Similar changes had been observed by Jesuit mathematicians in Rome and Bologna. Although Kircher recognised the difficulty which such observations posed to his project of using tables of declination to calculate longitude, he was hesitant to pronounce on the cause of this phenomenon, and effaced many of the cosmological speculations of his informants from the published work.

There is a fine balance, in this whole episode, between acknowledging the fallibility of the single observer/azimuth compass/assistant/witness/reporter and emphasising the immense power of a Jesuit experimental collectivity. Kircher's reaction to Gellibrand's observations, which were eventually to quash hopes for a geomagnetic method of marine longitude determination, is indicative of this tension. Every observer is born with original sin in Kircher's world. "A perfect observation, free of all error and falsehood could only be carried out by an angel", he claims in *Magnes*, so mere mortals must acknowledge their fallibility before jumping to conclusions of the nature of terrestrial magnetism or other questions of cosmological import. "While I assert this", Kircher continues, "nobody should think that I wish to detract from the most useful and absolutely necessary study of observations. I only wish to show how much caution, circumspection, industry and indefatigable labour is required in making observations, for them to be reliable".[50]

The Catholic Horoscope

Kircher's 1646 *Ars Magna Lucis et Umbrae* renewed Kircher's promise to publish his *Consilium Geographicum* for the collective restoration of all terrestrial knowledge. In the meantime, he provides his readers with a *Horoscopium Catholicum* - a composite

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[49]See APUG 557 ff. 41r-56v, and *Magnes* Lib. II. Pars V, Caput VI (p. 340 of 1654^3 edn.)
[50]*Magnes* (1641^1), p. 483: "ausim affirmare, observationem, ut perfecta sit, & omnis erroris fallaciaeque expers, ab Angelo fieri debere; Quod dum assero nemo, me utilissimo, & omnino necessario observationum studio quiquam detractum velim, existimet; sed hoc solum me intendere demonstrare, quanta in obserationibus faciendis cautela, circumspectione, industria, quam indefesso labore, ut ijs fidi debeat, opus sit".

sundial in the form of an olive tree (fig. 17) representing the different provinces of the Jesuit order that Kircher displayed to visitors to his museum in the *Collegio Romano*[51]. When a stylus was placed in each Province, and the device was positioned vertically so that the Roman time was given correctly, the clock allowed the time in all the different Jesuit provinces to be read correctly. In this way, the viewer could perceive that the Society of Jesus was performing its religious duties - masses, confessions, sermons and catechesis - throughout the world, day and night, with no interruption and in all known languages[52]. Kircher does not acknowledge any source for this remarkable invention, but it seems plausible that he may have drawn inspiration from a letter, now badly damaged, sent to Christoph Clavius by Robert Arden in 1587, describing a clock which would allow the coordination of the meals and prayers of Jesuits in Rome, Japan, the Moluccas and Peru[53]. Following emblematic themes developed in the 1640 *Imago Primi Saeculi Societatis Iesu*, celebrating the first centenary of the Jesuit order, Kircher's universal horoscope is the apotheosis of Jesuit globalism and clerical mechanization. Initially a cruciform version of the paper instrument was displayed, and dedicated to the new General Vincenzo Carafa on the day of his election[54]. Surmounted by a Habsburg eagle, carrying an Austrian [*Austri-acus*] compass-needle, a feature removed from the Amsterdam edition of the *Ars Magna* for the peace of mind of a Protestant readership,

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[51]See Kircher, *Ars Magna lucis et umbrae*. Romae: Ludovico Grignani; 1646, p. 553: "Horoscopium Geographicum universale Societatis Iesu construere, quo in omnibus Collegijs dictae Societatis toto orbe terrarum diffusis, quota hora sit uno intuitu demonstratur".

[52]Ibid.: "Uniuscuiusque vero Assistentiae Provinciae una cum Collegijs ad unamquanque pertinentibus ita disponuntur, ut styli horologijs singularum Provinciarum impositi, nomen IESU perfecte referant: imo non sine admiratione videbis machinam Soli expositam umbra sua perpetuo mobili, veluti quoddam nomen IESU ambulans ex Ortu in Occasum perpetuo umbratilis nominis incremento, ac decremento, non tam physica, quam mystica quadam ratione exhibere; ut vel id motu suo mirabili monstret, corruptibile non esse, quod dicinum Numen, nomenque tam largiter obumbravit".

[53]"Ex hac sola instrumente parte facile tota Societatis dispositio mira cum recreatione elucebit. dum enim Romae prandetis apparebit hoc in horologio alibi in Societate fratres nostros coenare ut Mala[cense]s alios iam ante horam cubitum inisse ut [Maacenses] et qui sunt in [Bandibus] Iaponiae alios tunc [intra] cubitum ire ut [....] alios [...] tunc surgere ut potosinos. [...] ita ut [*mutil.*] in Societate haberetur [*mutil.*] et sacrificiis [quasi] sine intermissione opera detur", Robert Arden to Clavius, Loreto, 1 January 1587, APUG 529 ff. 232r-233v, published in CC II.1, 88-91, on pp. 90-91.

[54]Kircher, *Ars Magna*, cit., facing p. 554, "Admodum Reverendo atque Religiosissimo Patri P. Vincentio Caraffae Soc. IESU Praeposito Generali. Athanasius Kircher, eiusdem Soc. offerebat. Romae ipso electionis die 7 Jan. anno 1646".

the olive-tree sun-dial was designed so that the shadows of the small gnomons, when aligned, spell the abbreviated name of Jesus, IHS, which appears to 'walk over the world' with the passing of time, like the synchronized, uniformly trained members of the Jesuit order who used the abbreviation as their symbol. Kircher's idealised Jesuit geography, placed on display to visitors in the Roman centre, comes to the heart of what is specific about Jesuit investigations of the natural world in the mid-seventeenth century.

But what of the great Geographical Plan? Giambattista Riccioli wrote to Kircher in 1642 to ask about when the *Consilium Geographicum* might at last appear in print. Riccioli had collected a vast number of observations himself, and conducted a lengthy series of experiments on precision time-measurements using pendulums which he applied to making eclipse observations. In some ways providing a competing model to Kircher's Utopian information-community, Riccioli surrounded himself with local disciples willing to observe pendulum oscillations for consecutive periods of up to twenty-four hours at a time, and extremely precise observational instruments[55]. Riccioli's impatience to see Kircher's *Consilium Geographicum* in print was in vain. In the 1654 edition of the *Magnes*, edited and amplified by Kircher's disciple Gaspar Schott, it became clear that the great geographical plan would never be revealed. "When I was keeping the work, composed with no small effort, amongst other things, in my Museum, and waiting for the right moment to publish it for the good of the Republic of Letters, it was secretly removed by one of those people who come to me almost every day from all over the world to see my Museum"[56]. Kircher's project for a universal reform of terrestrial

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[55]On Riccioli's time measurements see Alexandre Koyré, *An experiment in measurement*. Proceedings of the American Philosophical society. 1953 Apr; 97(2): pp.222-237, and Paolo Galluzzi, *Galileo contro Copernico.* Annali dell' Istituto e Museo di Storia della Scienza di Firenze. 1977; 2: pp.87-148. On Riccioli's early training, see Ugo Baldini, *La formazione scientifica di Giovanni Battista Riccioli*. in *Copernico e la questione copernicana in Italia*, a cura di Luigi Pepe, Firenze: Olschki; 1996: 123-182. (Pubblicazioni dell'Università di Ferrara; v. IV). On Riccioli's cosmology see Alfredo de Oliveira Dinis, *The cosmology of Giovanni Battista Riccioli (1598-1671)*. PhD thesis, Cambridge: Cambridge University; 1989, which includes an extremely useful intellectual biography (Chapter 1).

[56]*Magnes* (1654[3]) p. 294: "Dissimulare hic non possum animi mei iustum dolorem, quem ex iactua praefati consilii Geographici precepi: cum enim opus non sine vigilijs elaboratum, inter alia in Musaeo meo conservarem, tempusque opportunum in lucem publicam litterariae

knowledge through the concerted agency of the Jesuit order was stolen! The mysterious theft of the *Consilium* from Kircher's museum conveniently relieved him from the need to produce a method for determining longitude at sea by magnetic declination, an obligation that had become increasingly complicated with further observations of the temporal instability of declination, despite the continued optimism of Kircher's Jesuit disciples for the magnetic reform of geography and hydrography[57]. Even before the disappearance of the *Consilium*, Kircher's longitudinal concerns had swung decisively landwards. He wrote to Gassendi in 1642 to say that Cardinal Francesco Barberini was urging him to coordinate eclipse observations, in the same way that he had coordinated measurements of magnetic declination two years previously[58]. As with the declination observations, Kircher demanded that his informants on eclipses provide him with all of the details of the circumstances under which the observations were carried out, the names of those who were present as "indicators [*indices*] and witnesses of the said eclipses"[59].

The Kircher-Riccioli Dispute: Mobility, Patronage and Censorship

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Reipublicae bono emittendi praestolarer; ab uno illorum, qui quotidie paene Musaei inspiciendi causa ad me undique confluebant, clam subductum est".

[57]See e.g. Kircher, *Magnes*, 1654[3]pp. 348-40 Martino Martini to Kircher, Goa, 8. November 1640, "... Inventio longitudinis per Magnetem apud me non amplius est impossibilis, imo inventam omnino existimo, saltem speculative, practice autem prae temporeis brevitate non sum hactenus expertus, sed res in mente ita se habet. Conficiatur charta seu mappa hydrographica eo plane modo, quo communiter Naucleri utuntur: deinde hoc inventum addatur: Per duo loca, quae quam proxima sunt ad eundem meridianum, in quibus figit Magnes, licet latitudinem variatam multum habeant, ducatur linea quae totam chartam recte scindat, v.g. ducatur per caput das Agulhas & per Hierosolymam linea recta, quae per totam chartae latitudinem extendatur (in his enim duobus locis, tu asserunt, figit Magnes); deinde huic lineae ducantur prarllelae ex omnibus locis, in quibus Magnes figit, v.g. ex Insula del Corvo, ex Petra Blanca, ex flumine Magno Cantao, & praeterea ex locis ubi maxima est deviatio Magnetis &c. hae lineae licet in polis non concurrant, tamen repraesentabunt magneticum meridianum."

[58]"Me igitur continuis sollicitantes precibus, & prae caeteris ipse Eminentissimus Cardinalis Barberinus instanter urget; ut qua industria magneticas declinationes observari curassem, eadem & duarum huius anni futurarum Eclipseon observationes institui curarem; quorum quidem aequae & laudabili postulationi refragari nefas esse duxi", Kircher to Gassendi, Rome, 13 February 1642, published in Gassendi, *Epistolae*, cit., p. 446.

[59]"Quo facto obnixe rogo, ut pari studio singulas observatae Eclipseos circumstantias, una cum eorum, qui praesentes, & dictae Eclipsis indices, testesque fuerunt, Mathematicorum nominibus comprehensos Romam transmittere dignetur", ibid.

Giambattista Riccioli probably received a similar request at this time. In any case, he wrote to Kircher shortly afterwards to say:

> I have exquisite instruments [*organa*] in which, for reasons explained in an astronomical work that I have in my hands, I place my trust more than in those of Tycho himself, even if that great man got very close to the truth. I also have four of ours [i.e. Jesuits] who are extremely well trained and are both my witnesses and my assistants in conducting observations. I send the times of the eclipse counted both by the intervals of the motion of the pendulum after the transit of Arcturus, and deduced from the heights of Arcturus, Speca and Aquila, without any other calculations which I know would be superfluous to Your Reverence. We used optical tubes to distinguish the spurious eclipse from the true one[60].

In the end, it was Riccioli, not Kircher, who published a *Reformed Geography*, incorporating many of the observations previously published by Kircher into his tables and adding observations performed by himself and supported by the financial resources of the extremely wealthy Grimaldi family of silk-merchants[61]. Well before he did so, however, he was subjected to a process of censorship that reveals something of the tension between local and non-local modes of natural investigation in the Jesuit order.

On 24 November 1646, Riccioli was forwarded a copy of an anonymous censure from Rome. The letter requested him to "send to Rome that part of his work which is entitled 'On my own Discoveries', so that it can be known what he will put forward that is new with respect to the most excellent artificers Tycho, Kepler and Lansberg whose expenses in this matter of such great importance were supported for all their lives by Emperors and Kings". The anonymous Censor also asked "What methods and instruments were used to observe the motions of the stars", and insisted that Riccioli

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[60]"Habeo enim organa exquisita, quibus ob rationes in astronomico opere quod iam prae manibus habeo exponendas, magis fido quam Tychonicis ipsis, etsi magnus ille vir valde prope ad veritatem accessit; habeoque quatuor ex nostris optime instructos qui mihi in observando et testes et adiutores sunt. Tempora eclipsis tum numberatis ad perpendiculi motum intervallis post transitum Arcturi, tum ex altitudinibus Arcturi, Spicae, et Aquilae deducta mitto absque alio calculo quem R.V. superfluum esse scio. Adhibuimus autem tubos opticos ad discernendam eclipsim supriam a vera", Riccioli to Kircher, Bologna, 5 July 1642, APUG 561 ff. 177r-178v, published in Ivana Gambaro, *Astronomia e Tecniche di Ricerca nelle lettere di G.B. Riccioli ad A. Kircher*. Genova: Quaderni del Centro di studio sulla storia della tecnica del Consiglio Nazionale delle Ricerche 15.; 1989, pp. 44-52, on p. 44.

[61]Giambattista Riccioli, *Geographiae et hydrographiae reformatae*, Bologna; 1661, second edition: Venetiis, Typis Ioannis La Nou, 1672. For Riccioli's consideration of the longitude problem and magnetic declination see Lib. VIII, *Geomecographus*, Cap. 12-16, in op. cit., 1672[2] pp. 326-350.

"should also send that part of the work which he calls Instrumental Geography, so that it can be known from this what method he will use in emending and assigning the true longitudes of regions. For this is a task not for a single man, but such as deserves the unanimous collaboration of all the mathematicians of the Society".[62]

The tone of the censure clearly recalls Kircher's geographical project, and, indeed the handwriting of the anonymous text is a convincing match with Kircher's letters from the period, providing further confirmation of his authorship[63]. Riccioli sent a chastened official response to the Roman Censor[64], but Kircher sent a further, private letter to him at this time that included a number of more damning criticisms voiced by other people both inside and outside the Jesuit order. To this second letter, Riccioli responded at some length[65].

Dismissing as absurd the criticism that Riccioli, a theologian, should not engage in mathematics because it was "unbecoming for a single person to profess two different

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[62]"Desideratur a P. I. Baptista Ricciolo, ut Romam mittat eam operis sui partem, quam de propriis inventis inscribit. Ut primo cognoscatur, quid post tot eximios Artifices Tychonem, Keplerum, Lanspergium, qui huic tanti momenti negotio totam vitam Caesereis regiisque expensis incubuerint novi praestiterit. Quibus instrumentis et qua methodo in observandis syderum motibus usus sit. Mittat quoque eam partem quam Geographiam instrumentariam appellat, ut inde cognoscatur, quem in emendandis assignandisque veris Regionum longitudinibus modum tenuerit. Est enim hoc opus non unius hominis, sed tale, quod unanimem omnium totius Societatis Mathematicorum conspirationem mereatur. Si tamen promissa exolverit certe opus in magnum honorem et existimationem Societatis redundaturum nihil dubito", ARSI FG 662, f. 477 r, published in Gambaro, *Astronomia e Tecniche di Ricerca*, cit., p. 40, and re-transcribed (with amendments) in Baldini, *La formazione scientifica di Giovanni Battista Riccioli*, cit., p. 176, note 55.

[63]Gambaro (op. cit.) adduces no hypothesis concerning the authorship of the *censura*, whereas Baldini (op. cit.) explicitly dismisses the possibility of Kircher's authorship on the basis of a later letter from Riccioli to Kircher. However, the letter in question, discussed below, refers not directly to the anonymous *censura*, but to a letter, now lost, from Kircher to Riccioli reiterating some of the points in the original censure and adding a number of other points of contention concerning Riccioli's way of life. It is from these other points (particularly the inability of a single person to be proficient in two different faculties simultaneously) that Riccioli dissociates Kircher. Taken in its entirety, the existing evidence is entirely compatible with Kircher's authorship of the original anonymous *censura* of ARSI FG 662, f. 477 r.

[64]Riccioli to the Roman Censor, n.p., n.d. [Bologna, between 24 November and 22 December 1646?], published in Gambaro, *Astronomia e Tecniche* , cit., pp. 70-76.

[65]Riccioli to Kircher, Bologna, 22 December 1646, published in Gambaro, *Astronomia e Tecniche* , cit., pp. 77-81.

faculties", Riccioli invoked a number of illustrious polymaths, ranging from Thales to Tycho Brahe and Kircher himself. "To speak freely to you", he continued to Kircher, "it was worthwhile procuring a vacation from theology, and refusing the administrative offices that I was offered more than once, acquiring from whatever source the money necessary for the construction of instruments and observational glasses, and wearing away my health by so many long night vigils, that all of whatever mind I had, nay, not mind, but back and upper-arms, has been expended as if from rolling a great weight ahead of me."[66] Riccioli also defended himself strenuously against the accusation that he relied solely "on the judgements of [his] pupils"[67]. The following objection, however, was that Riccioli was a "private man" - "that is, as I interpret it, that I do not supply the expenses necessary for this business, but that they are supplied by my disciples from most noble families, Fr. Alfonsus Gianoti rector of this College, Marquis Cornelius Malvasia and, in the first place, by the Grimaldi, a most opulent family of this city"[68]. Riccioli did not deny the charge - "Certainly our metal instruments are present in the college, and I did not create them out of nothing"[69]. However, the expenses incurred in instrument-building were justified by their capacity to enhance the reputation of the Society for mathematics and to bring direct returns:

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[66]"Ago plurimas R.V.ae gratias pro sinceritate qua monitum me de multis voluisti, nec parum recreatus sum ex iudicium qui putant neminem posse pro dignitate duas facultates profiteri. Quasi vero mathesim inviderit Thaleti physicarum rerum contemplatio, Sosigeni, ut ex Proclo habemus, peripateticae philosophiae professio, Boetio, Bedae, Petavio nostro et similibus Theologia ac Philosophia, Gassendo Philosophia, Wendelino prudentia in unum etiam num ita Atlanticas molitur tabulas ut scribat de lege salica, et ne longum faciam, Tychoni Spagiricae et Chimicae indefessum studium, tubuque Idiomatum ac tot arcanorum abstrusa et profunda peritia. Sed ego illos prae te nihil moror multoque minus Parisiensem illum, qui adeo leviter, ne dicam temere, iudicat a nemine praestari posse quod ipse desperaverit, ut etiam putet me aliorum tabulas mere describere. Enimvero ut tecum libere loquar, operae pretium erat vacationem a Theologia impetrare, recusare gubernationes non semel oblatas, conquirere undecumque impensas pro organis et observationis speculis construendis, vigiliis ad tam multas noctes protractis valetudinem atterere, ut tandem totum qualecumque ingenium meum describendis alienis numeris enim non ingenium sed tergus et lacertos tamquam moli trusatili versandae impendere", ibid.

[67]"Primum est me solo iudicio discipulorum meorum stare, id vero perquam falsum est", ibid., on p. 78.

[68]"[Secundum] est me hominem privatum esse, hoc est, ut ego interpretor, non suffecisse impensis huic negotio necessarijs, at suffecerunt mei discipuli ex familijs nobilissimis et P. Alfonsus Gianotus Rector huius Collegij et Marchio Cornelius Malvasia et in primis DD. Grimaldi opulentissimi huius civitatis", ibid., loc. cit.

[69]"Certe extant metallica nostra organa in hoc Collegio et ego non de nihilo ea creavi et patent ac patuerunt tam multis ut mirum sit dubitari de hoc posse", ibid., loc. cit.

> To inspect and to be witnesses on one occasion or another, were not only ours [i.e. Jesuits], but also other men of this city, and they were astonished by the agreement of the different instruments, directed towards the same star, to the minutes. And, among others the same Rocca [i.e. Giannantonio Rocca] remarked that he would trust (hold back your envy of the word) my observations no less than those of Tycho himself. Dr. Antonio Roffini was so captivated by [the instruments], that although he was previously hostile to ours [i.e. the Jesuits], he will bequeath his library, most richly provided with mathematical books, to our College.[70]

Perhaps most revealingly, Riccioli politely refused Kircher's request that he should move to Rome:

> I say sincerely that there are reasons why I cannot do so without great damage to my work. Where you are, I cannot hope for the instruments and the books which, in addition to the library I already mentioned, I am given freely by the Marquis Malvasia, P. Cavalieri, P. Ricci, Dr. Manzini and others who are extremely well provided with them, far less the enormous gnomon which I use in the church of S. Petronius. Two Coriolians, engravers of figures in wood which are so fine that they seem to be in copper, and who are now obliged to me, as is the caster of new print-characters; the said D. Cornelius Malvasia Vexillifero, now a Senator, who encourages me and helps to cover my expenses together with the Most Eminent Cardinal [Girolamo Grimaldi] , who also expects the book to be dedicated to him -- all of these, I say, I cannot hope to find elsewhere.[71]

Where Kircher saw the acquisition of natural knowledge as operating through a centralised global epiistolary network of Jesuits, Riccioli's project was irretrievably

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[70]"[I]nspexere, et testes aliquando fuere multi non modo ex nostris, sed ex externis huius civitatis viris et stupuere diversorum instrumentorum in idem sydus directorum conspirationem usque ad minutias, et inter alios praedictus Rocca asseruit se non minus meis observationibus quam Tychonicis (sustine invidiam verbi) fidere. Illis vero ita captus est D. Antonius Roffinus, ut cum antea esset nostris infensus, in tanti operis gratiam, legarit Collegio nostro Bibliothecam suam instructissimam libris mathematicis".

[71]"Quod denique peramice sane hortaris ut Romam veniam, dicam sincere causas ob quas non possum sine maximo operis mei dispendio. Instrumenta istic et libros quos praeter dictam bibliothecam suppeditant mihi Marchio Malvasia, P. Cavalerius, P. Riccius, D. Manzinus et alij qui illis instructissimi sunt, multoque minus Gnomonem illum magnum, quo in Si. Petronij templo utor, non possum; duos Coriolanos incisores lignearum figuram adeo subtiles ut aenei videantur, et mihi obligatos iam sicut et Typographum novorum characterum fusorem, urgente praedictro D. Cornelio Malvasia Vexillifero nunc Senatus et suo et Eminentissimi Cardinalis [Grimaldus] qui ad impensam concurret, quique sibi librum dicandum praestolatur, hos inquam sperare alibi non possum", ibid., p. 81. See G.-B. Riccioli, *Almagestum Novum,* Bononiae: Ex Typographia Haeredis Victorij Benatij; 1651, Sig. *A^r - $A2^r$, letter of dedication to Princeps Hieronymus Cardinalis Grimaldi. For the involvement of Francesco Maria Grimaldi in the work see Sig. $A2^r$: "Nempe supra istius in me Domus munificentiam, P. Franciscus Maria Grimaldus e Soc. nostra Matheamtum Professor, suum operi huic nostro studium, verius dicerim se se totum superimpendit. Adfuit ille mihi cacelestia observanti Phaenomena, siderum ipse dexterrimus observator. Interfuit scribenti, de ingenij sui vena, nec pauca, nec poenitenda suggerens. Praefuit demum voluminimum editioni, labore indefesso, fide inviolabili, acri iudicio, sincera libertate, vigilantia obstinatissima: sed plura non amplius addo, ne ingenui ac religiosi maxime in hac parte viri, verecundiam lacessam ad iracundiam".

local. Apart from his own body, he could not even send the parts of his book that Kircher requested from Bologna to Rome because "the affectations of my health and my stomach pains"[72] rendered copying out the different parts of the book an impossibly arduous task. Local patronage, books, instruments, artisans, and Ignazio Danti's utterly immobile meridian line in S. Petronio[73] -- a fitting foil, perhaps, to Kircher's universal Jesuit horoscope -- conspired to prevent his removal to Rome. Where Kircher concentrated his energies on marshalling a distant community of observers, Riccioli cultivated close local friends and disciples. Too close, occasionally - his celebrated relationship with Francesco Maria Grimaldi extended to allowing the latter to shave him and cut his hair, and the tendency for the older Jesuit to entertain his younger disciple in his bedroom late at night, after the other members of the community had gone to bed, led to rumours reaching the ears of the General, who obliged Riccioli, against his protestations of health problems, to move from Parma to Bologna[74], where Grimaldi would eventually join him.

How should nature be investigated?

We have seen that for Athanasius Kircher, the Jesuit role in reforming natural knowledge was utterly continuous with the other parts of Jesuit ministry, a continuity that is emblematically represented by the marriage of longitude and prayer in Kircher's *Horoscopium Catholicum Societatis Iesu*. The self-effacing, centralised bureaucracy of natural knowedge encapsulated in this idea implies a certain reworking of the relationship between human expertise, observational instruments, techniques for

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[72]ibid. Riccioli's decline in bodily powers during the period prior to the publication of the *Almagestum Novum* is corroborated by the *Catalogi Triennales* for the period: on 15 May 1645 his "vires" are reported to be "mediocres", by 15 September 1649 they have become "imbiscelles", and by 1 October 1651 they are reduced to "debiles". See ARSI Ven. 40 ff.18v, 48v: #11 (for 1645), ibid., ff. 94v, 125v: #16 (for 1649), ibid., ff.178r, 204r: #14 (for 1651).

[73]On the use of meridian-lines in churches, including S. Petronio, to perform astronomical observations see John L. Heilbron, *Science in the Church.* Science in Context. 1989 Mar; 3(1): 9-29.

[74]See Muzio Vitelleschi to the Provincial for the Veneto, 13 September 1636, ARSI Ven. 1, f. 318v, cited in Baldini, *La formazione scientifica di G. B. Riccioli*, p. 174, note 40.

reporting and transmitting observations and local factors. What makes Kircher's project specifically Jesuit? One might approach this question on a number of levels: Kircher's harnessing of an existing Jesuit infrastructure -- the three-yearly congregations of provincial procurators in Rome -- to disseminate his observational imperative and his apparent reliance on Jesuit couriers to receive his responses. While central Europe was undergoing a revolution in postal service from the late sixteenth century on, with the rise of the Habsburg Taxis[75], the Jesuit "monarchy" generally functioned as its own postal service, through the extreme mobility of its subjects[76]. Apart from pointing to the importance of the Jesuit infrastructure for Kircher's project, one might point to the ethical codes enforced by Jesuit spiritual training, and the Ignatian *Constitutiones*, particularly as they relate to modesty, obedience and the union of souls in the Society through the frequent exchange of letters. The type of humility and self-abnegation involved in surrendering the results of one's labours to be published by someone like Kircher was particularly encouraged in the Jesuit order, as we have seen for the case of Christoph Grienberger. One might point to the vantage point enjoyed by Kircher - his room in the Collegio Romano, his ready supply of willing collaborators, his "mathematical archive" inherited from Clavius and Grienberger, his access to a vast stock of printed and manuscript works of a mathematical nature. One might look to the common culture, in terms of mathematical training, instrument-making and literary ability that gave Kircher and his distributed correspondents a shared basis for communication, a culture fostered by the Jesuit collegiate structure. Finally, one might look to a Jesuit tradition of precision measurement - ranging from Juan Bautista Villalpando's recovery of ancient metrology in his *Apparatus Urbis ac Templie*

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[75]See Gerhard Dohrn - van Rossum, *History of the Hour: Clocks and Modern Temporal Orders*, cit., pp. 335-340, E. John B. Allen, *Post and Courier Service in the Diplomacy of Early Modern Europe*. The Hague: Martinus Nijhoff; 1972.

[76]Mobility was central to the Jesuit apostolate from the very beginning, as Ignatius explained to Ferdinand I, King of the Romans in 1546: "Thus the spirit of the Society is to move on from one city to another in complete simplicity and modesty, and from one district to another, not to settle ourselves in one specific place" MHSI, I, 450-53, translated in *Saint Ignatius of Loyola: Personal Writings*, transl. Joseph A. Munitz and Philip Endean, London: Penguin; 1996, pp. 168-170.

Hierosolymotani[77] to Grienberger's trigonometric tables and star-charts, and the measurements performed by the "human-metronomes" who aided Riccioli in the preparation of his *Almagestum Novum*. [78]

[77]Villalpando, *Apparatus Urbis ac Templie Hierosolymotani* Rome, 1604, pp. 433-550. For the metrological/experimental aspects of Villalpando's work see the discussion in P. D. Napolitani, *La Geometrizzazione della realtà fisica: il peso specifico in Ghetaldi e in Galileo.* Bolletino di Storia delle Scienze Mathematiche. 1988; VIII: pp.139-237.
[78]See Alexandre Koyré, *An experiment in measurement*, cit., and Galluzzi, *Galileo contro Copernico*, cit.

CHAPTER 5

DISCIPLINE AND AUTHORITY

Introduction

Clavius's vision of a distributed community of trustworthy Jesuit mathematical practitioners, entrusted with the education of the sons of princes, respected by natural philosophers and theologians, and maintained in a fraternal bond through the frequent exchange of letters, was clearly well-suited to the structure of the Society of Jesus as a whole. Nonetheless this chapter will argue that the relationship between being a Jesuit and being a mathematical practitioner was made far more complex by the enormous differences that existed between the various contexts in which Jesuit mathematicans carried out their work. Although Christoph Grienberger, cocooned within the protected space of the Collegio Romano, might manage to reconcile exemplary Jesuit behaviour with mathematical work, for members of the Order who were obliged to live their lives in less shielded circumstances strong tensions could emerge between the types of behaviour expected of them as Jesuits and the type of behaviour required of courtly mathematical practitioners. In 1631 Muzio Vitelleschi could chasten Paul Guldin and Henricus Philippus for possessing mechanical clocks [*horologij rotati*], seen by Vitelleschi as "utterly incompatible with the religious poverty of the Society of Jesus", despite the attempt by the mathematicians to advise the General that such clocks were a necessary item of astronomical equipment, rather than a luxury item.[1] The tension could run deeper, however, as demonstrated by the participation of two Jesuits, Christoph

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[1]Vitelleschi to Guldin, Rome, 12 July 1631, ARSI Austr. 4 I, pp.484: "cum horologio rotata inter instrumenta mathematica compari non soleant, et si horologio aliquando opus fuerit dubiter cum eidem Domino Praefecto facendum erit, ipsi proculdubio non sit defuturus quo instruere. Utatur Qoare RV. precor non moleste fera sibi non concedi quod Societas religiosa paupertati consuit minime convenire", Vitelleschi to Henricus Philippus, ARSI Austr. 4 I, pp. 484-5: "Usum horologi rotati R.V. cupidissime concederem, nisi viderem me eo concesso rogendum ad idem pluribus, qui non minus illo quas R.V. reputant indigere, concedendum. Quare ne suo exemplo permittere cogar pluribuas talis machinulae usum quam Societas puritati religiosae paupertatis adversari censuit, rogo ut pro sua religiosa paupertatis amore, nolit se alijs exemplum fieri quo liberus peta ut se lege illa paupertatis solui".

Scheiner and Melchior Inchofer, in the events surrounding Galileo's trial of 1632-33. Inchofer's hopes to standardise the philosophical and theological doctrines taught in Jesuit colleges and printed works by members of the order, as part of a general attempt to reform the corruptions of the Society, culminated in a lengthy process of disciplinary enforcement in the 1640s, leading to the *Ordinatio pro Studiis Superioribus* of 1651.

The trial of Galileo and the credibility of the Jesuit mathematical practitioner

On 17 August 1633, less than two months after Galileo had publicly abjured the central tenets of the Copernican theory in Rome, Nicholas Fabri de Peiresc wrote from Aix to Athanasius Kircher in Avignon:

> I am more than a little sorry for Father Scheiner's poor adversary, and do not know how this can have come to pass as he only treated the question problematically, without declaring himself in favour of one opinion or the other. That is the way of the world. Certainly, he cannot excuse himself for treating Father Scheiner as badly as he did, but this would have been sufficiently repudiated in the Volume *Sol Mobilis*, which would even have reduced it *ad metam non loqui* as we say. For he had only to contradict him, which would have satisfied anyone else and would have allowed him to live in peace for the few days which remain to him. But God has reserved that mortification for the Glory which he had in discovering so many marvels in the heavens which were unknown before him. All because he envied Father Scheiner the discovery of sunspots and their motion, which then allowed him to induce the movement of the body of the Sun about its centre, which I regard as extremely important for the knowledge of Nature.[2]

This letter suggests that for Peiresc there was little doubt that the fate of Galileo was directly linked to his long-standing and bitter controversy with the Jesuit Christoph Scheiner over the discovery of sunspots[3]. As Peiresc had been keeping a close eye on the activities of Scheiner's *pauvre adversaire* ever since his meetings with Galileo in

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[2]"Je deplore bien un peu le pauvre adversaire du P. Scheiner, et ne sçay comment cela peult estre allé, puis qu'il n'avoit traité la question que comme problématique sans se declarer ne d'un advis ne de l'autre. C'est le monde. Certainement il ne se peut excuser, de n'avoir eu tort de traicter mal ledit R. P. Scheiner comme il avoit faict, mais on la luy avoit bien rendüe dans le volume du sol mobilis, jusqu'à le reduire ad metam non loqui comme l'on dict, car il n'eust sceu que contredire, de quoy un autre se seroit contenté, et l'auroit laissé vivre en paix, le peu de jours qui luy restent. Mais Dieu luy reservoit encore cette mortification, à la gloire qu'il avoit eüe en la descouverte de tant de merveillers des cieux incogneües auparavant luy. Pour avoir // envié au R. P. Scheiner la descouverte des macules solaires, et de leur mouvement qui a depuis fait induire le mouvement du corps du soleil al'entour de son centre, que j'estime grandement important, en la cognoiscance de la Nature", Nicholas Fabri de Peiresc to Athanasius Kircher, Aix, 17 August 1633, APUG 568, ff.198r-199v, on f. 198r-v.

[3]On the sunspots polemic, see especially Feldhay, *Galileo and the Church*, cit., pp. 256-291, A. Favaro, *Oppositori di Galileo, III. Cristoforo Scheiner*. Venezia, 1919 and W. R. Shea, *Galileo, Scheiner and the Interpretation of sunspots*, Isis, 61; 1970: 498-519,

Padua in 1601, his opinion on the matter carries some degree of weight[4]. His principal sources of information on this point seem to have been Gabriel Naudé[5] and Kircher himself. Naudé, then the librarian of Cardinal Giovanfrancesco dei Conti Guidi di Bagno, was very quick to cast suspicion on the involvement of the Jesuits in the trial of Galileo. He wrote to Gassendi from Rome in April 1633 to say that "the mob is bankrupt of [the *Dialogo*] in this country, because of the curse pronounced on [Galileo] by the Court of Rome, where Galileo has been summoned through the machinations of Father Scheiner and other Jesuits, who want to ruin him, and would assuredly have done so if he wasn't powerfully protected by the Duke of Florence"[6].

Kircher, on 9 August 1633, amplified the rumours that were already beginning to circulate in France by sending Peiresc a copy of a letter sent to him by Scheiner three weeks previously. In this letter Scheiner had described Galileo's act of obeisance to the Holy Office:

> A few days ago Galileo abjured and damned his opinion on the immobility of the sun and motion of the earth, before the Inquisitor and in the presence of 20 witnesses, *de vehementi,* that is to say vehemently suspected of heresy. His book will be banned.[7]

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[4]On the relations between Peiresc and Galileo see A. Favaro, *Amici e Corrispondenti di Galileo*, ed. Paolo Galluzzi, Firenze: Libreria Editrice Salimbeni; 1983, pp. 1535-1582 (*s.v.* Niccolò Fabri di Peiresc).

[5]Peiresc wrote to Gassendi that "M. Naudé m'escript que le P. Scheyner escrivoit dez lors ex professo contre le pauvre Galilée, qu'il travailloit puissamment et avec grandissime animosité, à ce qu'on leur mandoit de Rome; dont les effects n'ont que trop paru à mon grand regret et peult estre au dezadvantage des arts liberaulx", Peiresc to Pierre Gassendi, 25 June 1633, OG XV pp.164-165.

[6] OG XV pp. 87-88. See also Pietro Redondi, *Galileo Heretic*, transl. Raymond Rosenthal, Princeton: Princeton University Press; 1987 (orig. publ. 1983), p. 34.

[7]"Galilaeus paucis ante diebus abiuravit et damnavit suam de stante sole de motu terrae, sententiam, coram Inquisitore, in praesentia 20 testium, ut vocant de vehementi, laborans vehementi haereseos suspicione. Liber eius proscribetur" Scheiner to Kircher, Rome; 16 July 1633; in Kircher to Peiresc, Avignon, 9th August 1633, BN Fonds Français, no. 9538, f. 227r. See OG XV p.184 for an excerpt from Scheiner's letter. Peiresc's interpretation of this letter is clear from his letter to Gassendi of 12 August 1633: "Vous aurez aussy une lettre que m'a escripte le bon P. Athanaze Kircher, où il en a transcrit une aultre par lui reçeüe du P. Scheiner de Rome, ou vous serez bien aise de voir à quel poinct monte l'estime qu'il faict de vous, mais bien mortifié aussy de voir ce qu'il y dict du pauvre S^{r} Galilée, que je plains grandement; ce que je seroys bien d'advis de ne pas divulguer, si vous m'en croyez, pour bons respects, puisque la chose avoit esté tenüe dans Rome si secrette jusques à present. Si cela se doibt publier, il vauldra mieux qu'il vienne d'aultre main que de la nostre" OG XV p. 219

The tradition of ascribing the downfall of Galileo to the unseen hand of his Jesuit adversaries is one which has persisted in the historiography of the trial from the outset. Descartes was expressing an opinion that was already widely accepted when, in February 1634, he confessed to Mersenne that "I have allowed myself to be persuaded that the Jesuits aided in the condemnation of Galileo"[8]. Such a hypothesis finds a certain amount of circumstantial support from some of the surviving documents of the time, such as the reported claim made by Christoph Grienberger that "If Galileo had remained a friend of the Fathers of this College, he would be honoured in the world and would not have incurred any of his misfortunes. He could have gone on writing freely on any subject, including the motion of the earth".[9]

Amongst the Jesuits suspected of having formulated a denunciation against Galileo's *Dialogo*, initiating the process that led to the events of 22 June 1633, none has seemed a more likely candidate for the deed than Scheiner[10].

His acrimonious rivalry with Galileo is legendary, and his furious white-faced reaction to the publication of the *Dialogo* has been frequently cited.[11] His proclamation in a letter to Gassendi in February of the year of Galileo's trial that "I am preparing to

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[8] "Je me suis laissé dire que les Jésuites avoient aidé à la condamnation de Galilée", Descartes, *Oeuvres,* Correspondance I, pp. 281-282

[9]Galileo to Elia Diodati, Florence, 25 July 1634, OG XVI, p.117

[10] On Scheiner see the Lamalle biographical card in ARSI, the works cited in note 5 above, Franz Daxecker, *Briefe des Naturwissenchaftlers Christoph Scheiner SJ an Erzherzog Leopold V von Österreich Tirol 1620-1632*, Innsbruck: Publikationsstelle der Universität Innsbruck, 1995, A. von Braunmühl, *Christoph Scheiner als Mathematiker, Physiker und Astronom*, Bamberg, 1891, A. Müller, *Der Galileo-Prozess (1632-1633) nach Ursprung, Verlauf und Folgen dargestellt*. Freiburg im Breisgau: Herdersche Verlagshandlung; 1909, Corrado Dollo, *Tanquam nodi in tabula-tanquam pisces in aqua. Le Innovazioni della cosmologia nella Rosa Ursina di Christoph Scheiner*, in *Christoph Clavius e l'attività scientifica dei Gesuiti nell'età di Galileo*, edited by Ugo Baldini. Rome: Bulzoni; 1995, pp. 133-158 and Steve J. Harris, *Les chaires de mathématiques*, in L. Giard, ed., *Les jésuites à la Renaissance. Système educatif et production du savoir*, Paris: Presses Universitaires de France; 1995, pp. 251-261.

[11]Benedetto Castelli to Galileo, 19 June 1632, in OG XIV p. 360 "Il Padre Scheiner, ritrovandosi in una libraria dove un tal padre Olivetano [Vincenzo Renieri] venuto di Siena a' giorni passati, si ritrovava; e sentendo che il Padre Olivetano dava le meritate lodi ai Dialoghi, celebrandoli per il maggior libro che fusse mai uscito in luce, si commosse tutto con mutatione di colore in viso, e con un tremore grandissimo nella vista et nelle mani, in modi che il libraio, quale mi ha raccontata l'istoria, restò maravigliato: e mi disse di più che il detto Padre Scheiner haveva detto, che havrebbe pagato un di quei libri dieci scudi d'oro per poter rispondere subbito subbito"

defend myself and the truth"[12] has been read as pregnant with grim significance. The mention of Scheiner's name in the report to the Holy Office on the *Dialogo*, as a part of the Inquisitional proceedings against Galileo, made by another Jesuit, Melchior Inchofer, has also been remarked upon[13], as has Scheiner's departure from Rome for Vienna, allegedly shortly after the conclusion of the trial.[14]

Such a variety of suggestive "clues" has been enough to fuel a long-standing suspicion of Scheiner as the engineer of the downfall of Galileo and the ensuing crisis of conscience for Roman Catholic practitioners of astronomical investigation[15]. The lack of documentary evidence for Scheiner's role can also be conveniently explained away in terms of a Jesuit conspiracy of silence, whereby any incriminating documents would not be permitted to surface, lest they damage the reputation of the Order.

However, the fragile documentary basis for such a reading of the 1632-33 trial is easily seen from a close examination of the origins of any single piece of evidence. For

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[12]Scheiner to Gassendi, Rome; 23 February 1633; BN Fonds Français, no. 9531 c. 201r (cited in OG XV p. 47): "Ego pro me et veritate defensionem paro".

[13]In this report, Inchofer argued that Galileo's principle aim in writing the Dialogo was to attack Scheiner's *Rosa Ursina*, which was anti-Copernican, thus rendering Galileo's work Copernican. See Favaro, *Cristoforo Scheiner*, cit., pp. 93-94, and W. R. Shea, *Melchior Inchofer's 'Tractatus Syllepticus': A Consultor of the Holy Office answers Galileo*, in P. Galluzzi, ed., *Novità Celesti e Crisi del Sapere*, Florence: Giunti Barbèra; 1983, pp. 283-92. Inchofer's damning report is published in Maurice A. Finocchiaro, *The Galileo Affair*, cit., pp. 262-270. Pio Paschini says on the subject in his biography of Galileo: "Del padre Inchofer, del quale conosciamo il voto nel processo del 1633, non si sa altro in riguardo al Galilei. Egli incidentalmente fa anche il nome del padre Scheiner; ma se questo abbia esercitato qualche influsso, almeno nel campo dottrinale nel'esito del processo, non siamo in grado di stabilire", Pio Paschini, *Vita e Opere di Galileo Galilei*, Rome: Herder, 1965, p. 587

[14]The precise date of Scheiner's departure from Rome for Vienna is difficult to establish. Favaro 1919 argues from Raffaello Magiotti's letter to Galileo from Rome of 14 October 1633 that Scheiner was still in Rome at this date, preparing his Prodromus (OG XV pp. 300-301). The letter from Kircher to Peiresc cited below confirms that he was still in Rome on 1 December. On 3 January 1634 Wilhelm Weilhamer wrote from Parma to Giannantonio Rocca to say that "Expecto in dies P. Scheinerum, qui etiam forte apud vos transiturus est" (*Lettere d'uomini illustri del secolo XVII a Giannantonio Rocca*, Modena: Società Tipografica, 1785 pp. 7-9), suggesting that Scheiner left Rome at the end of December or in the first days of January.

[15] For a recent restatement of the possibility of Scheiner's authorship of a denunciation of Galileo see Mario D'Addio, *Il caso Galilei: Processo/Scienza/Verità*, Roma: Edizioni Studium; 1993, p. 147 note 52: "Le testimonianze conservateci dall'epistolario galileiano concordano nell'individuare il padre Scheiner come il promotore delle iniziative intese a sottoporre il Dialogo e il suo autore al giudizio del S. Ufficio". For a similar position see F. V. Ferrone and M. Firpo, *Galileo tra inquisitori e microstorici*, Rivista Storica Italiana, 97, 1985, pp. 177-238, 957-68, on pp. 511-513.

example, a document in the Peiresc correspondence in Paris demonstrates that Scheiner's departure from Rome for Vienna, at the invitation of Ferdinand II, must have taken place after 1 December 1633, and thus cannot be plausibly interpreted as a convenient escape from the scene of the "crime"[16]. The document is a letter which Kircher sent to Peiresc on his arrival in Rome, where he was to become the most famous professor and, later, *scriptor* of the Collegio Romano[17], unlike Scheiner who curiously never held a teaching post during his nine years in Rome.[18]

The letter bears a friendly greeting to Peiresc in the hand of Scheiner :

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[16] Kircher to Peiresc, Rome, 1 December 1633, BN Fonds Français 9538, ff.234r-v.

[17]For bibliographical information on Kircher see especially John Fletcher, ed., *Athanasius Kircher und seine Beziehungen zum gelehrten Europa seiner Zeit*, Wiesbaden: Harrassowitz, 1988 and M. Casciato, M. G. Ianniello and M. Vitale, eds., *Enciclopedismo in Roma barocca: Athanasius Kircher e il museo del Collegio Romano tra Wunderkammer e museo scientifico*. Venice: Marsilio, 1986. For biographical details see especially Carl Brischar, *Athanasius Kircher: Ein Lebensbild*, Würzburg: Katholische Studien, Jahrgang 3, Heft 5, 1877 and Conor Reilly, *Athanasius Kircher: A Master of a Hundred Arts, 1602-1680*, Wiesbaden: Edizioni del Mondo; 1974.

[18] In fact it was Kircher who was originally invited to the Imperial court, shortly after Kepler's death in 1631. However, Pereisc petitioned Urban VIII and Cardinal Francesco Barberini to have Kircher transferred to Rome, to continue his work on hieroglyphics, instead of devoting himself to less important mathematical matters. The petition was initially unsuccessful, so Peiresc was delighted to hear from Kircher that Scheiner too had been invited to the Imperial court and expressed the hope in a letter to Kircher that this might bode well for Kircher's future. According to Kircher's autobiography, he set off for Vienna nonetheless and, after a number of adventures at sea, his ship from Genoa was blown off course and landed at Civita Vecchia instead of Livorno. He then, we are told, made his way to Rome on foot, only to learn on his arrival (erroneously dated as 1634) that General Vitelleschi had obtained an order from Urban VIII, calling him to Rome, and had been sending letters to him while he was at sea. This fortuitous episode ("ex hoc capite Divinam Providentiam satis mirari non potuerim"), described in Kircher's autobiography (*Vita*, Augsburg: S. Utzschneider; 1684, pp.41-54) is flatly contradicted by further letters from Peiresc sent to Cassiano dal Pozzo and Claude Saumaise during the Autumn and Winter of 1633. These make it clear that he fully planned a stay in Rome even before leaving France. e.g. Pereisc to Saumaise, 14 November 1633: "Ce jesuite eut commandement de s'en aller à Vienne en Austriche et passa par icy, ayant prins sa routte du costé de Rome, où j'estime qu'il soit encores à présent, ayant eu de ses lettres de Genes, et m'ayant fort solennellement promis de m'escripre de Rome et de Vienne" (Peiresc, *Lettres à Cassiano dal Pozzo (1626-1637)*, ed. J.-F. Lhote and D. Joyal, Clermont-Ferrand: Adosa, 1992, pp. 27-50) and Peiresc to Cassiano dal Pozzo, 10th September 1633 (ibid. pp. 111-112). See also ARSI Lugd. 14, f.263. Kircher subsequently travelled to Malta, in the company of the famous convert, Landgrave Ernst of Hessen-Darmstadt (ARSI Ital. 6, ff.366, 373) and Sicily (ARSI Sic. 156, f.53v), before returning to Rome in 1639 (ARSI Rom. 57, f.153, n.14) and taking up the position of mathematics professor in the Collegio Romano, where he remained for the rest of his life.

> I too offer most humble greetings and dutiful servitude to your most Illustrious Lordship. Christoph Scheiner.[19]

Furthermore, Scheiner's letters from Rome to Archduke Leopold of Austria demonstrate that, although he was delayed by the slow publication of his *Rosa Ursina*, he had hoped to leave Rome as early as 1627[20], and had packed almost all of his belongings into boxes by 2 June 1628[21].

However, evidence for Scheiner's "innocence" also seemed to be in short supply, except for an intriguing claim made by Fr. Adolf Müller S.J. that Scheiner's lack of involvement in Galileo's trial was demonstrated by the "unpublished and confidential correspondence of Scheiner with the General of his Order".[22] The Galileo scholar Antonio Favaro was sceptical of Müller's claim in his essay on Scheiner, stating that "*questa pretesa prova non persuaderà alcuno*". To these strong words Favaro adds that Scheiner and General Muzio Vitelleschi were both in Rome during the period of the trial[23] so there was no clear reason why they should correspond, but such internal correspondence, especially on official matters, is far from being as rare as Favaro suggests.

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[19]"Ego quoque Illustrissimae V[estr]ae Dom[ination]i salutem humilli[ssi]ma et officiosa servitia offero. Christophorus Scheiner", Kircher to Peiresc, Rome, 1 December 1633, cit.

[20]"Ego spero me tandem etiam in Germaniam rediturum, ad quam sensim aspero... Die Teütsche Sprach hab ich noch nit vergessen, dan ich khan die Welsche nit. No io niente parlare Italiano", Scheiner to Archduke Leopold of Austria, Rome, 8 May 1627, in Franz Daxecker, ed., *Briefe des Naturwissenschaftlers Christoph Scheiner SJ an Erzherzog Leopold V von Osterreich Tirol 1620-1632,* Innsbruck: Publikationsstelle der Universität Innsbruck, 1995, p. 127.

[21]"Consarcinaui iam pleraque in Germaniam euehenda", Scheiner to Archduke Leopold of Austria, Rome, 2 June 1628, in Daxecker, *Briefe des Naturwissenchaftlers Christoph Scheiner SJ* , cit., p. 137.

[22] "Aus all den veröffentlichten Dokumenten und selbst der uns zugänglichen noch unveröffentlichen vertraulichen Korrispondenz P. Scheiners mit seinem Ordensgeneral ergibt sich auch nicht der leiseste Anhaltspunkt für irgend eine tatsächliche Beteilung Scheiners am Galilei-Prozess", A. Müller, *Der Galileo-Prozess,* cit., p. 131. Admittedly Müller might merely have been making a negative claim as to the lack of evidence for Scheiner's part in the trial, but this will not be fully clear until Scheiner's correspondence with Vitelleschi is published in its entirety.

[23]In fact, from 1628 they were both living in the same building - the *Domus Professa* beside the Church of the Gesù (previously Scheiner lived in the *Collegio Romano*). See Daxecker, op. cit., p. 138.

Unfortunately, no further evidence of the existence of these letters has appeared since Müller's book, despite Favaro's demand for hard evidence, leading others to reiterate the importance of these documents for a clear understanding of at least one aspect of the 1633 trial.[24] A search of the more likely parts of the Roman Archives of the Jesuits did not reveal any letters between Scheiner and General Vitelleschi for this period.[25]

However, a document which, despite not being, except in the loosest sense of the word, a letter from Scheiner to the General[26], seems to makes it difficult to sustain any suspicion of Scheiner's involvement in the proceedings of the Holy Office against Galileo.

This document is Scheiner's *censura* of a book entitled *Tractatus Syllepticus*[27] written by Melchior Inchofer[28], the very Jesuit who had been called to submit his opinion on

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[24] E.g. Pietro Redondi, *Galileo Eretico: Anatema*, Rivista Storica Italiana, XCVII (1); 1985: 934-56, on p. 949 "Sono state dichiarate altre prove scagionanti nella «corrispondenza inedita e confidenziale di Scheiner con il padre generale del suo ordine, accessibile ai padri» [...] Rivolgo qui, pubblicamente, un appello al padre Edmond Lamalle e ai suoi collaboratori dell'Archivio storico della Compagnia di Gesù perché sia fatta luce su questa segnalazione che né Favaro né altri studiosi hanno potuto accertare".

[25] Some letters from Vitelleschi to Scheiner before Scheiner's arrival in Rome can be found in ARSI Austria 3[I] pp. 171, 181, 184, 207, 213, 242, 246, 248, 270, 287, 312, 340, 411, 425. Letters sent to Scheiner after his departure from Rome are in ARSI Austria 5[I] pp. 18, 38, 53, 65, 74, 106. The only exchange of letters between Scheiner and Vitelleschi during Scheiner's time in Rome that I have been able to find took place in 1626, when Scheiner was still in the Collegio Romano (see Daxecker, op. cit., pp. 171-2).

[26] Although, as Ugo Baldini points out, "Le censure erano scritte in forma che potrebbe dirsi epistolare, indirizzate al Generale e consegnate direttamente a lui o al suo segretario privato" Baldini, *Legem impone subactis*, cit., p.89

[27] Melchio Inchofer, *Tractatus Syllepticus,* Rome: Lodovico Grignani, 1633. A manuscript version of this work is in the Biblioteca Casanatense in Rome (Ms. 1331 ff. 147r-213r)

[28] Melchior Inchofer was born to a noble Lutheran family in Köszeg, Hungary (not Vienna as is sometimes supposed) around 1585. From 1605 he studied in the German College in Rome, before entering the Roman Jesuit Novitiate of Sant'Andrea al Quirinale on 26 March 1607 (ARSI Rom. 172, f. 108 no. 608). He seems to have spent the following years studying in the *Collegio Romano* (ARSI Rom. 110 f. 44, ARSI Rom. 54 f. 256v, n.56). During the years 1617-1629 he lived in Messina, where he taught metaphysics, physics, theology and mathematics in the Jesuit college (ARSI Sic. 155, f.38, f.45v), and professed the four vows on 4th June 1623. His book *Epistola B. Mariae Virg. ad Messanenses Veritas Vindicata*, first published in Messina in 1629, was prohibited *donec corrigatur* by the Congregation of the Index. Inchofer went to Rome in 1630 to negotiate with the Cardinals of the Congregation (ARSI FG 675 ff.213-215v and 220-222v), and managed to publish a second edition of the book, which authenticated a letter reputed to have been written to the people of Messina by the Virgin Mary by making some very minor changes, the most important of which was a substitution of *Conjectatio* for *Veritas Vindicata* in the title. This was the reason that Inchofer happened to be in Rome in 1632 when Riccardi, Master of the Holy Palace, was setting up a committee to evaluate Galileo's Dialogo. Inchofer died in Milan on 28th September 1648 (ARSI Hist. Soc. 47 f. 50v).

Galileo's *Dialogo* to the Holy Office[29]. Inchofer's book, which appears to have been composed around the same time as his report on Galileo's *Dialogo*[30] is an extended series of arguments for the immobility of the earth and the motion of the sun based on Scripture and the Church Fathers.[31] Inchofer emphasises that a large number of biblical passages, interpreted literally, suggest that the Earth is stationary and that the sun moves, whereas the few passages which seem to imply the possibility of terrestrial motion are really cases of the word "earth" being written to signify the inhabitants of the world[32]. Eighteen years previously, on 12 April 1615, Cardinal Robert Bellarmine had written to the Carmelite friar Paolo Antonio Foscarini on precisely this issue, arguing that the Council of Trent had prohibited scriptural exegesis that did not conform with the common opinion of the Church Fathers, and that the latter were in agreement that the motion of the sun and immobility of the earth were to be interpreted

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For biographical information, see the Lamalle biographical *scheda* in ARSI, Dezsö Dümmerth, *Les combats et la tragédie du Père Melchior Inchofer S. J. à Rome (1641-48)*, Annales Universitatis scientiarum Budapestinensis. Sectio Historica, 17: 81-112, 1976, Shea, W. R. Shea, *Melchior Inchofer's 'Tractatus Syllepticus'*, cit., Oudin's biography in R. P. Nicéron, *Mémoires pour servir à l'histoire des Hommes Illustres dans la République des lettes,* Paris: Briasson; 1736, t. 35 pp. 322-346 and Sommervogel *s. v.*. Inchofer's dealings with the Cardinals of the Congregation of the Index do not seem to have ended with Galileo's condemnation. A 1680 inventory of the Jesuit archives (ARSI Miscel. 8) gives details of one compartment (Armarius EE. Capsula n° XXX) entirely devoted to the Holy Congregation of the Index. This apparently contained an *Epistola P. Melchioris Inchofer de libris prohibitis*, 1642. (The inventory also gives details of a large collection of manuscripts pertaining to the Sacred Congregation of the Holy Office (EE Capsula no. XXXII), but it is difficult to ascertain where these documents might be found in the present archives, if indeed they have even survived). Furthermore, Inchofer signs his *imprimatur* for Athanasius Kircher's *Ars Magna Lucis et Umbrae*, dated Rome, 21 December 1644, as Melchior Inchofer S.C.I.C. which must surely stand for *Sacrae Congregationis Indicis Consultor*.

[29]Finocchiaro, *The Galileo Affair*, cit., pp. 262-270

[30]The work seems to have been begun before 13 February 1633, the date of the *imprimatur* of Allacci's *Apes Urbanae*, which mentions a work by Inchofer with the title of *An sit de fide terram esse immobilem, ubi affirmativa multis ostenditur. Tractatus* as forthcoming. This is almost certainly the *Tractatus Syllepticus*, and the original title, which emphasizes the stylistic similarities between Inchofer's work and an article of Aquinas' *Summa Theologiae* , acquires special relevance in light of Scheiner's censure, discussed below. Coincidentally 13th February was also the date on which Galileo arrived in Rome to await trial. The reports on Galileo's *Dialogo* by Melchior Inchofer, Zaccaria Pasqualigo and Agostino Oriego were presented to the Holy Office on 17 April 1633.

[31]For an account of the context of publication and content of Inchofer's book see Shea, *Melchior Inchofer's 'Tractatus Syllepticus'*, cit. For background information on Inchofer and the Jesuit College in Messina, see Rosario Moscheo, *Melchior Inchofer (1585-1648) ed un suo inedito corso messinese di logica dell'anno 1617*, in Quaderni dell'Istituto Galvano della Volpe, 3: 1982: 181-94.

[32] See Shea, *Melchior Inchofer's 'Tractatus Syllepticus'*, p. 290

literally. For Bellarmine, perhaps the principal authority on such matters for later Jesuits such as Inchofer[33], the fact that these propositions did not concern the central mysteries of the faith, and were not *de fide ex parte obiecti* did not permit their denial, as they were *de fide ex parte dicentis*; that is, they were to be considered as matters of faith because of the sanctity of their author, who was none other than the Holy Spirit, speaking through the mouths of the Prophets and Apostles[34]. Thus, a person who denied that Abraham had two sons and Jacob had twelve was no less a heretic than a person who denied that Christ was born of a virgin.[35]

A series of *censurae* of Inchofer's *Tractatus* is preserved in the Jesuit Archives in Rome[36]. Before examining them, a brief review of the system of Jesuit censorship might be in order[37]. Despite the emphasis on doctrinal uniformity in the Jesuit order even since the 1550 Ignatian *Constitutiones*, it was only in 1597, during the Generalate of Claudio Aquaviva, that the policing of such uniformity, previously carried out at provincial level, was centralised in Rome and institutionalised in the form of a College of *Revisores*, based in the Collegio Romano.

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[33]Baldini suggests that Inchofer's *Tractatus* was directly influenced by Bellarmine's approach to biblical exegesis. See Baldini, *Legem impone subactis*, p. 297

[34]The second decree of the fourth session (8 April 1546) of the Council of Trent allowed for a certain amount of ambiguity, exploited by the Galileians, by stating that "nemo [...] *in rebus fidei et morum*, [...] sacram scripturam ad suos sensus contorquens, contra eum sensum, quem tenuit et tenet sancta mater ecclesia, [...] aut etiam contra unanimem consensum patrum ipsam scripturam sacram interpretari audeat, etiamsi huiusmodi interpretationes nullo unquam tempore in lucem edendae forent" (S. Ehses, ed., *Concilii Tridentini Actorum pars altera*, Freiburg im Breisgau, 1911, p. 92, emphasis added). Bellarmino's position, as Baldini points out, nonetheless insists that none of Scripture is external to *rebus fidei et morum*: "[I]n Scriptura non solum sententiae, sed etiam verba omnia, et singula ad fidem pertinent. Credimus enim nullum esse verbum in Scriptura frustra, aut non recte positum", *Roberti Cardinalis Bellarmini opera omnia*, Naples, 1856, Tom. 1. II, cap. XII. See Baldini, *Legem impone subactis*, p. 338 and Blackwell, *Galileo, Bellarmine, and the Bible*, cit..

[35]Robert Bellarmine to Paolo Antonio Foscarini, Roma, 12 April 1615, in OG XII, pp. 171-172. On Bellarmine's famous letter see Blackwell, *Galileo, Bellarmine, and the Bible*, cit., pp. 103-108.

[36]ARSI Fondo Gesuitico 661 f.194r-196r

[37]In the following sketch of the practice of censorship in the Jesuit order I am greatly indebted to the description given by Ugo Baldini in Baldini, *Legem impone subactis*, pp. 75-119. On the issue of *uniformitas doctrinæ*, see also Anita Mancia, *Il concetto di 'dottrina' fra gli esercizi spirituali (1539) e la Ratio Studiorum (1599)*, Archivum Historicum Societatis Iesu, LXI, 1992: 3-68.

The role of the *Revisores* was clarified in a set of rules[38] dating from 1601, and consisted in judging whether books written by members of the Society were fit for publication, based on a number of criteria including consonance with the Jesuit *Constitutiones*, Christian piety and the absence of anything that might bring the Society into disrepute. Books that did not concern serious issues need only be read in their entirety by two of the Revisores, and could be read in part by the remaining three, and the *censurae* could be produced as a result of a discussion. Books that impinged upon matters of theological and philosophical import were to be read completely by at least three Revisores and their *censurae* were to be sent to the General, who would decide on whether the book was to be published as it stood, emended prior to publication or left unpublished.

Muzio Vitelleschi[39], General of the Society at the time of Galileo's trial, was responsible for a number of reforms to the system, including requiring the censorship of dedications and translations of previously approved works and, in 1621, prohibiting the publication of anonymous and pseudonymous publications[40]. He also ordered, in 1623, that all printed books should be sent to the library of the Collegio Romano, though this was not always observed[41]. These reforms took place as a reaction to the

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[38]ARSI Instit. 46, f.61r-v. These are published in Baldini, *Legem impone subactis,* p. 85

[39] Vitelleschi, elected General of the Society in 1615 , was born in Rome on 2nd December 1563 and died there on 9th February 1645, making him a close contemporary of Galileo. Before he began to be involved in the administration of the Society he taught philosophy and theology in the *Collegio Romano*. At least three of his courses in natural philosophy from this period have survived, *Lectiones R.P. Mutii Vitelleschi in octo libros physicorum et quatuor de coelo, Romae, Annis 1589 et 90. In Collegio Romano Societatis Iesu,*. 4° ff. 389 (in the library of Bamberg), *Commentarius in libros de coelo et mundo*, APUG Fondo Curia 392. and his *In libros meteorologicorum, 1590,* BNR FG 747, 2876. A theology course, *De actibus humanis: In Prima 2ª D. Thoma 1602*, is conserved in ARSI Opp. NN 5. Documents pertaining to Vitelleschi's life, the controversy surrounding his election to the position of General and his death are in ARSI Vitae 127. See also Sommervogel *s.v.*.

[40]ARSI Congr. XXI, f. 224r, cit. in Baldini, *Legem impone subactis,* pp. 75-119. The practice continued unhindered despite this prohibition, even in Vitelleschi's full knowledge, as attested by a letter he sent to the Rector of the College of Paris in 1627 concerning the *imprimatur* of Orazio Grassi's pseudonymous *Ratio Ponderum*: "Nunc aliud quoddam est quod R.V. admonitum cupio. P. Grassi librum fecit sub aliene nomine de Ratione ponderum, isque liber nuper vulgatis est opera Domini Cramoisy Bibliopolae Parisiensis, qui etiam aliquot exemplaria ad Autorem misit. Verum animadversum est nullam in eo positam fuisse de more approbationem, quam ob causam hic videri non posset, quin subito a Magistro Sac. palat. supprimeritur", Vitelleschi to Ignace Armand, Rome, 23 March 1627, ARSI Franc. 4, f. 247v.

[41]ARSI, Rom. 3I, f.85r, cit. in Baldini, *Legem impone subactis,* pp. 75-119

increasing problem of maintaining the doctrinal uniformity desired by Loyola throughout the global network of Jesuit colleges, a problem accentuated by the difficulty of communicating with Colleges outside the Italian Province as fresh confrontations with *novatores* in philosophical and theological matters arose. In 1632 Vitelleschi wrote a letter to the Roman Provincial, in which he insisted on the importance of censorship in ensuring the "common good and peace of the Society."[42] Vitelleschi's interest in reinforcing the system is also displayed in his insistence on the production of lists of approved and prohibited philosophical propositions, a practice which eventually culminated in the 1651 *Ordinatio pro studiis superioribus*[43] prepared under the Generalate of Francesco Piccolomini, which prohibited a large number of propositions, including many related to corpuscularianism and astronomy, from being taught in Jesuit colleges.

From this brief sketch, it can be seen that Vitelleschi was extremely concerned with the practice of censorship. His opposition to deviations from Aristotelian cosmology is

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[42]This letter, subsequently distributed to the other provinces, gives a very clear idea of Vitelleschi's conception of the role of the *Revisores*: "Sa molto bene V.R. quanti, e gravi, travagli in diversi Regni, e Provincie ci sono per l'indietro avvenuti con occasione de' libri stampati da alcuni della Comp[agni]a, et ancora non siamo sicuri, che non ne sopravengano de' nuove. Questo negotio mi è stato sempre grandemente a cuore, e sono stato di continuo avvertito, perche non uscisse cosa alcuna, che potesse offendere, e pareva che si fusse e con regole, e con avvisi particolari provisto a bastanza: ma perche veggo, che non ha conseguito affatto l'intento, per soddisfare al mio debito, ho giudicato necessario di mandare a V.R. alcuni punti, che dovranno essattamente osservare tanto gli Autori, come li Revisori per il ben commune, e pace della Compagnia.
1. Che li Revisori nelle Provincie si deputino dal Generale, come si nominano gl'essaminatori per la professione, e siano obligati a leggere attentamente tutto quello, che sara loro dato a rivedere
2. Che alle Regole de' P[ad]ri Revisori tanto universali, come delle Provincie s'aggiunga, che non passino cosa alcuna in offesa de Principi qualunque si siano, ne di loro sudditi: ne questi, o quelli si nominino da gl'autori per dispreggio, o con poco rispetto o siano vivi, o morti.
3. Lascino gl'Autori affatto le questioni, che in questi tempi sono state cagione di tanti rumori.
4. Procurino le Superiori, che le Revisori su generali, come particolari habbino, e sappino distintamente queste cose, e leggano le regole de Revisori generali, e particolari. Se queste cose s'osservaranno essattamente, come spero, che sara col divino favore, e con la vigilanza di VR. cesserà il mio timore, e sollecitudine, e s'evitaranno affatto gli disgusti, che sin' hora hanno dato tanto trauaglio alla Compagnia", Vitelleschi to P. Provinciale Romano, Rome 31 January 1632; ARSI Rom 3[I] ff.173r-v

[43]The *Ordinatio pro studiis superioribus* of 1651 is published in Pachtler 1887-1894 Tom. III: pp. 235-249. On the *Ordinatio*, see Costantini, *Baliani e i Gesuiti,* cit., pp. 95- 109, and also Marcus Hellyer, *"Because the authority of my superiors commands": Censorship, physics and the German Jesuits.* Early Modern Science and Medicine. 1996; 1(3): 319-354.

attested by the position which he adopted in the debate on celestial fluidity, which began within the Society during his early years as General.[44] Despite the general acceptance of celestial fluidity and the Tychonic world-system amongst the astronomers of the Jesuit order after the publication of Giuseppe Biancani's *Sphaera* in 1620 Vitelleschi maintained his opposition at least until the 1630s. A letter that he sent to the Rector of the Jesuit College of Avignon, Father Claude Bonyol, in 1631 stated in no uncertain terms that:

> I received with your letter a certain writing on the fluidity of the heavens, and, as you are in a position of authority over higher studies, it will be up to you to make sure that this opinion is not proposed or defended in any way in the theses of our pupils. If at some time that opinion, put forth by others, becomes common and receives the approval of the majority, then we will easily allow our members to follow what is seen to be more probable in that matter. At the moment, however, in accordance with the Constitutions, the teaching of Aristotle must be followed.[45]

Given his attachment to Aristotelian cosmology, it seems likely that Vitelleschi would have paid close attention to the *censurae* of Inchofer's book, especially in light of the events which had taken place less than two months previously.

Two of the three surviving *censurae* approve the *Tractatus Syllepticus* without reservation, and without significant deviations from the standard codes of approval[46].

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[44]See Ugo Baldini, *La conoscenza dell'astronomia nell'Italia meridionale anterioramente al Sidereus Nuncius*, in *Atti del Convegno Il Meridione e le scienze (secoli XVI-XIX), Palermo 14-16 maggio1985*, ed. P. Nastasi, Palermo and Naples: Istituto Gramsci Siciliano, Istituto Italiano per gli studi filosofici; 1988, pp. 127-68, on pp.162-163 and Michel-Pierre Lerner, L'entrée de Tycho Brahe chez les Jésuites, ou le chant du cygne de Clavius, in *Les jésuites à La Renaissance: Système educatif et production du savoir*, ed. Luce Giard, Paris: Presses Universitaires de France, 1995, p. 175. The thesis of celestial fluidity was strongly supported, partly on scriptural grounds, by none other than Cardinal Bellarmino, who combined a tough line on scriptural exegesis with significant departures from Aristotelian teachings in natural philosophy. See Baldini, *Legem impone subactis,* pp. 293-296.

[45]"Accepi cum litteris R.V. scriptum quoddam de coeli fluiditate, et quandoquidem ipsa praeficitur studiis superioribus, erit ipsi curandum ne ullo modo in thesibus auditorum nostrorum ponatur neque defendatur. Si quando illa sententia prodita ab aliis fiat communis et plurimorum iudicio probetur, tunc facile concedemus ut nostri in ea re sequantur quod videbitur esse probibalius. Nunc autem secundum constitutiones doctrinam Aristotelis sequi oportet", Vitelleschi to Claude Bonyol, Rome, 21 March 1631, ARSI Lugd. 5, f. 608v, copy in ARSI Gall. 117 p. 142.

[46]The theologian and philosopher Giovanni Battista Rossi (1576-1656), who worked as Revisor for a period of twenty-two years, approved the book as follows "Perlegi libellum cui est titulus Tractatus Syllepticus de terrae coelique motu vel statione etc. et nihil inueni contrarium fidei, vel bonis moribus, neque doctrinae sanae, et uideo posse utiliter typis mandari. In Collegio Romano Societatis Iesu XII Aug. 1633. Io: Bapt. Rubeus"ARSI FG 661 f.195r. The other Revisor Ioannes Rho (1590-1662), reputed for his oratorical skills

Scheiner's *censura*, however, dated 9 August 1633, is of particular interest as after stating his approval of the book for publication and signing his name, he goes on to say:

> It appears that the author asserts too absolutely at the beginning of Page 34 that the motion of the Sun and the immobility of the Earth are matters of Faith, which should be modified, as they are in Question, and are not thought to be a true matter of Faith. Moreover he should also indicate briefly for what reason this might be a matter of Faith. I believe that similar considerations ought to be taken into account with respect to the circular motion of the Sun and the Centre of the Earth being in the middle of the Universe.[47]

This statement, made such a short time after Galileo's trial, seems to disqualify Scheiner from having denounced the *Dialogo* for doctrinal heterodoxy.

It simply wouldn't make sense for someone who had recently formulated a denunciation of Galileo's Copernicanism to criticise Inchofer for asserting absolutely that the motion of the sun and stability of the earth are matters of Faith, and to claim instead that they are "in Question", rather than truly *de fide*. If Scheiner regarded the heliocentric view as formally heretical and incompatible with a matter of faith he would, like the other Revisores, have given unconditional approval to Inchofer's book.

The tentative tone of his criticisms suggests that the issue was not entirely clear cut to his peers, but his position echoes that of other Jesuit mathematicians of the time, notably Orazio Grassi, another traditional scape-goat for the events of 1632-1633, who had argued in his response to Galileo's *Il Saggiatore*, the *Ratio ponderum Librae et Simbellae*, that

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(Sommervogel *s.v.*), approved the book in similar terms but added "Sunt in eo aliqua mathematica de Theorijs planetarum quam minus esse cultus me esse ingenue fateor, quippe nihil de illis censeo. Opus totum valde placuit, cui si adeat integra tractatio ex principijs philosophicis et Mathematicis, confectum dabit negotium de stabilitate terrae. Ita censeo Io. Rho Romae Nonis Augusti 1633."

[47] ARSI FG 661 f.194r. The whole document is published in M. J. Gorman, *A Matter of Faith? Christoph Scheiner, Jesuit censorship and the Trial of Galileo.* Perspectives on Science. 1996; 4(3): 283-320, on pp. 314-6. Page 34 of Inchofer's *Tractatus Syllepticus* contains the phrase "Quare Terram stare non solum per se est de Fide, sed etiam quatenus immediatè deducitur ex alia Propositione de Fide, quae est, Solem moveri circulariter, in qua proprie virtualiter continetur. Id fortasse eo sit certius, si etiam de Fide sit Terram esse Centrum Universi, quod an dici queat, infra in loco videbimus". Of course, it is unlikely that the pagination of the printed work should coincide with that of the manuscript examined by Scheiner and the other *Revisores*.

> to tell the truth, what has not been granted for the opinion on the earth's motion, *although its immobility is not considered among the fundamental points of our Faith*, will be even less permissible, if I am not mistaken, for that which constitutes the essential point of faith or contains all other essential points.[48]

It seems possible that Scheiner's *censura* might have sparked off a correspondence with Muzio Vitelleschi on the very issue of the status of the Copernican theory, which might be the correspondence cited by Müller. Vitelleschi's *imprimatur* for the *Tractatus* is dated 18 August, just nine days after Scheiner's *censura*, and states that "Three theologians of the Society [of Jesus], [...] reviewed it and approved it for publication"[49], thus making no mention of Scheiner's misgivings. The question of the jurisdiction of the Holy Office in deciding on matters of faith was still very much alive even in 1642, as attested by a letter from the Milanese Capuchin Valeriano Magni to Giovanni Barsotti of 3 August 1647:

> Of all this I gave the example that the case of Galileo, that is, the question whether the motion of the Sun and the immobility of the Earth asserted in Holy Writ is meant as real or apparent, has never been proposed, let alone defined, in the Church of God. When rumour had it that the Holy Office had declared Galileo's opinion to be heretical, I was wounded to the heart, because I feared that the heretics, not distinguishing the absolute authority of the Pope from the authority of the Holy Office, would presume to be able to oppose some geometrical demonstration to Papal authority, thought by the Catholics to be infallible. For this reason, in the month of August of 1642 I went to see the Master of the Holy Palace [...] who told me the qualification with which the proposition of the Earth's motion and the Sun's immobility was designated by the Holy Office. He showed me a printed book, which qualified that proposition as temerarious, which gave me great consolation[50]

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[48]Lothario Sarsi [Orazio Grassi], *Ratio ponderum Librae et Simbellae*, Paris: Cramoisy, 1626, published in OG VI, pp. 485-490, quoted in Redondi, *Galileo Heretic*, p. 336 [emphasis added].

[49]"Cum tractatum syllepticum, de terrae, solisque motu, vel statione, &c.P. Melchioris Inchofer, nostrae Societatis Theologi; Tres eiusdem Societatis Theologi, quibus id commissimus, recognoverint; ac in lucem edi posse probauerint; facultatem concedimus, ut Typis mandetur [...] Romae XVIII. Augusti MDCXXXIII", Inchofer, *Tractatus Syllepticus*, cit. (*imprimatur*).

[50]"Di tutto ciò ne apportai essempio con la causa del Galileo, cio è, la questione, Utrum il moto del Sole, e la quiete della Terra, asserti dalle Sacre Lettere, s'intenda reale, o vero apparente, mai esser stata proposta, molto men diffinita nella Chiesa di Dio, et perché la fama portava che il S.^{o} Offizio havesse dichiarata heretica l'opinion del Galileo, restai ferito allora al core, temendo, che li heretici, non distinguendo l'auttorità assoluta del Papa da quella del S.^{o} Offizio, presumessero di poter'opponere all'authorità del Papa, per parer de' Cattolici, infallibile, qualche dimostratione geometrica, e ricercai l'anno 1642 nel mese d'Agosto dal Maestro del Sacro Palazzo [...] che mi dichiarasse con qual titolo fosse qualificata dal So. Offizio la propositione del moto della Terra, e quiete del Sole. Egli mostrommi da un libro stampato, esser quella propositione qualificata come temeraria, cosa che mi recò gran consolatione..." Magni to Giovan Battista Barsotti, Warsaw; 8 March 1647, BAV Vat. Lat. 13512, c.78r, cited in Massimo Bucciantini, *Valeriano Magni e la discussione*

Magni had little in common with his Jesuit contemporaries on other matters of natural philosophy, as the debate on the vacuum was to demonstrate[51], but on this issue it seems there was a degree of consonance between their positions[52]. The standpoint of General Vitelleschi on this issue is less clear, but it is worth remarking that Scheiner claimed in his letter to Kircher of 16 July that Vitelleschi was among those who had urged him to write a response to Galileo's *Dialogo*, his *Prodromus pro Sole Mobili*:

> After my *Prodromus* [Forerunner] against Galileo, entitled *«Christophori Scheiner e Soc. Iesu, Pro sole mobili, terra stabili, Prodromus, oppositus suo censori, terrae motori, solis statori»*which is now in the hands of the most Reverend Master of the Holy Palace, and once I have the latter's approval, I will shortly leave for Germany. I have been called there to his Holy Imperial Majesty (one could wonder what I earn for the Emperor with mathematics). When the *Prodromus* has been completed, God willing, I say that I will go to every trouble to defend common astronomy against Galileo, as I am urged by the Pope, our General, and his Assistants, all of whom have followed the better [path]."[53]

The idea that Galileo's *Dialogo* was nothing more than a personal attack on Scheiner, a response to Scheiner's anti-Copernican work on sunspots, *Rosa Ursina*[54], may now seem absurd, but undoubtedly had a certain currency in the 1630s[55], as we have seen above from Melchior Inchofer's report to the Holy Office. Indeed, Galileo did not

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sul vuoto in Italia, Giornale Critico della Filosofia Italiana, Serie VI, Volume XIV (Anno LXXIII [LXXV]): 73-91.

[51] See Chapter 6 below.

[52]Cf. Giambattista Riccioli's claim that "The Holy Congregation of Cardinals, separated from the Pope, cannot make propositions de fide, either by defining them as de fide or by declaring the contrary propositions as heretical; thus, since no pastoral letter from a Pope or a Council directed or approved by him has yet appeared, it is not yet an article of faith that the Sun moves and the Earth is at rest [...] In spite of this, we Catholics, through both prudence and obedience, are obliged to accept that which has been decreed by this Congregation, or at least not to teach anything to the contrary", G.B. Riccioli, *Almagestum Novum astronomiam veterem novamque complectens*, Bologna: Ex Typographia Haeredis Victorij Benatij, 1651, Pars Prior, p. 52.

[53]"Ego, post meum Prodromum contra Galilaeum, cuius titulus iste est: «Christophori Scheiner e Soc. Iesu, Pro sole mobili, terra stabili, Prodromus, oppositus suo censori, terrae motori, solis statori», quod opus iam in manibus est R.mi D. Sac. Pal. Magistri, cuius approbationem nactus mox in Germaniam discedam, ad Sacr. Caesar. Maiestat. vocatus (quid cum mathematicis Imperatori, merito quispiam dubitare posset); absoluto inquam Prodromo, communem astronomiam contra Galilaeum opere pleno, Deo dante, defendam: ita hortatur Pontifex, Generalis noster, Assistentes, omnes meliora secuti", Christoph Scheiner to Athanasius Kircher, Rome, 16 July 1633, OG XV p. 184. On the very same day Scheiner wrote a letter to Gassendi in which he openly attacked Galileo as "mearum Inventionum Invasorem", OG XV p. 683.

[54]Christoph Scheiner, *Rosa ursina, sive, Sol,* Bracciani: Apud Andream Phaeum Typographum Ducalem; 1630.

[55]Scheiner's work was certainly discussed in a very heated, and generally abusive manner in Galileian circles. See Pio Paschini, *Vita e Opere di Galileo Galilei*, cit., pp. 465- 467

mince his words in describing the "vain and foolish ideas" of Scheiner in the *Dialogo*[56], and Scheiner suggests in his letter to Kircher that he was perceived by many members of the Roman hierarchy, including Urban VIII himself, as the champion of "common astronomy" against the Galileian threat[57]. By precipitating an external resolution to the debate, a denunciation of the *Dialogo* by Scheiner would have denied him the pleasure (for which he was willing to part with 10 gold *scudi*) of refuting Galileo's book immediately with astronomical and physical arguments[58]. To silence his opponent in such a way would have rendered such an answer superfluous.[59]

Melchior Inchofer, on the other hand, was so fervent in his anti-Copernican zeal that he wished to follow up his *Tractatus Syllepticus* with another work, vindicating the Holy Office and Congregation of the Index against the *Terrae motores*, but his fifteen minutes of fame had passed by this time, and he only succeeded in provoking the anger of the Jesuit *Revisores* against a book with the portentous title of *Vindiciae Sedis Apostolicae, SS. Tribunalium et Auctoriatum adversus Neopythagoreos Terrae Motores et Solis statores*. This work was not considered fit for publication, as firstly its title was felt to suggest to the unwary reader that, rather than being the work of an individual it was written on behalf of the institutions which it defended, and secondly because the (mathematical) arguments of Inchofer were not felt to be worthy of this

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[56]Galileo Galilei, *Dialogue Concerning the Two Chief World Systems - Ptolemaic and Copernican*, translated by Stillman Drake, Brekeley and Los Angeles: University of California Press, 1967, p. 346. Further attacks on Scheiner (*Apelles*) are to be found elsewhere in the *Dialogo* (e.g. pp. 357, 367)

[57]The notion of "common astronomy" deployed by Scheiner points to a high degree of disciplinary inertia. As Westman paraphrases Kuhn, "what is at stake [in a revolution] is the overturning of a whole way of scientific life, not the abstract and transcendental deliberations of some scientific jury using a calculus of relative problem-solving capabilities". Robert S. Westman, *Two Cultures or One? A Second Look at Kuhn's* The Copernican Revolution, Isis; 85: 79-115, on p. 82.

[58]See note 13 above.

[59]The "silencing" of Galileo in 1633 did not, of course, remove the need for an astronomical and physical refutation of Copernicanism, as demonstrated by Riccioli's monumental *Almagestum Novum* (cit.). However, what I am suggesting here is that it is difficult to reconcile the act of silencing involved in a denunciation with the visibility-enhancing dynamic of the 17th century astronomical duel. Riccioli's enquiry should, perhaps, be read not as a vindication of Scheiner, but, in so far as it relates to the trial at all, as a judicial post-mortem, an enquiry into the justness of the causes of the disputants. On scientific duels see Biagioli, *Galileo Courtier*, cit., pp. 60-73.

weighty and dangerous subject[60]. Inchofer tried to repeat the technique by which he had got his *Epistola B. Mariae Virg. ad Messanenses Veritas Vindicata* past the Index, by making a small change to the title, but the Jesuit *Revisores* were not impressed.[61]

The second remark made by Scheiner on Inchofer's book is also extremely relevant, and argues further for the view that, despite Inchofer's apparent reliance on Scheiner in his preparation of his report on the *Dialogo* the latter was more than a little uneasy about Inchofer's insistence on the authority of Scripture, interpreted literally, over any human enquiry. Scheiner suggests that Inchofer should temper, or qualify "the passage in which he says that the Authority of the Book is greater than the capacity of any human mind"[62]. Despite the tentative nature of these criticisms, they strike at the very heart of Inchofer's project, and show that Scheiner had fundamental objections to this project, and is thus arguably eliminated from having formulated a denunciation of the *Dialogo* which would necessarily have invoked the kind of arguments from Scripture which are so numerous in Inchofer's book.

There are, however, many aspects of this episode which remain to be clarified. One aspect is the curious fate of Scheiner's *Prodromus*[63]. Although a manuscript version of

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[60]ARSI FG 655 ff.198r-200v *Judicium Revisorum Collegij Rom. de Vindicijs P. Melchioris Inchoferi 29 Jan. 1636*. The report of the *Revisores*, Jakob Bidermann (1578-1639), better known for his theatrical works than his work as Revisor (see above Chapter 3), Giovanni Battista Rossi (1576-1656) and Ioannes Alvarado,is followed by a reply by Inchofer [f.199r], which is in turn followed by the final critical judgment of the *Revisores* on f. 202v: "Atque liber hic R. P. Melchioris Inchoveri talis omnino est, ut argumentum gravissimum, idque magis Theologicum quam mere mathematicum contineat. Debebat igitur & hic eius liber, ut edi iubeatur, lectorisque exspectationi satisfacturus putatur, esse multo solidior, gravior & efficacior, quam si de quocunque minusculo solum argumento tractaret". The censorship of this work by Inchofer, a manuscript of which is amongst Sforza Pallavicino's papers in the Biblioteca Casanatense in Rome (Ms. 182), is discussed in Baldini, *Legem impone subactis*, pp. 297-298.

[61]"Respondeo titulum libri hunc esse. Vindiciarum S. Sedis Apostolicae, Sacreorum tribunalium et Authoritatem ac libri duo. Si hic titulus nimis magnificus videtur, facile emendari potest, hoc, aut alio modo, Vindiciarum Sacrearum Auctoritatem" Melchior Inchofer, *Responsio ad ea quae Patris Censores opponunt in meo libro*, ARSI FG 655 ff.199r

[62]See Gorman, *A Matter of Faith?*, cit., p. 316. I have not found a corresponding passage in the *Tractatus Syllepticus*, perhaps suggesting that on this point Scheiner's criticisms were taken into consideration.

[63]Scheiner, *Prodromus pro sole mobili, et terra stabili, contra Galilaeum a Galilaeis, qui nunc primum in publicam lucem prodit*, Pragae: Gosvinus Nickel, 1651 [Copy consulted: Österreichische Nationalbibliothek, Vienna, 72.D.54]. On Scheiner's *Prodromus* see Favaro, *Cristoforo Scheiner*, cit., pp. 98-107

the work was completed and in the hands of Father Niccolò Riccardi, Master of the Sacred Palace, by 16 July 1633[64], the book had to wait until 1651, after Scheiner's death, for publication. This is even more curious in light of the fact that a printing of the book seems to have been carried out in 1642[65]. Unfortunately no trace of a debate concerning the book's publication seems to remain in the *Censurae librorum* of the Jesuit archives.

In his 1633 *Apes Urbanae*, a "Who's Who" of Roman *literati* under the Barberini pontificate[66], Leone Allacci mentions the manuscript of the work, which he describes as "A Forerunner for the stability of the earth against the same writer of Dialogues, in which Galileo's errors in logic, physics, mathematics, ethics, theology and in sacred matters are advantageously brought together so that everybody can see the mask pulled away from all of these to reveal doctrine constructed from ignorance"[67]. The final published version, despite containing personal slights on Galileo, generally avoids theological arguments in favour of astronomical ones. However, this detail, despite its convenience for a hypothesis of a removal of the theological parts of Scheiner's work prior to publication, should not be overestimated, as, firstly, in all likelihood, Allacci had not read the manuscript and, secondly, the unimpeded publication of Inchofer's

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[64]See above note 63.

[65]See Wilhelm Weilhamer to Giannantonio Rocca, Mantua; 23 April 1642, published in Rocca 1785 p. 301 "De Scheineri libro nondum scio aliquid certi quo pretio vendatur; suam quamprimum jam ipsi Authori scriptum fuit: Et liber editus in folio (sunt 30. folia cum figuris intermediis aeneis) contra Galilaeum libri tres, Inscriptio est Prodromus de terra stabili, & Coelo, seu Sole mobili; non habet indicem, nec praefationem: reservavit Author ista ad pleniorem impressionem: interea Lectori ista praegustanda proponit."

[66]L. Allatius, *Apes Urbanae, seu de viris illustribus qui ab anno 1630 per totum 1632 Romae adfuerunt, ac typis aliquid evulgarunt*, Rome: Ludovicus Grignanus, 1633. It is noteworthy that Allacci removed the entry on Galileo's Dialogo from his work before publication. He compromised by adding an entry on Pierre Gassendi, in the hope that this would be reflected by a parallel substitution in the Barberini entourage. In spite of Allacci's plans to mould the real theatrum mundi according to his paper pantheon, Galileo's place was filled by Kircher instead of Gassendi. See Allatius, *Apes Urbanae*, cit., pp. 70-71, and Gabriel Naudé's letter to Gassendi in OG XV p. 88. On Kircher's move to Rome see also above note 20.

[67]"Prodromus pro Stabilitate terrae contra eundem Dialogistam, in quo compendiose afferentur Galilaei errores Logici, errores Physici, errores Mathematici, errores Ethici, errores Theologici, atque sacri: adeoque ex omnibus his constabit detracta larua doctrinam hactenus mentita imperitia", Allatius, *Apes Urbanae*, pp. 68-71

Tractatus Syllepticus and Scheiner's criticisms of this work, argue against the suppression of Scheiner's work for reasons of theological content.[68]

A significant factor in the delayed appearance of the *Prodromus* may have been the changing attitudes of the successive Emperors Ferdinand II and Ferdinand III to Scheiner. According to Francesco Piccolomini, in a letter written from Presburg to Galileo on 5th February 1638, the new Emperor Ferdinand III had exclaimed to him two weeks previously that "Father Scheiner has neither the knowledge nor the ability to write books against Galileo". Moreover, according to Piccolomini, "It seems to his Imperial Majesty that Scheiner's book is wasted paper and otiose scribblings without conclusion"[69]. The popularity which Scheiner enjoyed under Ferdinand II and his brothers Archdukes Karl and Leopold, displayed by handsome donations to aid him in the foundation of the college of Neisse, seems to have vanished with the accession of Ferdinand III to the Imperial throne in 1637. Shortly before the death of Ferdinand II, Scheiner left Vienna for Neisse, never to return to the Imperial court. The expensive mathematical instruments with which he had equipped the college of Neisse, mostly the gifts of Habsburg patrons[70], were almost all destroyed or lost during his absence in Rome, and his lack of astronomical production at the end of his life suggests that they were not replaced.

The general desire among Jesuit mathematicians, including Christoph Scheiner, seems to have been one of trying to avoid collapsing the boundary which allowed the peaceful coexistence of revealed truth and astronomical research, under threat as much from the Galileian programme of scriptural exegesis informed by natural knowledge[71] as from the

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[68]The work does seem to have suffered some modifications before publication, as is borne out by the statement on the title page that a larger version of the work was composed *ante annos 20*.

[69]OG XVII pp. 276-7.

[70]See ARSI FG 1368/8/12

[71] On Galileo's programme, see W. R. Shea, *La contrariforma e l'esegesi biblica di Galileo Galilei*, in A. Baboli, ed., *Problemi religiosi e filosofia*, Padua: La Garangola, 1975, pp. 37-62). His principle of exegesis was expressed in his 1615 *Lettera a Madama Cristina di Lorena, Granduchessa di Toscana*, in which he defended Copernicanism from the accusations of heresy that had been flowing from Florentine pulpits. In this work, he argued that "I will say here that which I have heard from an extremely eminent ecclesiastical figure [i.e Cardinal

1616 decree against Copernicus[72]. This desire to maintain a space for the pious investigation of the natural world is manifest in Scheiner's criticism of Inchofer's assertion that solar motion and terrestrial stability are *de fide*. Such an assertion, coupled with Inchofer's style of argument from scripture and the Church Fathers rather than from astronomical observations and syllogistic demonstration threatened to paralyse natural knowledge, and to place the mathematicians of the Jesuit order outside a global republic of astronomical practitioners that they had helped to create.

Throughout the early seventeenth century Jesuit mathematical practitioners and theologians negotiated together to construct a stance of epistemological modesty, or "mathematical phenomenism"[73], which permitted the adoption of any hypothesis,

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Baronius] which is that the intention of the Holy Spirit is to teach us how to go to heaven, and not how heaven goes", OG V p.319. In his 1992 speech to the Pontifical Academy of Sciences, Pope John Paul II used exactly this passage from Baronius to define his own position on scriptural hermeneutics, which he related explicitly to that of Galileo's *Lettera a Madama Cristina di Lorena* (*Discours du Saint-Père à l'Académie pontificale des Sciences, 31 October 1992*, published in Festa 1995 pp. 389-406 on p. 402). Galileo drew further support for his views from another theological work that was to be placed on the Index in 1616 donec corrigatur, Diego a Zuñiga's commentary on Job (see OG V p. 336). Galileo's exegetical principles were strongly influenced by those put forward by Benito Pereira in his *Commentariorum et disputationum in Genesim*, Rome, 1599, and thus highly consonant with Jesuit theological sensibilities of his time. See Baldini, *Legem impone subactis,* pp. 296-297

[72]Indeed, a crucial role in preventing the complete prohibition of Copernicus in 1616 was played by Cardinal Maffeo Barberini, before he became Urban VIII, as we are shown by the diary of Cardinal Giovanfrancesco Buonamici for 2 May 1633: "In tempo di Paolo V^{o} fu contrariata questa opinione, come erronea et contraria a molti luoghi della Sacra Scrittura; perciò Paolo V^{o} fu di parere di dichiarla contraria alla Fede: ma opponendosi li SS^{ri} Cardinali Bonifatio Gaetano et Maffeo Barberino, hoggi Urbano 8o, fu fermato il Papa di testa, per le buone ragione addotte da loro Eminenze ...", OG XV, p.111. Buonamici reaffirms this statement in his *Relazione* of July 1633, in OG XIX p.410-11. Urban VIII's biographer, Herrera, adds that the future pope was motivated to prevent the prohibition of De Revolutionibus because of its utility in the Gregorian reform of the calendar, an argument that was then taken up by Ingoli in his suggested corrections to Copernicus's work (see below note 93). Herrera also states that "Cardinal Gaetani judged the same and Bellarmine, who consulted the geometers (*geometri*), approved greatly". Presumably the "geometers" in question are the Jesuit mathematicians of the *Collegio Romano*, headed at that time by Christoph Grienberger and Orazio Grassi. Herrera's biography is cited in D'Addio, *Il caso Galilei,* cit., p. 48. See also Massimo Bucciantini, *Contro Galileo: Alle origini dell'Affaire*, Florence: Olschki, 1995, p. 154.

[73]The term is familiar from discussions of Duhem's study, "□□□□□□ □□ □□□□□□□ □□□" (Pierre Duhem,*To Save the Phenomena*, transl. E. Doland and C. Maschler, Chicago,: University of Chicago press, 1969 (orig. publ. 1908)). For an account of the many faces of astronomical pragmatism during the 16th and early 17th centuries, see N. Jardine, *The Birth of History and Philosophy of Science. Kepler's "A Defence of Tycho against Ursus", with Essays on its Provenance and Significance*, Cambridge: Cambridge University Press, 1988 pp. 225-257.

provided that it was taken as a hypothesis, and that nothing more than probability was claimed for it. This is the conception of science which is advocated in the more famous part of Bellarmine's 1615 letter to Foscarini[74], and is also to be found in a later remark of another Jesuit-turned-Cardinal, Marchese Sforza Pallavicino, who argues as follows in a letter to Monsignor Carlo Roberti written around 1665:

> As regards the system of the world, St. Thomas spoke better than anyone when he told us that Astronomers do not intend to prove that one or other astronomical system is true, but that the system does not conflict with the appearances that we see, as innumerable other systems could be found which would also not conflict with appearances. And which of these happens to be true is only known by those who are in heaven, and not by us, mere little worms, distant from heaven by many thousands of miles, and who change the system every day to agree with the new appearances that arise. Who, living in Genoa and knowing nothing of Corsica except whatever he saw from there with a telescope, would boast of being able to describe [Corsica] in detail? And yet such a boast would be far more modest, as the thing in question is so much nearer and much smaller.[75]

The definitive list of corrections to Copernicus's *De Revolutionibus,* made by Francesco Ingoli, was presented to the Cardinals of the Congregation of the Index on 2 April 1618. The document, submitted for the approval of the mathematicians of the Collegio Romano including Christoph Grienberger and Orazio Grassi and used as the basis for the published decree of 1620[76], proposed a *via media* by which astronomical systems

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[74]"Dico che mi pare che V.P. et il Sigr. Galileo facciano prudentamente a contentarsi di Parlare ex suppositione e non assolutamente, come io ho sempre creduto che habbia parlato il Copernico. Perchè il dire, che supposto che la terra si muova et il sole stia fermo si salvano tutte l'apparenze meglio che con porre gli eccentrici et epicicli, è benissimo detto, e non ha pericolo nessuno; e questo basta al mathematico: ma volere affermare che realmente il sole stia nel centro del mondo, e solo si rivolti in sè stesso senza correre dall'oriente all'occidente, e che la terra stia nel 3o cielo e giri con somma velocità intorno al sole, è cosa molto pericolosa non solo d'irritare tutti i filosofi e theologi scholastici, ma anco di nuocere alla Santa Fede con rendere false le Scritture Sante", Bellarmino to Foscarini; 12 April 1615 in OG XII, pp.171-172. On Bellarmine's conception of astronomy see Baldini, *Legem impone subactis*, pp. 285-303

[75]Sforza Pallavicino to Carlo Roberti; c. 1665. Rome, Biblioteca Casanatense Ms. 4983 ff. 38r-v.

[76]OG XIX pp. 400-401. In her study of the trial, Rivka Feldhay uses the 1620 decree to construct a "Dominican voice" in the Galileo affair, based on the fact that it is signed by the Dominican friar Franciscus Magdalenus Capiferreus: "Thus, the decree of the Index of 1620, which attempted to control any further investigation of the motion of the earth, may be seen as a reflection not of scriptural fundamentalism but of the theology of the Inquisitors with which it was entirely in keeping", Feldhay, *Galileo and the Church*, p. 212. However, Ingoli, despite working as a Consultor of the Congregation of the Index, was no Dominican. More importantly, the Jesuit mathematicians to whom the Congregation submitted his text for evaluation "all approved and praised the wishes of the said Lord Francesco, and judged it to be wholly profitable that it should be permitted that the work be amended and corrected in accordance with his corrections" (W. Brandmüller and E.J. Greipl, eds., *Copernico, Galileo e la Chiesa. Fine della controversia (1820). Gli atti del Sant'Uffizio.*, Florence: Olschki, 1992, pp. 444-445, cited in Bucciantini, *Contro Galileo*, cit., p. 87). Feldhay's use of the document to argue for a fundamental opposition between Jesuit and Dominican "celestial hermeneutics",

and theological doctrine could peacefully coexist and by which apparent contradictions between them could be resolved. This document characterised the proper method of astronomy as the use of "false and imaginary principles in order to save celestial appearances and phenomena", and added that "it is customary for the science of Astronomy in particular to make use of false suppositions"[77]. This attitude allowed the more unpalatable passages of Copernicus to be construed simply as breaches of astronomical etiquette.

However after the 1633 trial, as a consequence of conflicting visions of the relationship between astronomical investigation and cosmological truth and Galileo's "fall from grace", the *via media* proposed by Ingoli had been closed off, and the Jesuit vanguard of Catholic astronomy was prevented from invoking the key tenets of the Copernican theory even as hypotheses in published works[78].

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central to her re-interpretation of the 1632-3 trial, is therefore inappropriate. On the genesis of the 1620 decree see Bucciantini, op. cit., pp. 141-147.

[77]BAV Barb. Lat. 3151 ff.58r-61v: "I state that it is possible for these amendments to be made without danger to truth or Holy Scripture: because as the science which is treated by Copernicus is astronomy, whose proper method is to use false and imaginary principles in order to save celestial appearances and phenomena, as seen from the Epicycles, eccentrics, equants, apogees and perigees of the Ancients, if the places in which Copernicus does not treat the motion of the earth hypothetically are rendered hypothetical, they will challenge neither truth nor Holy Writ. On the contrary in a way they will fit together with the latter because it is customary for the science of Astronomy in particular to make use of false suppositions". The task of "correcting" *De Revolutionibus* was originally assigned to Bonifacio Cardinal Gaetani. However his death in June 1617 led Ingoli to take over the job. See Bucciantini, op. cit., pp. 141-147 (the document is published on pp. 207-209). Surprisingly, the document does not appear in any of the collections of documents relating to Galileo's trial. An English translation of the document is in O. Gingerich, *The Censorship of Copernicus's De Revolutionibus*, Annali dell'Istituto e Museo di Storia della Scienza di Firenze, Anno VI: 45-61.

[78]This is not to deny the existence of a certain degree of flirtation with the Copernican theory by Jesuits in unpublished works and letters. Much of the evidence for Copernican sympathies among the Jesuits is based on hearsay, e.g. Pietro Dini's letter to Galileo of 16 March 1615 "I understand that many Jesuits are secretly of the same opinion, although they keep quiet about it" (OG XII p.181) Interestingly, there have even been suggestions that Scheiner himself was a closet Copernican: As late as 1626 Francesco Stelluti wrote to Galileo that Scheiner "is in agreement with you about the system of the world" (OG XIII p. 300). Other Jesuits reputed to be inlined towards the Copernican theory include Orazio Grassi, Niccolò Cabeo, Wenceslas Kirwitzer and Wilhelm Weilhamer. On Copernican Jesuits see Favaro, *Cristoforo Scheiner*, cit., pp. 105-106, J. L. Russell, *Catholic Astronomers and the Copernican System after the Condemnation of Galileo*, Annals of Science, 46 (4); 1989: 365-86 and J. Lattis, *Between Copernicus and Galileo,* cit., pp. 202-205. On Kirwitzer's declaration of Copernicanism in his letter to Christoph Grienberger of 7 June 1615 (in APUG 534 ff. 90r-91v) see Baldini, *Legem impone subactis,* pp. 215-216 note 35 and Lattis, op. cit., p. 205.

Economies of truth

Christoph Scheiner cultivated close relationships with the most powerful members of the Habsburg dynasty including Archduke Karl, Archduke Leopold and Emperor Ferdinand II. He used his astronomical discoveries and instruments such as the pantograph[79], which allowed an unskilled person to make accurate drawings from life, to secure his favour with Archduke Maximilian and Archduke Karl (who invited Scheiner to be his personal confessor), and to acquire lavish Habsburg funding from Karl and Ferdinand II for Jesuit projects such as the church in Innsbruck (designed by Scheiner) and the new College of Neisse.[80]

In 1624, just after Scheiner's arrival in Rome, Archduke Karl died in Madrid[81]. Scheiner, who had already done some minor intellegence work for Leopold[82], was thus led to rely ever more on the Archduke's favour in his attempts to secure his position on his return to Austria and to ensure the continuation of the architectural projects begun under his supervision in Neisse and Innsbruck. From Rome, he reported on the inefficiency of Leopold's recently deceased intelligence agent at the papal court, Michael Will[83]. Scheiner, previously reproached by Vitelleschi for involving himself in affairs that were inappropriate to his station[84], took it upon himself to procure a new agent for Leopold.

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[79]See Scheiner, *Pantographice seu Ars delineandi res quaslibet per parallelogrammum lineare seu cauum, mechanicum mobile*, Romae; 1631.

[80]For details of Karl's monetary donations to Scheiner for the foundation of the College of Neisse see ARSI 1368/8/7. On Scheiner's ill-fated church for the College of Innsbruck, which collapsed in 1626, see *Memoriale P. Scheineri pro fabrica 1621. Fabrica templi*, Copy in Museum Ferdinandeum, Innsbruck, Ms. FB 51838. The original, dated 16 October 1621, is conserved in the archives of the Jesuit college of Innsbruck.

[81]Daxecker, *Briefe des Naturwissenchaftlers Christoph Scheiner SJ* , cit., p. 15

[82]Among other things Scheiner provided Leopold with detailed information about the private affairs and political intentions of his brother, Archduke Karl in 1621, around the time when Karl asked Scheiner to be his confessor. On Karl's future intentions towards the Jesuits Scheiner wrote that he would be easily won over to the Society "from which he has sucked milk since infancy". Daxecker, op. cit., p. 45

[83]Scheiner's list of reproaches of Michael Will included his lack of affection for the Jesuits, his association with a prostitute of uncertain gender, and the infestation of his house with terrifying ghosts the night after his death. Christoph Scheiner to Archduke Leopold of Austria, Rome, 8 January 1627, in Daxecker, op. cit., pp. 114-5

[84]Daxecker, op. cit., p. 68

The chosen man, Abbot Camillo Cattaneo, was, according to Scheiner, Cameral secretary to Urban VIII, very devoted to the house of Austria and an admirer of the Jesuit order[85]. Previously, on Vitelleschi's personal recommendation, he had been the agent of Scheiner's deceased patron Archduke Karl.

When Scheiner was preparing to depart from Rome he sent most of his belongings ahead to Innsbruck in fourteen wooden boxes. The boxes were well stuffed with hay and straw, bound twice, and covered with a waxen fabric to protect them against "any injuries from heaven and earth"[86]. A final covering was marked with a picture of a bottle [*signum Flasconis*] to warn the bearers of the fragility of the objects within. In numerous letters to Archduke Leopold, Scheiner emphasised the preciousness of the objects contained in these boxes, and the terrible dangers that might arise if they were opened before his arrival in Innsbruck[87]. The contents of these boxes, then, provide an important clue to the system of values within which Scheiner's career was embedded.

Scheiner explained to the Archduke[88] that about five of the boxes were intended for Leopold himself. The contents of three or four of the boxes were for the Emperor and the remaining boxes contained Scheiner's personal affairs. As Scheiner reveals in a later letter[89], when he fears that some of the boxes may be opened before his arrival, their prized contents included a total of around 10 "bodies" - saintly relics procured by Scheiner "not through the generosity of the Pope, but through [my] private

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[85]Anticipating Leopold's distrust of a non-German agent, Scheiner lapses into a macaronic German that he seemed to feel would reassure the Archduke: "Es sind nit alzeit alle Teütschen Teütsch, und auch nit allezeitt alle Welschen [i.e. Italians] Welsch: das Blättlein kheret sich zue Zeitten umb. Ego scio hunc Virum uere Germanum [a play on words between "sincere" and "German"], et si non pro certo scirem [...] nequaquam ita expresse scriberem". Christoph Scheiner to Archduke Leopold of Austria, Rome, 8 December 1626, in Daxecker, op. cit., p. 107

[86]Christoph Scheiner to Archduke Leopold of Austria, Rome, 30 March 1630, in Daxecker, op. cit., p. 144

[87]"Rogo si Oenipontum peruenerint, ut Vestra Serenitas in meum aduentum ipsas clausas retineat, cuius postulati caussas grauissimas habeo; cum enim res Caesaris sint ubique intermixtae p fieret chaos horrendum, et facile possent aliquid pati...", ibid..

[88]Scheiner to Archduke Leopold, Rome, 2 June 1628, in Daxecker, op. cit., p. 137

[89]Christoph Scheiner to Archduke Leopold, Rome, 27 July 1630, in Daxecker, op. cit., p. 148

endeavours"[90]. The boxes also contained a huge number of *Agni Dei* - oval wax tablets blessed by the pope on Holy Saturday and marked with the image of the Paschal lamb, the words "*Ecce Agnus Dei qui tollit peccata mundi*", the name of the current pope and the year of his pontificate. For Leopold alone there were 12,000 of these wax tablets in Scheiner's boxes, probably intended to be distributed within the regions under his control.

As Pope Paul II had written in a Bull of 21 March 1470[91], the *Agnus Dei* was invested with remarkable powers. It effaced sins, incited Christians to praise God, and protected the bearer against fire, shipwreck, hurricanes, lightning, hailstones, and evil influences. Pregnant women who wore an *agnus dei* were guaranteed a safe delivery[92]. Given the supernatural powers of these consecrated tablets, it was not surprising that they were in such high demand that forgery became a serious problem in the fifteenth century. In fact it was to deal with this very problem that Paul II issued his bull, *Immoderata perversorum cupiditas* which gave details of the punishments that would be incurred by those who continued to manufacture or sell illicitly the *agni dei* which it was his unique privilege to distribute. Offenders would be excommunicated, incarcerated and, if clerical, stripped of all ecclesiastical benefits and offices.[93] Paul II also ordered that those who were currently in possession of forged *Agni Dei* should bring them within eight days to the bishop of Lesina, who would exchange them for an equal quantity of wax or equivalent compensation[94].

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[90]"Corpora sacra afferam minimum 8, verum non ex liberalitate Pontificia, sed industria privata, quam auxit studium gratificandi Serenitati Vestrae et Collegio Nissensi benefaciendi amor", Scheiner to Archduke Leopold of Austria, Rome, 2 June 1628, in Daxecker, op. cit., p. 137

[91]*Bullarium Romanum* Tom. V pp. 199-200

[92] "[I]nter cetera, invitentur ad Dei laudes, ab incendio atque naufragio liberentur; procella quoque turbinum, fulgura, grandines, tempestates et omne malignum molimen procul ab eis pellantur; praegnantes absque partus periculo conserventur", ibid.

[93]"Si quis autem contra inhibitionem nostram huiusmodi temere venire praesumpserit sententiam excommunicationis incurrat; et si clericus fuerit, omnibus, quae obtinuerit, beneficiis et officiis ecclesiasticis priuatus existat; et nihilominus laicus, quoties id fecerit, per annum carceri mancipetur ob tanti facinoris ultionem", ibid.

[94]"Volumus autem, quod ii, qui cereas imagines sive Agnos Dei confectos huiusmodi apud se habuerint, infra octo dierum spatium a prohibitione praesentium computandum, illos venerabili fratri nostro Nicolao episcopo Pharensi consignare teneantur, recepturi pro cera

The "face value" of an *Agnus Dei* wax tablet clearly exceeded its "intrinsic value" as a piece of wax by a great deal in the systems of exchange operating in the worlds inhabited by Paul II and Christoph Scheiner.

The ten "bodies (*corpora*)" sent by Scheiner to Innsbruck were mostly the ashes of saints. No amount of inspection of such ashes could establish their intrinsic sanctity. Their value was established by the marks on their containers and, perhaps most importantly, by the words written by Christoph Scheiner in his frequent letters to Archduke Leopold from Rome[95]. After the rediscovery of the Roman catacombs in 1578, there was a dramatic growth in the distribution of early Christian relics through clerical channels, particularly to the German lands where Jesuits, Capuchins and Praemonstratensians used them as a powerful means of combatting heresy. The arrival of such relics in Austria and Southern Germany, sometimes accompanied by miracles, provoked pilgrimages to their new places of rest.

The system of values revealed by two of the main components of Scheiner's luggage is, then, crucially extrinsic - it is founded on chains of belief associated with inscriptions which connect the items to privileged sites and conditions of production. In this respect, as the words of Copernicus and Paul II suggest, it is structurally isomorphic with the system of values associated with both the standards laboratory - the standard metre bar in Paris for example[96] - and the mint. Bellarmine's distinction discussed earlier in this

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aequivalentem compensam vel satisfactionem condignam, alioquin sententias et poenas praedictas, ipso termino elapso, incurrant", ibid.

[95]E.g. "Item de Corpore S. Iulii Cineres, et similiter de Corpore S. Saturnini, quos hic Romae pro me singulariter exoraui, per quos tamen non excludo partem tertiam corporis", Christoph Scheiner to Archduke Leopold, Rome, 27 July 1630, in Daxecker, op. cit., p. 148

[96]On the difference between the metrology of intrinsic standards and the metrology of artefact [extrinsic] standards see Joseph O' Connell, *Metrology: The Creation of Universality by the circulation of Particulars*, Social Studies of Science, 23, 1993: 129-73. O' Connell uses the theological differences between Calvinism and Catholicism as a metaphor for this difference (e.g. op. cit. p. 154). However, I am arguing here that the metaphor should be taken seriously - the conflict of social models discussed by O' Connell is not limited to the field of metrology.

chapter can be usefully applied in this context - even if certain scriptural passages are not articles of faith intrinsically (*de fide ex parte obiecti*) they are extrinsically (*ex parte dicentis*) beyond doubt, as the credentials of the speaker - the Holy Spirit - are unchallengeable.

The exceptionally laudatory *imprimatur* of Galileo's *Assayer* written by Niccolò Riccardi, later Master of the Holy Palace during the 1633 trial, relates philosophical innovation to metrological analysis very explicitly. Deviating radically from the formalised norms of the genre, Riccardi concludes:

> I count myself lucky to have been born when the gold of truth is no longer weighed in bulk and with the steelyard, but is assayed with so fine a balance[97]

Galileo's text presses the analogy further:

> But since it seemed to me that [Grassi] used too crude a steelyard in his weighing of Sig. Guiducci's propositions, I have elected to employ an assayer's balance precise enough to detect less than the sixtieth part of one grain.[98]

In answering Orazio Grassi, Galileo is proposing to test the truth-content of Grassi's philosophical coin intrinsically, by assaying it with a fine balance. He is thus ignoring the claims of privilege - noble witnesses, Grassi's own high reputation, the authority of the Collegio Romano - that Grassi used widely in his *Libra Astronomica*[99]to support the foundation of his astronomical and philosophical claims. By questioning the skill, authority and honesty of Jesuits like Grassi and Scheiner, Galileo threatened to undermine public confidence in the value of their philosophical coin. The threat became especially acute when Galileo's chosen audience included powerful patrons of the Society, such as Archduke Leopold of Austria.

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[97]OG VI p. 200, translated in Stillman Drake and C. D. O'Malley, *The Controversy on the Comets of 1618,* Philadelphia: University of Pennzylvania Press, 1960, p. 152.
[98]OG VI p. 220, Drake and O'Malley, *The Controversy on the Comets,* cit., p. 171
[99]Drake and O'Malley, op. cit., p. 69: "But why was it so readily believed that this Gregoriana of ours, renowned for the many interests of its academicians should be considered as, among other things, the eyes of all, and that it ought especially to be consulted and its answers awaited?", ibid. p. 111: "I have no few witnesses to the fact that I say this not more surely than truly; first, many fathers of the Collegio Romano - however, many others were willing to recognise this on the authority of my teacher - and many others as well".

In 1618 Leopold, whose sister, Maria Magdalena, was married to the Grand Duke of Tuscany, had met Galileo in Florence. Galileo, despite a long period of illness, attempted to cultivate Leopold as a patron by sending him telescopes, a copy of the *Sunspot Letters* (written in answer to Scheiner's *Tres Epistolae de maculis solaribus* and *Accuratior Disquisitio*) and his unpublished treatise on the tides. In return for his gifts, Galileo sought the Archduke's opinion on his tidal proof of the Copernican theory, which he prudently described as "a poem, or a dream" in view of the 1616 Decree of the Index[100]. He also hoped to use Leopold to increase his favour with the Grand Duchess in order to further secure his position in the Florentine court[101]. Mario Guiducci's 1619 *Discorso delle Comete* was dedicated to Leopold and Galileo, the real author of Guiducci's discourse, did not miss an opportunity to attack Scheiner caustically in one of the opening paragraphs of the work:

> May I be granted the ability to explain them to you vividly, for I esteem more highly the praise of having been a good imitator than I do that other kind which is usurped by those who have attempted to make themselves the inventors of views that are really [Galileo's], pretending themselves to be Apelleses[102], when with poorly coloured and worse designed pictures they have aspired to be artists, though they could not compare in skill with even the most mediocre painters.[103]

Leopold's astronomer, Johannes Remus Quietanus, summarised the contents of the book for his master (prevented from reading it immediately by pressing affairs of state) and wrote to Galileo to describe the Archduke's reaction:

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[100]"[R]eputo questa presente scrittura che gli mando, come quella che è fondata sopra la mobilità della terra overo che è uno degli argumenti fisici che io producevo in confermazione di essa mobilità, la reputo, dico, come una poesia overo un sogno, e per tale la riceva l'A[ltezza] V[ostra]"Galileo to Archduke Leopold, Florence; 23 May 1618, OG XII 389-392.
[101]See Biagioli, *Galileo Courtier*, cit., p. 219 note 41
[102]Scheiner's early works on sunspots were written under the cumbersome pseudonym of *Apelles post tabulam latens*, referring to the story of Apelles, the favourite painter of Alexander the Great, who hid behind one of his paintings so that he could hear genuine appraisals of his work. Galileo's suggestion seems to be that Scheiner, as a plagiarist and unskilled draftsman is unworthy of the generous patronage that he has received on behalf of his order from the house of Austria.
[103] OG VI pp. 47-8, Drake and O'Malley, *The Controversy on the Comets* p. 24.

> He was very pleased by the work and was most grateful. He sent it immediately to Father Scheiner, who answered that he will pay your Lordship back in the very same coin.[104]

The attacks on Jesuit natural philosophy in the *Assayer*, which Galileo also sent to Leopold[105], thus posed a clear threat to the patronage niche carefully cultivated by Jesuits such as Scheiner in the Empire, precisely the patronage niche attacked by Inchofer and Scotti in the *Monarchia solipsorum*.

In return for substantial financial contributions from Leopold to Jesuit activities, Christoph Scheiner provided him with an intelligence agent in Rome, holy relics, *agni dei* and astronomical expertise. The value of all of these commodities rested entirely on Scheiner's credibility. In his letters to Archduke Leopold Scheiner repeatedly slips from Latin into a childish vernacular to assure Leopold of his loyalty, truthfulness and right conduct: "Ich sey so unschuldig als wie ein Khind"[106], "Ich bin halt der alte Scheiner, und einfaltige Schwaab"[107], "Ich bin noch der alte Scheiner, Euer Hochfürstliche Durchlaut mag mir wol trawen"[108].

The contrary projects of Galileo and Melchior Inchofer both implied that these claims, and the various types of information that they sought to validate, were worth decidedly less than the paper on which they were written.

From the *Monarchia solipsorum*(1645) to the *Ordinatio pro studijs superioribus* (1651)

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[104]"L'ha piacuto assai l'opera et l'è stata gratissima, e subito l'ha mandato al P. Scheiner il quale rispose che pagarà V.S. con la medesima moneta" Johannes Remus to Galileo Galilei, Vienna; 24 August 1619, OG XII pp. 488-489.

[105]Leopold's letter of thanks for the *Assayer* (OG XIII p. 162, 26 December 1623) is short, formal and in Latin, unlike his previous letters to Galileo, which are in Italian and relatively informal. The fact that Leopold sent no further letters to Galileo suggests that, although he compliments the book, Galileo's ridicule of Grassi and, to a lesser extent, Scheiner, in the *Assayer* may not have been altogether to his taste.

[106]"I am as innocent as a child", Daxecker, op. cit., p. 125

[107]"I remain the old Scheiner and simple-minded Schwab" (Scheiner was originally from Wald, a village near Mindelheim in Schwaben), ibid., p. 127

[108]"I am still the old Scheiner, Your Most Royal Majesty can truly trust me", ibid., p. 144

In 1645, just after Vitelleschi's death, a vitriolic satire of the Jesuit order was published in Venice. This work, entitled *Monarchia solipsorum*[109] ("The Monarchy of the Solipsists"), was dedicated to Leone Allacci, and was generally assumed by contemporaries to be the work of Giulio Clemente Scotti[110], previously a classmate of Sforza Pallavicino in the Collegio Romano. Evidence has recently come to light that points to Inchofer's involvement in the composition of this work[111]. On 3 January 1648 Inchofer's room in the German College was searched under the orders of General Vincenzo Carafa, and manuscripts were found linking him to Scotti. These included letters from Scotti and manuscript versions of works criticising the Jesuits[112]. Scotti, no longer a Jesuit, was beyond the disciplinary measures of the order but Inchofer had no such escape-route and was forcibly taken to Tivoli the following morning, where, after a long disciplinary process, he was condemned to a month's penance "according to the rules of St. Ignatius"[113] in the monastery of the Holy Trinity. He died only a few months later. Inchofer's involvement in this episode may be seen as part of a more general desire to reform what he perceived as the corruptions of the Society of Jesus of his day. The principal departure from the Ignatian origins of the Society criticised by in the 1645 *Monarchia Solipsorum* and also in Inchofer's unpublished, *Historia Octavae Congregationis Generalis* was the monarchical system of government which conferred lifelong, absolute power on the General. "The word Monarchy was either unknown to Ignatius rejected by him", Inchofer insisted in his *Historia*.[114] Bad government,

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[109]*Lucii Cornelii Europaei Monarchia solipsorum*, Venice, 1645.

[110]On Scotti, see the biography by P. Oudin in R. P. Nicéron, *Mémoires pour servir à l'histoire des Hommes Illustres dans la République des lettes*, Paris: Briasson; 1736, t. 39, pp. 65-85

[111]ARSI Hist. Soc. 166, *Causa P. Melchioris Inchofer*. Inchofer's confession is on ff. 65r-74v. These documents form the basis of the account of the last year of Inchofer's life given in Dümmerth, *Les combats et la tragédie du Père Melchior Inchofer S. J.* , cit.

[112]Many of these documents are contained in the volume ARSI Congr. 20d, *Melchioris Inchofer scripta de VIII Congregatione generali, aliaque Epistolae ad eum datae*.

[113]Although Dümmerth suggests that Inchofer would have been subject to regular flagellation during this period, there is nothing to suggest this in ARSI Hist. Soc. 166, and physical punishment was generally discouraged by the Society. In reality, the documents contained in this codex suggest that Sforza Pallavicino played an important role in mediating between Inchofer and the General to allow Inchofer to have his books so he could continue his studies during his period of incarceration.

[114]"Ignatio vocabulum Monarchia aut ignotum aut explosum fuit", Inchofer, *Historia 8ae congregationis generalis*, ARSI Congr. 20d , f. 56r.

epitomised by Vitelleschi's tyrannical rule, also permitted exotic theological and philosophical opinions to spread unchecked amongst Jesuit professors.[115] By arguing against the concentration of power in a single individual, the General, the *Monarchia* attempted, as Giorgio Spini points out, to enable provincial Jesuit colleges to challenge the authority of the General if his position appeared to be in conflict with the Ignatian *Rules* and *Constitutions*.[116] The words of Ignatius in the foundational documents would thus acquire a degree of legislative authority that was explicitly rejected by Ignatius himself on many occasions in his advocation of a flexible, jurisprudential approach to the government of the order and "*moderatio*" in the interpretation of rules. Obedience to one's superiors, and accomodation to local traditions are generally emphasised above obedience to any textual authority in Ignatius's own writings.[117]

The criticisms of the order contained in the *Monarchia solipsorum* seem to have been brought before the Inquisition through the mediation of Leone Allacci, according to Inchofer's own unpublished history of the ninth general congregation, apparently one of the documents discovered when his rooms were searched[118]. The newly elected pope wrote a memorandum to the Fathers of the 8th General Congregation, emphasizing a number of points on which the Jesuit order urgently required reform. Innocent X insisted on the reform of the absolute power of the General, which had come in for particular criticism in the *Monarchia*:

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[115]" Philosophica apud eos fere huiusmodi sunt. An Scarabeus paradigmaticè stercora voluat in orbem, An si Mus in mare mingat timendum naufragium. An puncta mathematica sint receptacula spirituum. An hiatus ventris, sit spiraculum animae. An canum latratus lunam reddat maculosam; & plura id genus, quae pari contentione dictantur, & excipiuntur" *Monarchia solipsorum*, p. 29.

[116]See Giorgio Spini, *Ricerca dei Libertini: La Teoria dell'Impostura delle Religioni nel Seicento Italiano*, Roma: La Nuova Italia; 1983 (2nd edition), p. 244. On the *Monarchia Solipsorum* in general, see ibid., pp. 233-246. Although Spini was unaware of the documents relating to Inchofer's secret trial in ARSI, he judges that Inchofer is the most likely author of the Monarchia on grounds of style and content, as well as contemporary rumours in Jansenist circles.

[117]See O'Malley, *The First Jesuits*, pp. 335-345, *Constitutions*, #822.

[118]"Sub id tempus prodijt libellus Lucij Cornelij Europaei de Monarchia solipsorum. Qui quantum novitate placuit, tantum obscuritate absterrius, et nihilominus curiosa ingenia exercuit. Leo Allatius cui inspeciem dicatus est, primus ipse apud Sacrum Tribunal nomen deposuit", Inchofer, *Historia 8ae congregationis generalis*, ARSI Congr. 20[d] f. 8r.

> If it is not decided that the perpetuity of the Generalate should be abolished, then a way should be sought to moderate the absolute authority of the General. General Congregations should also take place every eight years without fail, and it should not be possible for them to be prevented or postoned either by the General or by the entire Society, as has occured in the past.[119]

Echoing Inchofer/Scotti's criticisms of theological and philosophical exoticism in the Order, the Pope also required that

> No doctrine should be taught or professed other than that of St. Thomas, or those commonly accepted by the Church Fathers[120]

An examination of the proceedings of the Eighth General Congregation reveals that the Pope's memorandum set the agenda. As soon as Carafa had been elected, six deputations were set up to deal with the different problems pointed out by Innocent X. The fifth deputation was destined for "the promotion of the study of letters, the examination and revision of the books of the *Ratio Studiorum*, especially the parts relating to the selection of opinions, so that any excessive license or novelty of opinions is curbed, especially as these points are most strongly recommended now by the Pope"[121]. It was also decided to divide the deputation for studies into two parts, a first for *literae humaniores* and a second for theology and philosophy.[122] The link between the doctrinaire Thomism advocated by Innocent X and a return to doctrinaire Aristotelianism in philosophy, including natural philosophy or *physica*, was emphasized by a lengthy document on the reform of studies composed shortly after the Congregation by the Prefect of Studies of the *Collegio Romano*, Leone Santi.[123]

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[119]"Quando non si pensa di levare la perpetuità del generale determinare il modo di moderare l'autorità tant'assoluta del Generale, e che ogni otto anni si faccino le Congregationi Generali omninamente, senza che ne del Generale, ne da tutta la Compagnia possino essere impedite o dilatate, com'e seguito ne tempi passati", Innocent X to 8th General Congregation, ARSI Congr. 1, ff. 199r-v (two further copies inside the same codex, inside front cover and ff. 201r-202v).

[120]"Che non si possa leggere ne professare altra dottrina che quella di S. Thomaso, et altre che communamente sono state abbraciate dai Santi Padri", ARSI Congr. 1, f. 199r.

[121]ARSI Congr. 1, f. 226r: "Ad promovenda l[itter]arum studia, examinando et recognoscendo libros de Ratione studiorum, in illis maxime quae pertinent ad opinionum delectum, ut refrenetur nimia quaedam opinionum licentia et novitas, praesertim cum iam aliquot Summi Pontifice hoc valde Societati commendarint".

[122]ibid., f. 227r: "De promovendis studijs Deputatio partienda in duas: de humanioribus litteris unam; de Theologicis, et Philosophicis alteram".

[123][Leone Santi], *Dubia et Postulata Praefecti Studiorum Collegii Romanii de formandis Decretis circa Studia. 1646*, ARSI Rom. 150 I, ff. 268r-271v

> Scholastic theology signifies none other than that which supposes Aristotelian philosophy. If, therefore, our authors commonly depart from Aristotle, they are not transmitting not scholastic theology, but, as some would say, fantastic theology, for each individual forges his own with great confusion and perturbation to the Church. But how much less can someone defend and explain the theology of Saint Thomas in his theological conclusions [...] if in his philosophy he departs from the principles of Aristotle and the entire Peripatetic school? For unless minds are contained within certain limits their excursions into exotic and new doctrines will then be infinite, as will their ways of talking, with constant danger lest we should be brought before the Holy Tribunal of the Inquisition.[124]

When this document was composed Santi was waging a war with the unorthodox theological and philosophical opinions of Sforza Pallavicino within the Collegio Romano itself[125]. The Ninth General Congregation in 1649 ensured that the *Revisores* of the Collegio Romano would play a central role in establishing the reponse to the problem of doctrinal indiscipline. Even before the Eighth General Congregation, in 1645, the *Revisores* could criticise a series of philosophical 'paradoxes', possibly due to Honoré Fabri in Lyon, with the words

> We judge that these theses should in no way have been permitted to be defended, much less to be printed, because their author is seen to pursue novelties studiously and to abhor common opinion. The doctrine and method of Aristotle are not followed and in the name of paradoxes many things are inverted.[126]

Clearly in this case the response of the *Revisores* came too late - the conclusions had been defended publicly and printed in 1643. The response to the practical problems of centralised policing of opinions and printed works was to compose and distribute lists of prohibited propositions. The *Revisores* had been ammassing dangerous philosophical and theological propositions from the Provinces with increasing vigour under Vitelleschi and Carafa. The *Revisores* submitted to the Ninth Congregation that Carafa had

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[124]"Theologia Scholastica nihil aliud significat quam eam, quae philosophiam Aristotelicam supponit. Si ergo nostri auctores ab Aristotele passim recedant, non scholasticum Theologiam tradent, sed, ut quidam dicunt, phantasticam; unusquisque enim propriam procudet cum magna confusione ac perturbatione Ecclesiae. Iam vero tanto minus Theologiam D.T. in conclusionibus eius theologicis [...] defendere et explicare quis poterit, si eius philosophiam ab Aristotelicis principiis, et universa Peripatetica schola discesserit? Deinde quia nisi certis limitibus ingenia determinentur, infinitus erit excursus in peregrinas, novasque doctrinas, et loquendi modos cum assiduo periculo, ne ad Sacrae Inquisitionis tribunal deducamur", ibid.

[125]See ARSI FG 657 ff. 431-454.

[126]"Censemus nullo modo debuisse permitti ut Theses illae defenderentur multo minus ut imprimerentur quia earum Author videtur studiose novitates sectari a communibus sententiis abhorrere. Aristotelis doctrinam et methodum non sequi et sub nomine paradoxorum multa inuertere"

embarked on a very useful practice in insisting that both philosophical and theological propositions that were suspected of exoticism should be sent from the provinces to Rome in order to be judged by them.[127] The deputation for studies submitted a list of propositions not to be taught in Jesuit colleges[128]. The secretary of the Congregation, Pierre Cazré, himself a mathematical practitioner [129], objected immediately to the suggested prohibition of the Cartesian proposition that matter was indistinguishable from quantity that "The 23rd proposition is most common, and in many places more common than the other, and and although it has already been said to be prohibited, the prohibition has not been effective, and if this is done again, I hardly think that [the prohibition] will be observed in the future"[130]. In spite of Cazré's objections, the list of prohibited propositions were sent unaltered to the *Revisores* of the *Collegio Romano*[131] and were published unchanged in 1651 as the *Ordinatio pro studiis superioribus*. Even after the publication of the *Ordinatio*, objections continued to be voiced. Roderigo de Arriaga postulated to the Tenth General Congregation that

> [A]s there are great quarrels every where concerning the number and quality of the opinions rejected by Rev. Fr. Piccolomini of good memory, the Congregation is asked if it would be worth asking many Universities to send their judgements on those opinions to our Rev. Fr. General, so that once these are considered he would judge which must still remain prohibited and which not. This is especially so because some sentences are rejected which are defended by most approved authors of the Society and of other orders, which do not concern the faith or good morals, and cannot cause any offense, even by their appearance. It appears to me that our faculty of discoursing about these [opinions] should not be removed in any way.[132]

Arriaga's objections went unheeded and the 1651 *Ordinatio pro studiis superioribus* retained its hold over the two public theatres of Jesuit erudition - print and classroom.

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[127]*Revisores Generales* to 9th General Congregation, Rome, 28 December 1649, ARSI Congr. 20e ff. 49r-v.

[128]*Propositiones quas Patres Deputati pro studijs censuerunt non a praeceptoribus nostris docendas. 1649*. ARSI Congr. 20e f. 226r

[129]Cazré was professor of mathematics in Pont-à-Mousson (1622-23) and later Reims (1623-24, 28-29). His works include a criticism of Galileo's science of motion, *Physica demonstratio qua ratio, mensura, modus, ac potentia, accelerationis motu in natuali descensu gravium determinantur. Adversus nuper excogitatam a Galileo Galilei* , Paris: Jacques du Breuil, 1645.

[130]ARSI Congr. 20e f. 234r

[131]*Instructio pro studiis superioribus Iussu nona Congregationis Generali confecta et missa a R.P.N. Francisco Piccolomineo Praeposito Generali*, Rome, 3 October 1650, ARSI FG 657 pp.641-667.

[132]ARSI Congr. 20e f. 413r

Although principally directed against the public teaching of novel doctrines or "discussing useless subtleties" in Jesuit colleges, the terms of the *Ordinatio* made it clear that it was also directed to printed works:

> For this reason this catalogue has been communicated to all of our professors of Philosophy and Theology, as well as the Prefects of the higher faculties, so that they can ensure that opinions of this kind are not propagated either in theses or in disputations, and that they are not taught in our schools. It has also been sent to all of the *Revisores*, so that if it happens that they are found inserted in books which they are examining, they will not permit them to be published.[133]

The agents of this reform of Jesuit teaching would be the Rectors of each college, the Provincials carrying out their routine *visitationes* to the colleges in their province, and the local Prefect of Studies. A college that was especially sound in doctrine would serve as a model for the other colleges in its province. In the *Collegio Romano*, "*totius Societatis facile primo*", the prohibitions would be observed most carefully.[134]

The *Ordinatio* had significant effects on the way the Jesuit "physico-mathematician" could manifest himself in print. In criticising works such as Athanasius Kircher's *Itinerarium Extaticum*[135] or Francesco Maria Grimaldi's *Physico-mathesis de lumine*[136], the Jesuit *Revisores* could now refer to the propositions of the *Ordinatio* directly, as

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[133]"Quare communicetur catalogus hic omnibus nostris Professoribus Philosophiae et Theologiae, nec non Praefectis superiorum facultatum, ut curent, ne hujusmodi sententiae vel proponantur in thesibus, vel in disputationibus propugnentur, vel in scholis nostris doceantur. Denique communicetur etiam cum revisoribus omnibus, ut, si contingat insertas reperiri in libris, quos examinant, eos edi in lucem non permittant", *Ordinatio*, cit., p. 7.

[134]*Ordinatio*, cit., p. 98.

[135]Athanasius Kircher, *Itinerarium Extaticum*, Rome: Vitalis Mascardi; 1656. See Franciscus Le Roy, *Responsio ad quandam censuram in qua redarguuntur propositiones sex, ex Itinerario Extatico P. Athanasii Kircheri desumptae*, ARSI, Fondo Gesuitico 675, ff.247-248. On the censorship of this work see Carlos Ziller Camenietzki, *L'Extase interplanetaire d'Athanasius Kircher: Philosophie, Cosmologie et discipline dans la Compagnie de Jésus au XVIIe siècle.* Nuncius. 1995; X(1): 3-32.

[136]Francesco Maria Grimaldi, *Physico-mathesis de lumine, coloribus, et iride*, Bologna, 1665. See ARSI FG 670 ff. 53r-55r, published in Baldini, Legem impone subactis, pp. 102-3, e.g. f. 53r: "Propositione 42a significat colores, etiam qui appellantur permanentes, non distingui reipsa a lumine, nec proinde esse qualitates. Et propositione 14a docet operationem magneticam consistere in effluvio substantiali omnia corpora pervadente: cumque propositione 15a dicat se ex occasione ostensurum quis sit verus conceptus rarefactionis et condensationis, verisimile est eum itidem explicaturum esse per ingressum corpusculorum, minus consentanee ad propositionem 37a in Ordinatione pro Studiis". The 27th proposition of the *Ordinatio* was: "Elementa non transmutantur invicem, sed unius particulae in alio delitescunt incorruptae, quarum ingressus rarefactionis et condensationis est ratio", *Ordinatio*, cit., p. 92.

grounds for refusing publication. Reactions to this increased disciplinary vigour were varied. Honoré Fabri attempted to avoid the scrutiny of the *Revisores* altogether by publishing many of his works under the name of his student Pierre Mousnier[137]. Orazio Grassi hinted that he planned to destroy a work in a letter sent to Baliani in 1652 that "I see that I will not be able to publish my study of colours because of the rigorous orders made [...] in these last General Congregations, in which ours are forbidden to teach many opinions, some of which are the substance of my treatise, and they claim to prohibit them not because they consider them to be bad or false, but because they are new and not ordinary. It will thus be necessary for me to sacrifice them to Holy Obedience, by which I will undoubtedly gain more than I would be publishing them".[138] As late as 1674 Fabri felt it necessary to demonstrate that he had never defended the propositions prohibited by the *Ordinatio* in his third *Epistola* to Ignatius Pardies, to which he appended a list of Aristotelian propositions to which he subscribed.[139]

Clearly, Piccolomini's *Ordinatio* was particularly intended to eradicate the exoticism in theology and philosophy ridiculed by the *Monarchy of the Solipsists* and frowned upon by Innocent X. As well as adopting pseudonyms, destroying manuscripts or adopting

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[137]On Fabri see E. Caruso,*Honoré Fabri, gesuità e scienzato*. Miscellanea secentesca. Saggi su Descartes, Fabri, White, Milano: Università di Milano; 1987: pp. 85-126. A. Boehm, *L'aristotélisme d'Honoré Fabri (1607-1688).* Revue des sciences réligieuses. 1965; XXXIX: pp.305-360, E. A. Fellman, *Die Mathematischen Werke von Honoratus Fabry*. Physis. 1959; 1: pp.6-25, 69-102 and David C. Lukens, *An Aristotelian Response to Galileo: Honore Fabri S.J. (1608-1688) on the causal analysis of motion*. Dissertation: University of Toronto; 1980.

[138]Orazio Grassi to G. B. Baliani, Savona, 25 August 1652, Biblioteca Braidense, Milan, AF XIII, 13, 4, f. 233r, in Serge Moscovici, *L'Experience du mouvement. Jean-Baptiste Baliani, disciple et critique de Galilée*, Paris: Hermann, 1967, pp. 251-2, on p. 252.

[139]*Honorati Fabri Societatis Iesu ad P. Ignatium Gastonem Pardesium ejusdem Societatis Iesu Epistolae Tres de sua Hypothesi Philosophica*, Mainz: Apud Joan. Petrum Zubrodt, 1674, p. 116: "Unum restat mihi faciendum, ac respondendum circa ea (humanissime Pardesi) quorum per te certior factus sum: scripseras enim, me a multis pro Cartesiano, aut Democritico, seu Atomista, ut vocant, traduci, & nonnulla in mea Hypothesi Philosophica, vel adstrui, vel contineri, que per Societatis leges, aut Decreta, a nostris doceri vetantur: in duabus prioribus literis, quas ad te scripsi, primum ni fallor, evici, nimirum me, nec Cartesianum, nec Gassendistam, nec demum Atomistam, aut Democriticum esse; alterum in hisce ultimis praestare conabor, ostendamque, mea Placita iis Propositionibus omnino adversari, quas R.P.N. Franciscus Piccolomineus, in sua Ordinatione pro studiis superioribus, juxta deputationem, quae de illis habita est, in Congregatione nona Generali, ad Provincias missa, Anno 1651. ex scholis nostris proscripsit: quamvis enim nulla Censura illas affecerit: eas tamen in nostris gymnasiis doceri, prohibuit; quod ut penitus evincam, singulas juxta numerorum seriem, in qua extant, recensendas esse, duxi, & cum meis placitis conferendas".

the "doctrinal duplicity" manifested in Grimaldi's *De Lumine*[140], a significant number of Jesuit authors thus responded to the new rigour by presenting their work as technique rather than physics - *ars* rather than *philosophia naturalis*. Thus, perhaps somewhat paradoxically, the period of enforced disciplining of exoticism in natural philosophy within the Jesuit order coincided with an explosion of works composed by Jesuit mathematicians dealing with artifical magic, exemplified by the works of Athanasius Kircher, Gaspar Schott and Francesco Lana Terzi. The new, magical space in which many Jesuit mathematicians carried out their work after the 1640s nonetheless compromised the authority with which they could make pronouncements about the operation of causes in the natural world.

[140]The title of Grimaldi's *Physico-Mathesis* speaks eloquently in this respect. An approximate translation is "Two books of Physico-mathematics of light, colours and the rainbow, and other connected matters, in the first of which new experiments are put forward, along with the reasons deducted from them in favour of the substantiality of light. In the second, however, the arguments put forward in the first book are dissolved, and it is taught that the Peripatetic doctrine of the accidental nature of light can be held as probable", Grimaldi, *Physico-mathesis*, cit.

CHAPTER 6

EXPERIMENT, EXPERTISE AND CENTRALISED AUTHORITY: THE VACUUM DEBATE

> Your Most Illustrious Lordship should not affirm the existence of the vacuum so strongly because of that famous experiment; as now even the disciples of Galileo deny it, and would even like to claim that it is impossible, even by divine power, which I do not believe. It is certain that one experiences that small animals can live and sound can be produced within that space in the vessel that they thought remained empty, so therefore there is body.
>
> Sforza Pallavicino[1]

Introduction

In July 1660, the Jesuit natural philosopher Honoré Fabri wrote from Rome to Lorenzo Magalotti, secretary of the Accademia del Cimento, to congratulate him on the ongoing experimental investigations of the Florentine experimental academy. While approving in enthusiastic terms of the advancement of natural philosophy through the systematic accumulation of experimental data by the academy[2], Fabri warned Magalotti that the experimental enterprise itself was fraught with dangers:

> I frequently say, and perhaps you might have heard me say it on some occasion, an experiment is like a very good sword, in that if an agile man uses it for the defense of prince and realm it achieves many glorious deeds but if, however, it is used by someone driven by fury, nothing is to be expected but terrible slaughter and patricide.[3]

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[1]"V.S. Illma non affermi si animosamente il vacuo per quella famosa esperienza; poiché i seguaci stessi del Galileo ora il negano in Firenze: anzi vogliono che sia impossibile eziando per divina potenza, ciò ch'io non credo. Certo è, sperimentarsi che entro a quello spazio della caraffa, il quale pensavano che si dimostrasse rimaner vacuo, vivono animaletti, e si forma il suono; adunque vi è corpo", Sforza Pallavicino to Carlo Roberti, n.p., n.d., Biblioteca Casanatense Ms. 4983 ff. 38r-v in Pallavicino, *Opere,* Tom. II pp. 19-20.

[2]"Laudo, probo, et ut voce tua utor, osculor sanctissimas illas Academiae vestrae Leges; Libertatem illam dicendi, arcanum illud, altercationum Scholasticarum proscriptionem approbo, eamque experimentorum Sylvam in re Physica maximi facio, quae nisi praemittatur, nihil unquam in illa facultate assequi possumus", Honoré Fabri to Lorenzo Magalotti, Rome; 31 July 1660; BNCF, Ms. Gal. 283 ff. 76r-77v, on f. 76v.

[3]"Dictitare soleo, et tu fortè a me audire aliquando potuisti, experimentum ad instar optimi gladij esse, quo si vir strenuus utatur, pro defensione Principis et Patriae, multa sanè praeclarè

One of the politically dangerous experiments that Fabri undoubtedly had in mind was the experiment first carried out by Evangelista Torricelli sixteen years previously to demonstrate the existence of the vacuum and the weight of air. From the late 1640s to the 1660s a large number of works were published by Jesuit natural philosophers, theologians and mathematicians in Rome, Bologna, Vilnius, Paris, Lyon and elsewhere which attempted to refute the anti-Aristotelian conclusions derived by Torricelli and the other vacuists from the experiment. Although the reaction was by no means completely uniform, and Jesuit writers employed radically different hypotheses in their efforts to provide alternative explanations for the anomalous phenomenon of the suspension of the mercury in the Torricellian tube, the large-scale nature of the Jesuit reaction suggests that in attempting to understand the positions adopted by Jesuit participants in the debate we should look to non-local institutional factors. The debate had significance for the order that went far beyond the bounds of pure intellectual curiosity. This chapter will attempt to trace some of the different political and theological factors that combined to give the Torricellian experiment such a highly charged meaning for Jesuit experimental practitioners in the middle of the seventeenth century. By documenting the relationship between the participation of Jesuits in specific replications of the void experiment and discussions of its significance with broader goals of the order in the complex political context of the time around the Peace of Westphalia, I hope that a picture will emerge of the way the work of the individual Jesuit experimenter was given meaning by the goals of the order as a whole on the turbulent political and theological stage of Europe at the end of the Thirty Years War.

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geret, si verò quispiam in furorem actus, nihil ab eo praeter nefandas caedes et patricidia expectandum est", ibid.. Magalotti seems to have encountered Fabri while a student at the *Collegio Romano*. See Eric Cochrane, *Florence in the forgotten centuries 1527-1800*. Chicago and London: The University of Chicago Press; 1973, pp. 231-4. On Fabri's troubled relationship with the academicians of Prince Leopold during the 1660s see also Albert van Helden, *The Accademia del Cimento and Saturn's ring*. Physis. 1973; 15: 237-259 and John L. Heilbron, *Honoré Fabri, S.J. and the Accademia del Cimento*. Actes XII Cong. Int. Hist. Sci.; 1968. ; 1971: 3b, pp. 45-49.

The Genesis of an Experimental Fact

Although the empty-space left by the mercury at the top of the Torricellian tube became invested with a huge variety of theological and political meanings by the end of the 1640s, the experimental work that led to Torricelli's elated exclamation in 1644 that "We live submerged at the bottom of a lake of elementary air, which we know to have weight by indubitable experiments"[4] was ostensibly driven by a problem in civil engineering[5]. In July 1630 Giovanni Battista Baliani, a high dignitary and port-official in Genoa, was attempting to build a siphon in order to transport water over a hill of 84 *palmi di Genova* in height[6]. He wrote to Galileo to give a detailed explanation of the behaviour of the siphon. "When it is opened, while the upper part remains closed, the water escapes everywhere, and if one side is kept closed and the other is opened, [water] still comes out on the open side."[7] In particular Baliani informed Galileo that the water descended to a certain fixed point on the opened siphon, before stopping, a phenomenon that left him "stupefied".[8] Galileo wrote back to Baliani, suggesting that the expense of constructing the copper siphon would have been spared had Baliani first thought to ask him for advice, as the question was one which he had considered long before. Although Baliani, like Torricelli later on, wished to account for the phenomenon in terms of air-pressure, Galileo's interpretation, later expanded in his *Discorsi* consisted in advocating a theory of matter as being held together by an infinite number of infinitestimal vacua. Just as a rope of a given thickness will break under its own weight

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[4]"Noi viviamo sommersi nel fondo d'un pelago d'aria elementare, la quale per esperienze indubitate si sa che pesa", Evangelista Torricelli to Michelangelo Ricci, Florence, 11 June 1644, in Torricelli, *Opere*, vol. III, p. 216.

[5]On the relationship between the science of hydrostatics and practical problems of water management in seventeenth century Italy see Cesare S. Maffioli, *Out of Galileo: the Science of Waters, 1628-1718*, Rotterdam: Erasmus; 1994.

[6] "Ci conviene far che un'acqua di due oncie di diametro in circa traversi un monte, e, per farlo, conviene che l'acqua salisca a piombo 84 palmi di Genova, che son circa 70 piedi geometrici", Gio. Battista Baliani to Galileo Galilei, Genova; 17 July 1630, OG XIV, 124-125

[7]"Però questo sifone non fa l'effetto desiderato; anzi aperto, ancorchè chiuso dal di sopra, l'acqua esce da tutte le parti, e se si tien chiuso da una parte, aprendo dall'altra, ad ogni modo da questa esce l'acqua", ibid.

[8]"Avviene un'altra cosa che mi fa stupire; et è, che aprendosi la bocca A, esce l'acqua sin che dalla parte D sia scesa per la metà in circa, ciò è sin a F, e poi si ferma", ibid.

if it exceeds a certain length, the water in a siphon of more than 18 *braccie* will "break" under its own weight, when the limited resistance of the interstitial vacua is overcome. In the *Discorsi*, Galileo linked his discussion to a much-contested demonstration using the "Aristotle's wheel" problem that the mathematical continuum was actually composed of an infinite number of indivisible points, separated by interstitial vacua[9]. The type of atomist approach used by Galileo in this explanation was closely related to the revived interest in Hero's *Pneumatica* in late sixteenth century Italy[10], and Galileo's Venetian friend Paolo Sarpi also leaned towards a Heronian conception of matter in his private writings.[11]

Readers of the *Discorsi*

Although much of the work had been written in 1631-4, the *Discorsi* were only finally published in Leiden in 1638[12]. The discussions of siphons inspired a number of different groups to conduct further experiments along the lines suggested by Galileo. In the presence of the Minim mathematician Emmanuel Maignan and the Jesuits Athanasius Kircher and Niccolò Zucchi, Gasparo Berti conducted a spectacular, but equivocal experiment outside his Roman palace at some time between 1641 and 1643. The experiment, initially little more than an urban version of Baliani's troublesome siphon, involved attaching a lead pipe of around 22 *braccie* in height to the side of Berti's house. The pipe was filled with water through an open valve from one of the bedrooms in the house with the valve at the base of the pipe remaining closed. When the upper valve was closed the lower valve was opened allowing the water to fall into a tub

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[9]Galileo Galilei,*Two New Sciences*, translated by Stillman Drake, Madison; 1989, p. 33.
[10] See William R. Shea, *Galileo's Atomic Hypothesis,* Ambix. 1970; 17: pp.13-27, Marie Boas, *Hero's Pneumatica: a study of its transmission and influence.* Isis. 1949; 40: pp. 38-48.
[11]See Paolo Sarpi, *Pensieri Naturali, Matematici e Metafisici*, a cura di Luisa Cozzi e Libero Sossi. Milan and Naples: Riccardo Ricciardi; 1996, pp. 238-9, 333, 419, also Gaetano Cozzi, *Paolo Sarpi tra Venezia e l'Europa*. Torino: Einaudi; 1979, and Libero Sosio, *Galileo Galilei e Paolo Sarpi*, in *Atti del Convegno Galileo Galilei e la Cultura Veneziana, Venice, 18 June 1992*, Venice: Istituto Veneto di Scienze, Lettere ed Arti; 1995: 269-311.
[12]Stillman Drake, *Galileo at work*. Chicago, London: University of Chicago Press; 1978, p. 386.

in the courtyard.[13] A glass tube fitted to the top of the pipe allowed the water level to be observed to fall only to a certain point before stopping, leaving an apparently empty space above. A sophistication of the experiment suggested to Berti by Kircher incorporated a bell, which was made to ring in the empty space by means of a magnet[14]. The various reports of the experiment are contradictory, in both their accounts of the phenomena observed and their interpretation. Years later Raffaello Magiotti remembered the small bubbles that he had seen rising through the water in the glass portion of the siphon, which he suspected of going to replace the air in the top of the tube. "Those bubbles [*pulighe*]", he wrote to Mersenne in 1648, "have always been on my mind"[15]. The sound of the bell in the space convinced Athanasius Kircher that it contained air[16], although Maignan countered this argument with the possibility that the sound of the bell might be transmitted along the string attaching it to the tube[17]. Magiotti wrote to Torricelli describing the experiment, and suggesting that sea-water might come to rest lower in the tube than freshwater. This, according to Magiotti, inspired Torricelli and

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[13]On the Berti experiment see Athanasius Kircher, *Musurgia universalis, sive Ars magna consoni e dissoni*, Rome: Francesco Corbelleti, 1650 p.11 ff, Emmanuel Maignan, *Cursus Philosophicus concinnatus ex notissimis cuique principiis*, Toulouse: Apud Raymundum Bosc.; 1653 Tom. IV esp. p.1849, Gaspar Schott, *Mechanica hydraulico-pneumatica,* Würzburg; 1657, p. 306 ff, idem., *Technica Curiosa sive mirabilia artis, Libris XII. comprehensa.* Würzburg: Jobus Hertz; 1687 [1664] pp. 202-204. The genesis of the experiment is discussed in Frank D. Prager, *Berti's Devices and Torricelli's Barometer from 1641 to 1643.* Annali del Istituto e Museo di Storia della Scienza di Firenze. 1980; Anno 5(Fasc. 2): pp. 35-53, and Cornelius de Waard, *L'Experience barometrique: ses antécédents et ses explications*. Thouars: J. Gamon; 1936. On Berti's career as a "mechanikos", see Joseph Connors, *Virtuoso Architecture in Cassiano's Rome*, in *Cassiano Dal Pozzo's Paper Museum*, London, 1992, vol. II (Quaderni Puteani 3), pp. 23-40 on pp. 27-8.

[14]"Intra vero phialam me suggerente, campanulam una cum malleolo lateribus phialæ ea dexteritate inferuit, ut malleolus ferreus magnete ab extra attractus elevatusque mox a magnete liber proprio pondere campanulae illisus sonum faceret", Kircher, *Musurgia*, loc. cit.

[15]"Infatti, quelle pulighe mi sono restate sempre nella mente", Raffaello Magiotti to Marin Mersenne, Rome; 12 March 1648, in Mersenne, *Correspondance*, XVI, 168-171.

[16]"Concludimus itaque, quod tametsi vacuum in natura rerum possibile foret, sonus tamen in eo contingere minimè posset. Nam cum sonus sit affectio aeris, imò aër sit materialis causa soni, illo deficiente, sonum quoque deficere necesse est; & contra ex proposito experimento clare ostendimus, vacuum in natura rerum minime assignari posse", Kircher, *Musurgia*, loc. cit.

[17]This is also suggested by Honoré Fabri. See Pierre Mousnier [Honoré Fabri], *Metaphysica demonstrativa*, Lyons: 1648, p. 579: "cum affixum sit superiori basi, licet in ea cavitate vacuum esset, sonus tamen adhuc audiri posset; quia cum tremulo motu tintinnabuli in ipsam fistulae basim traducitur".

his collaborator Michelangelo Ricci to conduct experiments with heavier and heavier fluids, culminating in the use of mercury in the famous Florentine experiment of 1644.[18]

Berti was not alone in being inspired by Galileo's work to begin experiments on siphons. During the negotiations to publish the *Discorsi* outside Italy, an attempt had been made in 1636 to have the work published in Moravia, under the patronage of Cardinal Dietrichstein, who died before this could be carried out. One of the prime movers behind this effort was the Capuchin friar from Milan, Valeriano Magni[19]. Magni was a vehement opponent to the hold of Aristotelian philosophy over the universities of Europe and was later to dismiss Aristotle in scathing terms in his *De Atheismo Aristotelis*, published in 1647[20], writing that "[Aristotle] is a tyrant, who has burdened the human race, more pernicious than any heresiarch, or any man brought forth by any age"[21] . During the 1630s and 40s he had attempted to develop a new philosophical system of his own, drawing on Platonic and other sources, to constitute an alternative to the Christianised Aristotelianism sanctioned by the decrees of the Council of Trent and by the Jesuit hegemony over education in Catholic Europe. Magni's first published philosophical work, a popular treatise expounding a Platonic Christian philosophy influenced by Bonaventure's *Itinerarium mentis in Deum*, entitled *De luce mentium*, and published in 1642, was submitted to numerous theologians for approval[22]. Athanasius

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[18]The standard study of the experiment remains Cornelius de Waard, *L'Experience barometrique: ses antécédents et ses explications*. Thouars: J. Gamon; 1936. See also W. E. Knowles-Middleton, *The History of the Barometer*, Baltimore: Johns Hopkins University Press; 1964, pp. 10 ff., S. Moscovici, *L'Experience du mouvement. Jean-Baptiste Baliani, disciple et critique de Galilée*. Paris; 1967, C. Costantini, *Baliani e i Gesuiti*. Florence: Olschki; 1969 and Massimo Bucciantini,*Valeriano Magni e la discussione sul vuoto in Italia.* Giornale Critico della Filosofia Italiana, 1994; Serie VI, Volume XIV(Anno LXXIII (LXXV)): pp. 73-91.

[19]See Jerzy Cygan, *Das Verhältnis Valerian Magnis zu Galileo Galilei und seinen wissenschaftlichen Ansichten*. Collectanea Franciscana. 1968; 38(n. 1-2): 135-166.

[20]Jerzy Cygan, *Valerianus Magni (1586-1661). "Vita Prima", operum recensio et bibliographia*. Rome: Istituto Storico dei Cappuccini; 1989, pp. 315-6 #8.

[21]"Tyrannus est, qui premit genus humanum perniciosius ulla heresiarcha, ullove hominum quos tulerit aetas ulla", Valeriano Magni, *De Atheismo Aristotelis*, Warsaw, 1647

[22]For a detailed study of the *De Luce Mentium* see A. Boehm, *Deux essais de renouvellement de la scolastique au XVIIe siècle. I. L'Augustinisme de Valerien Magni (1586-1661).* Revue des Sciences Réligieuses. 1965; 39: pp.230-267. Magni's philosophical system has been the subject of a recent monograph, Stanislav Sousedík, *Valerianus Magni 1586-1661. Versuch einer Erneuerung der christlichen Philosophie im 17. Jahrhundert*. Sankt Augustin: Verlag Hans

Kircher attacked the work in scathing terms in a report that may have been prepared at the request of the Congregation of the Index, writing that "The treatise *De luce mentium* contains many dogmas extracted from the workshops of the Pythagoreans and Platonists".[23]

Magni's next philosophical publication was his 1647 *Demonstratio ocularis*[24], in which he described his experiments on the vacuum.
As he wrote in 1647, his reading of Galileo's *Discorsi*, perhaps the manuscript that Pieroni had brought to Bohemia, had encouraged him to conduct his own investigations on the behaviour of liquids in tubes:

> After I had recognised from a certain little work by Galileo Galilei, that it is not possible to raise water in a tube or a pipe above eighteen *braccie*, I realised, on this account, that it would not be possible to raise mercury up to a height of two *braccie*, on account of the difference between its weight and that of water. For this reason, I was beset with an enormous desire to prepare glass tubes in the same way, until I had brought out to the eye a famous, disputed question hidden from the world. I did this and saw with my own eyes: Place without a located [body], the successive motion of a body in the vacuum, [and] light inhering in no body.[25]

Magni performed this experiment in the court of the Polish King Wladislaus IV Vasa in July 1647, as he narrates in the *facti historia* of his *Demonstratio.* To the suggestions of

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Richarz; 1982. The tone of this study is somewhat coloured by the author's aim to demonstrate that Magni's philosophical system was a precursor of Kantian transcendental idealism. A study that relates Magni's anti-Aristotelianism to his ecumenism is Cesare Vasoli, *Note sulle idee filosofiche di Valeriano Magni* in Vittore Branca and Sante Graciotti, eds. *Italia, Venezia e Polonia tra medio evo e età moderna,* Florence; 1980; Studi 35: pp. 79-112.

[23]"Censura libri de luce mentium. Tractatus de luce mentium multa continet ex Pythagoraeorum Platonicorumque officina deprompta dogmata: quorum principem locum oblivet Lux mentium quam Author toto passim opusculo demonstrare conatur increatum esse, atque identificari cum Numine assistente et illuminante; iuxta illud priscorum philosophorum, quos sectatur epiphomena", Athanasius Kircher, *[Censura libri de Luce Mentium]*, APUG 561 f.101r.

[24]Valeriano Magni, *Demonstratio ocularis loci sine locato: corporis successive moti in vacuo: luminis nulli corpori inhaerentis*. Warsaw: In officina Petri Elert; 1647.

[25]"Porro ex opusculo quodam Galilei de Galileis cognoueram, quod per mechanica instrumenta non sit possibile aquam eleuari in fistula, seu canali ultra octodecim ulnas, quapropter intellexi nec posse ab eadem virtute contiguante eleuari mercurium usque ad secundam ulnam, ob excessum eius grauitatis super grauitatem aquae: quapropter me incessit ingens cupido parande eiusmodi fistulae ex vitro, quatenus ad oculum dirimerem qaestionem celeberrimam disputatam a mundo condito. Feci, & vidi oculis meis. Locum sine locato. Corpus motum successiue in vacuo: Lumen nulli corpori inhærens", Valeriano Magni, *Demonstratio ocularis* p. 6.

members of the Mersenne circle, especially Gilles Personne de Roberval, that he had plagiarized the experiment from Torricelli and others during a visit to Italy in 1644-1645[26], he replied, in a subsequent *Narratio apologetica,* appended to the fourth 1647 edition of the *Demonstratio ocularis* [27] that "When I was in Rome I never saw, or even heard the name of Angelo Ricci. In Florence I never saw Evangelista Torricelli, not because these men are not famous, but because I am unknown to them. In Florence I had frequent discussions, even with Prince Leopold, of the obstinacy with which the Peripatetics hold onto the sentences of Aristotle, even against what is seen and felt. Even when I was asked there if there might be a plan for my philosophy to be published in that city, under the auspices of the Most Serene Grand Duke of Tuscany, nobody mentioned the vacuum to me in that city. In Rome in 1645 the Reverend Father Mersenne did not share any [information] with me regarding that experiment."[28]

Although fully acquiescing in the priority of Michelangelo Ricci and Evangelista Torricelli in carrying out the experiment, Magni reiterated, in the same letter, that he had elaborated his own "plan to overcome the impossibility of the vacuum" from Galileo's work, and from the use of "an Archimedean balance" (i.e. a hydrostatic balance) received as a gift in 1644, from which he had discovered that the proportion between the weights of water and mercury was approximately 1 to 13.[29]

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[26]Gilles Personne de Roberval to Pierre Desnoyers (in Warsaw), Paris, 20 September 1647; Mersenne, *Correspondance*, Vol. 15, pp. 427-441, on p. 429: "at ibidem praecipue vero Romae atque Florentiae celeberrimas inter eruditos de ea re viguisse controversias quas non potuit ignorare Valerianus qui circa eadem tempora in regionibus degebat et cum doctis illis conuertebatur".

[27]See Jerzy Cygan, *Valerianus Magni (1586-1661). "Vita Prima", operum recensio et bibliographia*. Rome: Istituto Storico dei Cappuccini; 1989, p. 314, n. 6

[28]"Romae non vidi, neque unquam novi ex nomine Angelum Ricci: Florentiae Evang. Turricellium nec vidi, nec nomine tenus unquam cognovi: non quia viris illis desit claritas nominis, sed quod ego sim obscurus illis. Florentiae habui commemorationem frequenter etiam cum Serenissimo Principe Leopoldo de pertinacia Peripatetus in sententia Aristotelis contra ipsum visum, & tactum: imo quaesitum ibi, an consultum foret meae Philosophiae, si ea ex illa civitate, sub auspicis Serenissimi Magni Ducis Ætruria, prodiret in lucem, nec tamen aliquando sonuit mihi in illa Urbe vox ista, vacuum. Romae A.R.P. Mersennus anno 1645 nil mecum contulit de hoc experimento" Valeriano Magni, Dedicatory letter to Gilles Personne de Roberval of *De inventione artis exhibendi vacuum Narratio apologetica*, Warsaw, 5 November 1647, in Mersenne, *Correspondance*, Vol. 15, pp. 527-531, on p. 528.

[29]"Consilium ergo de superanda impossibilitate Vacui, incidit mihi apud Galilaeum, quod aqua nequeat per attractionem ascendere in fistula ultra cubitum decimum octavum et ab usu

The fact that others had performed the experiment before Magni was no reason for him to be unhappy:

> By these [tubes] I exhibited the experiments of the vacuum that were published not in order to be able to teach the possibility of the vacuum, but so that from this I could argue for the falsity of the first principle of Aristotelian Physics. For this reason I am delighted for these experiments to be [known] earlier amongst you, and to be confirmed by your authority. I seek life from truth, not praise.[30]

Although the *Demonstratio Ocularis* had only made cursory reference to the path by which Magni came to attempt the mercury experiment, his *Narratio Prima* in response to Roberval gave further details of the labours that had preceded his performances in the Warsaw court of Wladislaus IV:

> It was eight years ago [i.e. 1639-40], when obstructed by various matters, I attempted in vain to have a tube made over eighteen cubits in height, and four years ago (that is, since using the Archimedean balance) when I began to seek a glass tube of three cubits in height. Two years elapsed since my first effort: The glass-makers in Cracow neither wanted to make nor could make a tube suitable for the work at hand. I produced a wooden one, which I still have now, and which has been seen by, among others, the noble man Girolamo Pinocci, an outstanding cultivator of the liberal arts. However, in this the mercury came to rest far below the correct [*debita*] height, and this varied on successive occasions, because of the different quantities of air drawn through the pores of the wood"[31].

Magni's troubles with wood were ended by the arrival of the expert Venetian glass-blower Gasparo Brunori in Warsaw:

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librae Archimedis, quam Cracoviae anno 1644. dono accepi a Tito Livio Buratino, viro erudito in Mathematicis: qua occasione cognovi proportionem gravitatis inter aquam, et mercurium esse 1 ad 13 proxime", ibid..

[30]"Iis ergo exhibui eperimenta Vacui, Typo evulgata, non tamen in eum finem, ut docerem possibilitatem Vacui, sed ut inde arguerem falsitatis prima principia Physicae Aristotelicae: quapropter gaudeo, experimenta haec esse anqiquiora inter vestrates, firmarique vestra quoque auctoritate. Vitam quaero ex veritate, non laudem." ibid., pp. 529-30.

[31]"Anni sunt octo, quibus varie praepeditus, frustra dispono fabricam fistulae, altae ultra cubitos octodecim, et quatuor (scilicet ab usu librae Archimedis) quibus quaero tubum vitreum alititudinis trium cubitorum. Biennium est elapsum a prima diligentia: nec tamen officina vitrearia prope Cracoviam aut voluit, aut potuit dare fistulam, congruam operi disposito. Adhibui ligneam, quam etiam nunc habeo, cernente inter alios Nobili viro Domino Heyronimo Pinocci, liberalium artium cultori eximio. Verùm Mercurius stetit in illa, longe infra alititudinem debitam, eamque per singulas vices variabat, pro varia copia aeris attracti per poros ligni", ibid., p. 529.

> From this most courteous person I received many tubes of different heights and diameters, including some with a bulbous end.[32]

Glass was to be crucial to Magni's public "ocular demonstration" in the Warsaw court. Magni could satisfy himself as to the emptiness or otherwise of the space above the mercury in his wooden tubes, most probably by tapping the sides and "listening" for the meniscus, and could place his finger over the end of a shorter wooden tube to feel, in private, the pull of the "prohibitive virtue of the vacuum"[33]. In order to render the experiment, and in particular his conclusion concerning the nature of light, public to the successive gatherings of theologians, nobles and *literati* in the Warsaw court, the vacuum had to be transparently open to public inspection.

Magni paraded the various pieces of evidence for the independence of his experimental research before Mersenne's interlocutor in the Polish court, the Queen's secretary Pierre Desnoyers. These included his copy of Galileo's *Discorsi*, the hydrostatic balance, the wooden tubes used in his unsuccessful earlier trials, and two letters from eminent members of the Capuchin and Dominican orders in Rome, confirming that before the appearance of the *Demonstratio* nobody had heard anything about a vacuum experiment in Rome.[34] His trump-card was yet to come, however, and he continued:
"Two years ago the Reverend Father Giovanni Battista Andriani of the Society of Jesus left Rome, where he taught Rhetoric[35], and came to Warsaw, where he witnessed [*spectavit*] the vacuum experiments, as a complete novelty. Therefore, it is possible for a Capuchin to be unaware of what is new in philosophy in Rome, if even the Collegio

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[32]"Demum, cum Gaspar Brunorius Venetus, qui apud Reges Angliae, Daniae, et Sueciae suam in fabrica vitri celebravit artem evocatus Dantisco a Serenissimo *Rege* Poloniae, venit Warsaviam, ab illo humanissime accepi plures diversae altitudinis et diametri tubos, ex quibus aliquos, quorum altera extremitatum protuberat".
[33]"Virt[us] prohibitiva vacui", ibid., p. 529.
[34]"Dominus de Noyers vidit allegata documenta, scilicet librum Galilaei, libram Archimedis, tubos ligneos, epistolas duas" ibid., pp. 530-1.
[35]Andriani was professor of rhetoric in the Collegio Romano from 1638-1646, so his departure from Rome may have been later than Magni suggests. Villoslada, R. G., *Storia del Collegio Romano dal suo inizio all soppressione della Compagnia di Gesù*. Rome; 1954, p. 335.

Romano of the Society of Jesus knew nothing of it".[36] If the Jesuits in the Collegio Romano knew nothing of the mercury experiments in 1645 or 1646[37], they made strenuous efforts to remedy this after the publication of Magni's *Demonstratio Ocularis*.

Jesuit Reactions

1. Niccolò Zucchi

In early 1648 an anonymous nineteen-page pamphlet was published in Rome, with the title *Magno Amico nonnemo ex Collegio Rom[ano] S[ocietatis] I[esu] S.D. Experimenta vulgata non vacuum probare, sed plenum et antiperistasim stabilire.* The author of the pamphlet, written in the form of a letter to the French Jesuit mathematician Jacques Grandamy[38], was the rector of the Collegio Romano, Niccolò Zucchi[39].
"You have interrogated a Davus", Zucchi began his response to Grandamy, "but one who often converses with Oedipi[40]. He has lived with so many of them that perhaps

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[36]"Biennio ab hinc R.P. Joannes Baptista Adrianus Societatis Jesu discessit Roma, ubi docuerat Rhetoricam, venitque Warsaviam, ibique spectavit experimenta Vacui, velut inaudita: Ergo Capuccinum nescivisse quid Romae innovatus in Philosophia, est possibile: siquidem id ignoravit Collegium Romanum Societatis Jesu". ibid. p. 530.
[37]It is worth noting that Kircher had developed a mercury thermoscope to measure the differences of the winds, which would probably have been physically highly similar to the Torricellian device, by 1641: "Hac arte ego machinas argento vivo animatas alias me construxisse memini, quibus omnes ventorum differentiae propè verum cognoscebantur, vis et qualitas elementaris uniuscuiusque rei iuxta gradumsuum certa applicatione dispiciebatur, quae omnia perfectius naturaliusque in Sphaera, cuius spirales Solis Cycli, e vitreis Syphonibus constructi sint repræsentari possunt; cuius arcanas rationes libenter hic ostenderem, nisi eas nostrae Meteorologicæ arti reseruassam." Athanasius Kircher, *Magnes, sive de magnetica arte libri tres*, Rome, 1654 [1641], pp.410-411
[38]Cygan (op. cit., p. 387) suggests that the *Magnus Amicus* of Zucchi's title was Magni himself, on the basis of a letter written by Fabio Chigi, the future pope Alexander VII, to Franciscus Van der Veetren on June 26 1648 (BAV Chigi a I 46, f.283) which says of Zucchi's pamphlet that "Auctor adiuncta epistolae est Pater Zucchi Rector Collegi Romani, is cui scribet est Pr. Valerianus Magni Cappuccinque". However, Zucchi himself, in a letter written to Gaspar Schott, mentions that the pamphlet was addressed to Grandamy. See Schott, *Mechanica hydraulico-pneumatica*, cit., p. 464.
[39]On Zucchi, see Baldini, Ugo. *Una lettera inedita del Torricelli ed altri dei gesuiti R. Prodranelli, J.C della Faille, A. Tacquet, P. Bourdin e F.M. Grimaldi.* Annali dell'Istituto e Museo di Storia della Scienza di Firenze. 1980; V (no.1): pp.14-36.
[40]The reference is to the Terentian disclaimer, "Davus sum, non Oedipus", i.e. "I am no solver of enigmas".

something of their erudition will have stuck to me [sic], by which I might satisfy what has been proposed"[41]. One of the domestic "Oedipi" to whom Zucchi was alluding was undoubtedly Athanasius Kircher, who, although he had yet to publish his enormous study of Egyptian culture, the *Oedipus Aegyptiacus*[42], had been brought back to Rome from Malta through the intercession of Francesco Barberini in order to continue his studies of hieroglyphics. Zucchi's treatment of the vacuum experiments was consciously non-technical, in order not to breach the protocols of the epistolary genre. "As a guardian, it will be permitted for me to have carried out experiments of my own, which I have frequently repeated, in addition to those that have been exhibited by others", he writes, "but I do not add the measurements of the glass tubes, of the mercury poured into them, nor of the parts of these left empty by [the mercury] when it descends, both in the vibrations and when at rest, nor do I add the number of the same vibrations, or similar things, as they would be of little help for the solution of those matters that are proposed to me, and my desire is to retain the brevity of the letter, as much as is possible, without paying the price of vigilant truth" [43]. Zucchi describes four experiments: the mercury experiment as performed by Magni, the water experiment carried out by Gasparo Berti, the experiment carried out by Zucchi himself on

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[41]"Davum interrogasti, sed versari solitum cum Oedipis, quibus conuiuere tanti est, ut mihi ex illorum eruditione aliquid fortè adhaeserit, quo propositis satisficiam", Niccolo Zucchi, *Magno amico nonnemo ex Collegio romano S.I. experimenta vulgata non plenum sed vacuum et antiperistasim stabilire*, Rome: L. Grignani;1648, Sig. A *recto*.

[42]*Oedipus Aegyptiacus hoc est universalis hieroglyphicae veterum doctrinae temporum iniuria abolitae instauratio*, Rome: Vitalis Mascardi, 1652-4. 3 tom, 4 vols. Kircher seems initially to have harboured hopes that Ladislaus IV, Magni's patron, might be willing to sponsor the publication of this work (Kircher to Cyprian Kinner, Rome, 20 February 1648, Hartlib Papers 1/33/31B). However Ladislaus IV died on 20 May 1648 prompting Kinner to remark to Hartlib that "Kyrcherus a Poloniae Rege nihil sperare habet: quia nullus nunc est Rex" (Kinner to Hartlib, Danzig, 5 August 1648 Hartlib Papers 1/33/44B). Although Kinner mentions Magni's experiments in the same letter, I have been unable to find any direct connection between this episode and the vacuum experiments of the previous year (by this time Magni had left Warsaw for Danzig). On the contents of the *Oedipus Aegyptiacus* see Joscelyn Godwin, *Athanasius Kircher and the Occult*, in John Fletcher, (ed.). *Athanasius Kircher und seine Beziehungen zum gelehrten Europa seiner Zeit*, Wiesbaden: Harrassowitz; 1988: pp. 17-36.

[43]"Ut praestem, licet praeter exhibita ab alijs, propria, & saepius iterata experimenta adhibuerim; non apponam tamen mensuras Tuborum vitreorum, aut infusi argenti vivi, aut partium in illis ab eo descendente tam in vibrationibus, quam in quiete derelictarum, nec vibrationum ipsarum numerum, aut similia; quia ad solutionem eorum, quae mihi proposita sunt, minus faciunt, & Epistolae brevitatem quantum fieri possit, sinè veritatis intentae dispendio, retinere animus est", Zucchi, *Magno amico*, loc. cit..

antiperistasis with a thermoscope in a cave, and an experiment carried out on the freezing of water in glass containers.

To justify his inclusion of such a large number of experiments he writes "It has pleased me to multiply knots, so that by untangling them it will appear more clearly that it is not necessary to forge new dogmas every day from the difficulties that arise, or to recast the antiquated comments of the ancients, but that it is better to curb intemperate minds by cooling them down, than to heat them up, so that while some attack the received philosophy with a sincere heart, others will not accomplish greater destruction by the study of novelty".[44] Zucchi's treatment of the Berti experiment, later echoed by Kircher in his *Musurgia Universalis*[45], used the fact that the bell in the space above the water produced a sound to argue that, as no accident could exist without a subject, the space was full.[46]

Zucchi's "solution" to mercurial suspension was the introduction of a "subtle body", or "spirit", which was extremely distended and filled the upper part of the Torricellian tube.[47] When water was reintroduced to the tube, and displaced the mercury, this spirit, which had the property of being extremely abhorrent to water, but extremely attractive to mercury, was reabsorbed violently into the mercury, and hence the space disappeared.

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[44]"Placuit multiplicare nodos; ut ex illorum solutione clarius constet, non oportere ex difficultatibus occurrentibus nova quotidie dogmata cudere, aut antiquata veterum commenta recoquere; sed satius esse quorundam ingeniorum intemperem iniecta frigida compescere, quam fovere; ne studio novitatis, dum animo sincero aliquid Philosophiam iam receptam impetunt, ad meliora labefactanda alij progrediantur." ibid., Sig. A3 r - v.

[45]"Nos vero ut falsitatem eorum opinionis, vel ipsa auriculari experientia demonstraremus, arreptem magnetem phialæ vitreæ è regione malleoli ferrei foris applicuimus, qui mox attractum malleolum eleuauit, abstracto vero magnete malleolus pondere proprio illisus campanulæ limpidissimum sonum edidit", Athanasius Kircher, *Musurgia universalis, sive Ars magna consoni e dissoni*. Rome; 1650, p.11.

[46]"Porrò in superiori parte, quae huiusmodi expiratione repletur, appulsu malleli ad campanulam donum edi, nullo ibi existente vacuo, nullo accidente sine subiecto; & evidenter convinci, ibi fuisse corpus violenter dilatum ex eo" ibid., Sig. A4 *verso*.

[47]"Est igitur corpus tenue, seu spiritus, qui superiores Tubi partes maxime distensus replet", ibid. Sig. [A6] *verso*.

Very little evidence has survived to document Zucchi's entry into the debate on the vacuum. A large collection of his papers, consisting for the most part of an enormous spiritual diary, contains only a single-leaf, inserted inside the back cover, on which there is a fragment of what appear to be notes made by Zucchi on Magni's work prior to composing his reply.[48]

Zucchi's biographer, Daniello Bartoli, recounts how nature's abhorrence of a vacuum entered Zucchi's spiritual advice on humility to those in his charge, to such an extent that he adopted the rhyming nickname "Turabuchi" or "stop-gap". Zucchi, according to Bartoli, used to advise future Jesuit preachers that "As nature performs violent acts, that appear to be miracles against the order of nature itself in order to avoid the vacuum, such as when heavy bodies rise and light ones descend [...] thus, so that there is no Vacuum in the pulpit you must make yourselves ascend to it, not for the ability that you have, but because of the extrinsic virtue of obedience"[49].

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[48]Nicolò Zucchi, *[Nicolaus Zucchius Manuscripta Diversa]*, APUG Fondo Curia 1595, inside back-cover (crossed-out): "[...]vivum, elevatur, et sustinetur aqua inter dictos Tubos, non esse aliquid extra illos tubos, sed intra illos, dum tale grave elevatum, vel manens suspensum (patet alioqui deorsum tubo) tali sua determinata gravitate non potest ex sua, vel contigui corporis substantia ulterius distendere quod repleat spatium suo descensu derelinquendum. Ille ut secretus à Vulgo [*mutil.*] ita inter Patricios [*mutil.*] calculo recensendus qui nulla habet difficultatem dim.. [*mutil.*] etiam pro maiori spatio vacuum inter maiora corpora, sicut inter atomos, quibus illa componit spatia vacua passim constituit; Asserit sustineri ex vi medij extrinseci gravitantis, et sua gravitate aequilibrantis illud liquidi spissoris, quod elevatur, ex sustinetur inter vitreos, iuxta experimentum primum".

[49]"Hor questo, che ad ogni altro potrebbe esser materia da gloriarsene, il P. Zucchi sel fece maravigliosamente servire per argomento da umiliarsi; e cominciò fin da' primi anni, e proseguì fin che visse a chiamarsi col sopra nome di Tirabuchi: e come la Natura (diceva egli) per ovviare il Vacuo, fà violenze, che paion miracoli contro all'ordine stesso della Natura, come è, salire i corpi gravi, e discendere i leggieri; nè bada punto all'esser più d'una specie che di qualunque altra quel che che sia ch'ella trae, ò che sospigne a riempiere lo spatio che rimarebbe vuoto; cosi, accioche non si dia il Vacuo nel pergamo al mancarvi del Predicatare, esservi egli fatto salire, non per abilità che v'havesse, ma per estrinseca virtù dell'Ubbidienza che ve l'attraeva", Daniello Bartoli, *Della vita del padre Niccolo Zucchi*, Rome: presso il Varese; 1682, p. 35. Curiously, the "estrinseca virtù" sounds more similar to Bartoli's own interpretation of the mercury experiment, in terms of pressure, than to Zucchi's, which Bartoli criticises strongly in his late work on the Torricellian experiment: "La cagione di questo natural sintoma dell'argentovivo la trove attribuita da un valente huomo [i.e. Zucchi] alla necessità di multiplicare spiriti con che poter riempire quel vano del cannello che starà sopra l'argento: e ogni secesa che fà è come una strappata che si dà alle viscere di quell'infelice mercurio, accioche così agitato, scomosso, e premuto, fumichi e svapori in maggiore abbondanza", Daniello Bartoli, *La tensione, e la pressione disputanti qual di loro sostegna l'argento vivo ne' cannelli, dopo fattone il vuoto*, Rome; 1677.

Zucchi's pamphlet did not go unnoticed outside Rome. From Münster, Fabio Chigi, the papal nuncio, wrote to Athanasius Kircher in Rome to describe the reception of the pamphlet.[50] "I passed Father Zucchi's diatribe on to the experts [*periti*] and it [was] disputed zealously with four members of the Society for two hours, with many reasons and experiments, just as he relates. I hope that your letter might please Father Maderson, whose mind is oppressed by continuous worries, and afflicted by such a long effort to obtain peace for the city, wavering between the various vicissitudes of war".[51]

Before travelling to Münster, as the lengthy peace-negotiations drew to a close, Chigi had been in Cologne. From there the future pope had written to Kircher to criticise the vacuum experiments performed by Magni in no uncertain terms: "I strongly doubt the vacuum of the other grey-bearded innovator; and I fear lest one should discover that he is complaining in his Hood, having prattled on so often in vain"[52]. Kircher's relationship with Chigi dated back to Kircher's time as confessor to the famous convert Cardinal Frederick, Landgrave of Hessen-Darmstadt in Malta, which coincided with Chigi's period as apostolic delegate[53]. Chigi's links to the Jesuits became ever closer as he

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[50]"Communicavi diatribam P. Zucchi peritis, et cum quatuor Societatis post mensam ad duas horas multis rationibus atque experimentis acuiter disputatum, prout refferet, spero Pater Madeson oppressum animum assiduis occupationibus tractatum, afflictum civito tam diu conatu pacis assequendeque, ancipitem inter bellorum successus varios, recreant literes Paternitatis Vestris, aliosque amicos, quos nominat, quosque plurimum nomine me veluti salvere iubeat, expectans interim ipsos literas ac si quid eorum gratia possim, ut mandent libere confidenteque. Ita faciat P[aternit]a V[estr]a ac mei memor luius in specibus ac sacris esse velit", Fabio Chigi to Athanasius Kircher, Münster; 29 May 1648; APUG 556, f.27r.

[51]"Communicavi diatribam P. Zucchi peritis, et cum quatuor Societatis post mensam ad duas horas multis rationibus atque experimentis acuiter disputatum, prout refferet; Spero Pater Maderson oppressum animum assiduis occupationibus tractatum, afflictum civito tam diu conatu pacis assequendeque, ancipitem inter bellorum successus varios, recreant literae Paternitatis Vestrae", Fabio Chigi to Athanasius Kircher, Münster; 29 May 1648, APUG 556 f.27r.

[52]"De vacuo alterius seniculi iam Novatoris valde dubito; et vereor ne nimis vere se deprehendisse conqueratur in suo Galero, toties et frustra decantato", Fabio Chigi to Kircher, Cologne; 14 February 1648, APUG 556, f.18r. Copy in BAV Chigi a. I 45, ff. 164r-165v.

[53]See Vincent Borg, *Fabio Chigi, Apostolic delegate in Malta (1634-1639). An edition of his official correspondence*, Vatican City: Biblioteca Apostolica Vaticana; 1967, pp. 272-3, 312, 318, 328, 330 and *passim*. In a letter to Cardinal Francesco Barberini written on 1st February 1638, after Kircher's departure from Malta, Chigi expresses his high esteem of Kircher to the papal nephew: "E qui per fine, le fo humilissima riverenze, non lassando di attestare il godimento mio grandissimo della litteratura del padre Atanasio, il quale hora meritamente

became involved in the anti-Jansenist debate that followed the 1640 publication of Jansenius' *Augustinus*[54]. Most probably Kircher sent him Zucchi's "diatribe" in response to his earlier letter criticising Magni.

2. Paolo Casati: The Eucharist enters the debate

Another recipient of Zucchi's treatise, this time from the author himself, was Paolo Casati, professor of mathematics at the Jesuit college in Bologna.[55] For Casati, neither Zucchi's answer nor the treatise written by the Bolognese physician Giovanni Fantuzzi sufficiently confuted the claims of the Capuchin friar. "Many things are intact", Casati wrote to Giannantonio Rocca.[56] "I have people who are vigorously encouraging me to write an an answer, more adequate and distinct than Fr. Zucchi's one"[57].
Casati's lengthy response, the *Vacuum Proscriptum*, was published in Genoa the following year, after being strongly endorsed by the Jesuit censors[58]. As well as

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sotto la protettione di V. Em.a, viene a fatigare per benefitio universale in teatro più proportionato al suo ingegno", Borg, op. cit., p. 352.

[54]See Marcel Albert, *Nuntius Fabio Chigi und die Anfänge des Jansenismus 1639-1651. Ein römischer Diplomat in theologischen Auseinandersetzungen*, Rome, Freiburg and Vienna: Herder; 1988.

[55]See Paolo Casati to Giannantonio Rocca, Bologna; 1 June 1648, in *Lettere d'uomini illustri del secolo XVII a Giannantonio Rocca*, Modena: Società Tipografica; 1785, pp. 386-389, "Godo che alle mani di V.S. sia capitato l'opusculo di quel Cappuccino Polacco, di cui pure avevo inteso parlare, ed avevo letto una risposta scritta dal P. Niccolò Zucchi in Francia a chi lo richiedeva del suo parere, intorno a certa esperienza fatta con l'argento vivo per provare il vacuo, & egli dalla stessa pretende si provi l'opposto: detta risposta è stata stampata in Roma, e me ne fu mandato una copia dallo stesso Padre".

[56]"Stavo quasi per scrivere, che non mandasse detto piego, pensandomi, che solo vi si contenessero le cose del Cappuccino, il cui opusculo con quelle due aggiuntarelle della disputa datta in Varsavia e quell'altra de possibilitate vacui, ho ultimanente veduto, essendosi stampato detto Opusculo nel fine d'un Libretto scritto contro di esso dal Dottore Fantucci. Ma la risposta è assai tenue, e molte cose sono intatte", Paolo Casati to Giannantonio Rocca, Bologna; 20 July 1648, in *Lettere d'uomini illustri del secolo XVII a Giannantonio Rocca*. Modena: Società Tipografica pp. 394-395.

[57]"Ho chi mi sollecita gagliardamente a scrivere una risposta adeguata, e distinta più che quella del P. Zucchi" ibid.

[58]For the remarks made by the Roman *Revisores* on Casati's work see ARSI FG 662, ff. 473r-475r., e.g. the censure by Casati's friend Mario Bettini, which suggests the importance which the Revisors attached to the defence of Aristotle from the attacks of Magni (f. 474r): "Ho scorso il Vacuum proscriptum, etc. (della quale disputa havevo ancora havenda qualche congnitione con occasioni du qualche congresso con l'autore) et mi pare opera dotta, ben fondata, seriosa, utile, anzi necessaria per stabilire la verita della dottrina Aristotelica contro il vacuo. Mario Bettino".

including a huge number of new experiments and physical arguments on the vacuum, Casati introduced, very early on in his treatise, an element that had been absent from Zucchi's pamphlet . Responding to Magni's claim to have demonstrated that light inheres in no substance, he wrote:

> But here who does not hear the heterodox miracle-haters shouting out and mocking the carlessness of the orthodox, who have been so negligent in the investigation of nature, that they have taken an accident not inhering in a substance in the most sacred mystery of the Eucharist for a miracle? [...] Indeed, what do the holy operations of the priest confer on the accidents of the bread if they are now separated from the bread by the work of nature? Is it that which the Tridentine Synod defined by Transubstantiation? But, so that in carrying out the mysteries the minister does not differ from Christ, it is required that before transubstantiation, the substance remaining can be truly said to be bread. This is very well, but who defines whether the sensible accidents are separated, or conjoined to the substance? For however much it is conceded that this combination of accidents inheres in the substance of bread, with the ineluctable bond between substance and accidents dissolved, whenever no body stands under an accident (as Fr. Magni affirms about the light pervading the empty glass tube) who will not equally be uncertain, whether the whiteness, flavour and the other attributes of the bread remain abstracted from its body by the powers of nature?[59]

Casati was alluding to the famous thirteenth session of the council of Trent of 11 October 1551, in which the Thomist account of transubstantiation had been re-affirmed against the deviant theories propounded by Luther and Melanchthon[60]. Magni had

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[59]"Quis autem hic non audiat Heterodosus Misothaumatos succlamantes, Orthodoxorumque oscitantiam irridentes, qui in naturae inuestigatione adeo hebetes fuerint, ut in Augustissimo Eucharistiæ mysterio accidentia substantiæ non inhærentia miraculi loco adhuc habuerint? [...] Quid vero si iam a corpore seiuncta, naturæ opificio, panis accidentia Sacerdoti sacris operanti offerantur? Illa ne, quam Tridentina Synodus definiuit, Transsubstantio? At, ne in peragendis mysteriis à Christo minister dissentiat, exigis, ut ante transsubstantionem, permanente substantia, panis vero vocabulo dici possit. Bene est. Sed oblata accidentia auulsane sint, an substantie coniuncta, quis definiat? Quamuis enim hæc accidentium complexio, sicui substantiæ, panis inhærere concedatur, soluto tamen inelucatbili substantiæ cum accidentibus vinculo, sicubi nullum corpus accidenti subsit (ut de lumine vitreum tubum vacuum peruadente affirmat P. Magnus) quis non æque ambigat, an hæc albedo, & sapor, & reliqua pani attributa, a suo corpore naturæ viribus abstracta permaneant?", Paolo Casati, *Vacuum proscriptum. Disputatio physica*, Genvae: Ioannes Dominicus Peri; 1649, p. 5

[60]See *Conciliorum Oecomenicorum decreta*, Bologna 1973, pp. 693-695, Session XIII, 11 October 1551, esp. ch. I, III, IV and canons 1-4. On the question of physical explanations of the Eucharist during the sixteenth and seventeenth centuries see Redondi, *Galileo heretic*, cit., pp. 203-226 and *passim*. Redondi's principal claim, that the incompatibility of an atomist conception of matter with the Tridentine account of transubstantiation was the prime motive behind the Galileo trial of 1632-33 has been widely disputed. See especially F. V. Ferrone and M. Firpo, *Galileo tra inquisitori e microstorici*, Rivista Storica Italiana, 97, 1985, pp. 177-238, 957-68. Other useful treatments of the Eucharistic question include J.R. Armogathe, *Theologia Cartesiana: L'explication physique de l'Eucharistie chez Descartes et dom Desgabets*, La Haye: Nijhoff, 1977, with a particularly helpful bibliography. For an important introductory treatment see the article by F. X. Jansen, "Eucharistiques (accidents)" in *Dictionnaire de théologie catholique*, vol. V, cols. 1360-1452.

feared such a reaction, which was also hinted at in the contemporaneous works of Pallavicino[61] and Kircher[62], since at least July 1647. On 3 August of the same year he wrote to Giovanni Barsotti in Rome, to tell him that:

> I was visited on the last day of July by the Auditor of the Most Illustrious Mons. Nuncio, while I was with two Piarist fathers. When we spoke about my demonstration of the vacuum, the objection of some theologians was mentioned, that with such a demonstration the miracles due to transubstantiation in the Holy Sacrament are removed. This gave me occasion to say what follows. I said, that St. Augustine and St. Thomas Aquinas in particular, disapproved of the authorities of the Faith becoming involved in philosophical questions easily, as very dangerous to the Faith itself, whence I added that this was the current situation, that is, the involvement of the truth of the aforementioned miracles with the most violent ocular demonstration of the vacuum[63].

Magni was apprehensive that "some people who are not well-disposed towards me", might cause difficulties with the Nuncio, and that the latter would find himself

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[61]"Paucis hisce annis Thomas Campanella dominicanus, vir qui omnia legerat, omnia meminerat, praevalidi ingenij, sed indomabilis, quid non ausus est aut contra Aristotelem in philosophia, aut contra Divum Thomam adeoque Scholasticos universos in Theologia? Neque illi multum absimilis Valerianus Magnus franciscanus, pius utique ac doctus, nec minus ad actionem, quam ad contemplationem natus, idemque vel in sacco regibus carus, haereticis formidolosus. Is enim, & libellum vulgavit ubi assiduam quamquam aenigmatis indigentem; et aliam dissertatiunculam nuper dedit in qua non tantum inane solidis permixtum adversus Aristotelem se demonstrasse gloriatur, verum etiam ibi vacuo stantes asseverat; adeoque praecipua Theologorum dogmata super ineffabilis Eucharistiae mysterio convellit? Nec tamen haec qualiscumque novandi libido ad Ordines illos praeclarissimos manat. Alia enim longe sunt haec duo: praefervidis quibusdam ingenijs laxiores habenas permittere ne constricta violentius erumpant; ac, eisdem ceu inculpatis, laudandisque favere, patrocinari, subscrivere. Praetereo, inquam, haec omnia; & id unum noto a nostris censoribus vel inobservatum, vel dissimulatum."Sforza Pallavicino,*Vindicationes Societatis Iesu, quibus multorum accusationes in eius institutum, leges, gymnasia, mores refelluntur*. Romae: typis Dominici Manelphi; 1649. pp. 223-4.

[62]Kircher does not mention the Eucharist explicitly in his attack on Magni in the *Musurgia Universalis*, but hints at the dangers posed by Magni's interpretation to religious orthodoxy: "Hinc argumentantur; spacium RH. in superiori tubi parte relictum vere & proprie vacuum esse, cum fieri non possit, ut interim aliud corpus in abeuntis mercurii locum substitui potuerit. Hinc veluti insolentes & importuni iactatores triumphum ante victoriam canentes multa sane essutiere *non tantum naturalium rerum principiis repugnantia, sed & in orthodoxa fide periculosa*; ut dum locatum sine loco, accidentia sine subiecto naturaliter subsistere subtilissimi hoc experimento se demonstrare posse imprudentius iactitant."Kircher, *Musurgia universalis*, cit., pp. 11-13, emphasis added.

[63]"Fui visitato l'ultimo di Luglio dall'Audit[or]e di Mons. Ill$^{mo.}$ Nuntio, mentre stavano meco due P[ad]ri delle Scuole Pie, et parlandosi della mia dimostratione del Vacuo, fu commmemorata obiectione di qualche theologo, che cotal dimostratione toglie li miracoli consequenti alla transubstantiatione nel S.mo Sacramento, cosa che a me diede occasione di dir quanto soggiongo. Dissi, che S. Agostino e S. Thomaso d'Aquino in particolare, biasmavano l'interessare l'auttorità della fede facilmente nelle questioni filosofiche, come tentativo pericolosissimo all'istessa fede: laonde soggiunsi tale essere il caso occorrente, ciò è l'interessa[re] la verità de sudetti miracoli con la violentissima dimostratione oculare del Vacuo. Poi i mi burlai di questo timore, come che proceda dal non intender bene ciò, di che si parla", Valeriano Magni to Giovan Battista Barsotti, Warsaw; 3 August 1647; BAV Vat. Lat. 13512, f.78r.

abandoned by theologians, none of whom desired to be the author of the proposition that the vacuum removed the miracles from the Eucharist.[64] Fearing that his projected philosophical reform might prejudice his chances for the Cardinal's purple, despite the recommendations of Wladislaus IV,[65] Magni completed his letter with a bid for recognition of his services to the Faith, and a plea that "Your Lordship will not show my [letter] to anyone living, except for the brother of the Most Illustrious Monsig. Nuncio, when you know it to be necessary to do so".[66]

3. Nature on Trial: Etienne Noël's response to Pascal

Blaise Pascal's *Expériences Nouvelles touchant la vide* were published in October 1647, three months after the appearance of Magni's *Demonstratio*.

The work occasioned a rapid response from the Jesuit rector of the Collège de Clermont in Paris, Étienne Noël, who had recently published a resumé of the Aristotelian physics courses that he gave at the college of La Flèche.[67] The Collège de Clermont seems to have been well-provided with the material prerequisites for experimental investigation

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[64]"Lo pregai, che, come da se, consigliasse a sottoscritto, et da loro sottoscritto, temendo io, che alcuni, a me non bene affetti, mi movessero difficoltà con l'auttorità di Mons. Illmo. Nuntio, et che poi, al stringere della causa, egli si trovasse abbandonato da Theologi, de' quali niuno volesse essere auttore, che il Vacuo tolga i miracoli al S[antissi]mo Sacramento", ibid., f. 78v. On the complex relationship between theories of vacuum, atomism and the Eucharist in the seventeenth century, see Redondi, *Galileo Heretic*, cit..

[65][Wladislaus IV Wasa], *Epistola ad sanctissimum dominum nostrum Urbanum papam VIII. scripta ab Vladislao IV Poloniae et Sueciae rege serenissimo.* ; Gedani; 1636 (Manuscript of Urban VIII's copy, dated 4 February 1636, in BAV Barb. lat. 6614, n.1). Ironically, as Denzler points out, Magni's bid for the cardinalate coincided with the moment at which the Propaganda Fide had finally decided to dismiss him from his missionary services. See Georg Denzler, *Die Propagandakongregation in Rom und die Kircher in Deutschland im ersten Jahrzehnt nach dem Westfälischen Frieden*, Paderborn: Verlag Bonifacius-Druckerei; 1969 pp. 191-2.

[66]"Ho sudato, et affaticato molto: ho sparso con ferite mortali molto sangue per mano de gli heretici et finalmente desidero morire mille volate l'hora per mantenimento di lei. Questa mia V.S. non mostrera ad huomo vivente, che al fratello di Mons. Illmo. Nuntio, quando pero V.S. conosca esser necessità di farlo" ibid.

[67] Etienne Noël, *Aphorismi physici seu physicae peripateticae principia breviter ac dilucide proposita*, Flexiae: Apud Georgium Griveau; 1646.

and other artificialia in this period, if we are to judge from the notes made by Samuel Hartlib in his *Ephemerides*, admittedly written eight years later:

> The Iesuits in Collegio Claremontano kept an 1. Hydraulicum. 2. Opticum et 3. Mechanicum Collegium. They are very communicative and are trying all manner of Optical. etc. conclusions having many choice Rarities [...] They have made in one roome an exact Representation of systema Copernicanum Mobile. And they are going about to make an other systema Tycho Brahaicum Mobile [...] The Claremont-Iesuits have in their Church a Lampe with a Concave Glasse which gives as much light as a hundred candles.[68]

Noël's first letter to Pascal complemented the *Expériences Nouvelles,* on being "*fort belles et ingénieuses*" but gently rejected the existence of the vacuum on physical grounds[69]. Glass is porous - we know this from the fact that light passes through it and from various other phenomena, such as the fact that a sealed bottle placed on hot ashes will not break[70]. The apparent vacuum is another body, which enters through the pores of the glass and follows the retreating mercury down the Torricellian tube[71]. Pascal's reply to Noël attempted to display the incoherence of his Aristotelian terminology, such as his definition of light as "*un mouvement luminaire de rayons composés de corps lucides, c'est-à-dire lumineux*", and magnanimously complimented him that "one cannot

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[68]Samuel Hartlib, *Ephemerides 1656 Part 3*. (June - September 1656) Sheffield, Hartlib Papers, 29/5/93B-94B.

[69]"J'ai lu vos Expériences touchant le vide, que je treuve fort belles et ingénieuses, mais je n'entends pas ce vide apparent qui paraît dans le tube après la descente, soit de l'eau, soit du vif-argent. Je dis que c'est un corps, puisqu'il a les actions d'un corps, qu'il transmet la lumière avec réfractions et réflexions, qu'il apporte du retardement au mouvement d'un autre corps, ainsi qu'on peut remarquer en la descente du vif-argent, quand le tube plein de ce vide par le haut est renversé; c'est donc un corps qui prend la place du vif-argent. Il faut maintenant voir quel est ce corps", Etienne Noël to Blaise Pascal, Paris; Oct. 1647, in Pascal, *Oeuvres Complètes*, ed. Mesnard, Vol. II pp. 513-518

[70]"Présupposons encore une chose vraie, que le verre a grande quantité de pores, que nous colligeons non seulement de la lumière qui pénètre le verre plus que d'autres corps moins solides dont les pores sont moins fréquents, quoique plu grands, mais aussi d'une infinité de petits corps différents du verre que vous remarquerez dans ces tringles qui font paraître les iris, et de ce qu'une bouteille de verre bouchée hermétiquement ne se casse point en un feu lent sur des cendres chaudes", ibid., pp. 514-5.

[71]"Si donc on me demande quel corps entre dans le tube et prend la place que le vif-argent quitte en descendant, je dirai que c'est un air épuré qui entre par les petits pores du verre, contraint à cette séparation du grossier par la pesanteur du vif-argent descandant et tirant après soi l'air subtil qui remplissait les pores du verre, et celui-ci, tiré par violence, traînant après soi le plus subtil qui lui est joint et congéné, jusques à remplir la partie abandonnée par le vif-argent." ibid., p. 516.

deny you the glory of having upheld the peripatetic physics as well as it is possible to do so".[72]

Unlike his initial letter to Pascal, Noël's response brought the theological problems of the vacuum to the foreground. "If you say to me that the species of the Holy Sacrament have parts, separated from each other, but are nonetheless not bodies, I will answer that firstly, by the composite of parts separated from each other we understand that which we normally call long, wide and deep, and secondly, one can explain the doctrine of the Roman Catholic Church concerning the species of the Holy Sacrament, by saying that the small bodies that remain in the species are not the substance of the bread. This is the reason for which the Council of Trent never uses the word accident when speaking of the Holy Sacrament, despite that in effect these little bodies are really the accidents of the bread, according to the definition of accidents accepted by the whole world, which does not destroy the subject, whether present or absent. Thirdly, [I will say that] without a miracle, every composite of parts separated from each other is a body, and I think that, in order to decide on the question of the vacuum, it is not necessary to have recourse to miracles, seeing as we are presupposing that all of your experiments contain nothing beyond the forces of nature".[73] Noël's explanation of the Eucharist, equating the quantitative and qualitative accidents of the Eucharist with "little bodies" was heterodox, and ran against the directives of the Jesuit college of revisors in Rome. A document composed by the *Revisores* in May 1632 made this clear for the case of accidents "which have a contrary", i.e. qualities such as whiteness, while censoring the

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[72]"On ne peut vous refuser la gloire d'avoir soutenu la physique péripaticienne aussi bien qu'il est possible de le faire" Pascal, *Oeuvres Complètes*, II p. 527.

[73]"Si vous me dites que les espèces du Saint Sacrament ont des parties les unes hors les autres, et néanmoins ne sont pas corps, je répondrai: premièrement, que, par le composé de parties les unes hors les autres, on entend ce que nous appelons ordinairement long, large et profond; secondement, que l'on peut fort bien expliquer la doctrine de l'Église disant que les petits corps qui restent dans les espèces ne sont pas la substance du pain. C'est pourquoi le concile de Trente ne se sert jamais du mot d'accident, parlant du Saint Sacrement, quoiqu'en effet ces petits corps soient vraiment les accidents du pain, selon la définition de l'accident reçue de tout le monde: ce qui ne détruit point le sujet, soit présent, soit absent; troisièmement, que, sans miracle, tout composé de parties les unes hors les autres est corps; et je crois que, pour décider la question du vide, il n'est pas besoin de recourir aux miracles, vu que nous présupposons que toutes vos expériences n'ont rien par-dessus les forces de la nature", Noël to Pascal, Paris; 1 November 1647, in Pascal, *Oeuvres*, cit., Vol. II pp. 528-540, on p. 531.

propositon that "both material substantial forms and accidental forms which have a contrary, have a matter [*materia*] of which they are constituted: it is otherwise for immaterial substantial forms and material accidental forms having no contrary."[74]

The *Revisores* of the Collegio Romano assessed this proposition as follows:
"Of the second proposition we say that it, similarly, is improbable and must be retracted, all the more so because certain absurdities, contrary to the Mystery of the Eucharist, can be deduced from it; e.g. that the whiteness of the Host (as a material accidental form having a contrary) is constituted from matter [*materia*] ; or rather that the thing itself is completely composed of matter and form. This opinion, if defended openly by [the] author, would not pertain to our censure but to that of the Inquisition."[75]

Despite Noël's heterodox opinion of the nature of the Eucharistic accidents, the tone of his second letter, and the publication of his *Le Plein du Vide* in 1648 make it clear that he regarded Pascal's short treatise as a major threat to the Aristotelian structure around which his career had been built. The dedication of Noël's work, which appears to have been published at the end of January 1648, proclaims that Noël will demonstrate the "integrity" of Nature, accused of the void, and show the "falsehood of the deeds [*faits*] with which She is charged, and the impostures of the witnesses that are opposed to Her. If She was known to everyone as well as She is known to Your Highness, to whom she has revealed all her secrets, She would have never been accused by anyone, and one would have never dared to try Her on the basis of false depositions, and experiments

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[74]ARSI F.G. 657 p. 171: "2a Tam forma substantialis materialis, quam accidentalis, habens contrarium, habet materiam ex qua constituitur: Secus forma substantialis immaterialis, & accidentalis materialis non habens contrarium". This censure is discussed in Gorman, *A Matter of Faith?*, cit.

[75]ibid. p.171: "Ad 2am dicimus; Itidem improbabilem, & retractandam esse: idque eo magis, quod quaedam inde absurda, contra Mysterium Eucharistiae deduci possint; v.g. Albedinem S. hostiae (tanquam formam materialem accidentalem, habentem contrarium) constitui ex materia; adeoque re ipsa esse totum compositum ex materia & forma. Quae quidem opinio, si ab auctore palam defenderetur, non ad nostram, sed Inquisitionis Censuram, pertineret".

that are poorly understood and even more poorly confirmed"[76]. In Warsaw, Magni too was quick to see the significance of Pascal's work for his anti-Aristotelian agenda. Desnoyer's informed Roberval that "Our Capuchin wants to translate the little treatise of Monsr. Pascal into Latin, and print it, as he is making a shield of everything [against Aristotle]. His principal aim does not end with the vacuum, as *he doesn't just want Aristotle to vacate the universities, but to be excommunicated*"[77]. Just as Pascal was later to recruit the anti-Jesuit invective of Magni's *Commentarius ... De homine infami*[78] in the *Provinciales*[79], Magni attempted to recruit Pascal to multiply his lines of attack on Aristotelian physics, although the promised translation never appeared. He was persuaded to remove his *De Atheismo Aristotelis* from later editions of his *Demonstratio Ocularis*, on the advice of friends who persuaded him that he would prejudice his chances of the Cardinalate.[80] Although Noël's *Le Plein du Vide* addressed, principally, the experiments conducted by Pascal, as reported in the *Expériences Nouvelles*, Noël made it clear to Pascal privately that his most bitter invective was aimed at Magni[81].

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[76]Noël, *Le Plein du Vuide*, 1648, published in *Oeuvres de Pascal*, ed. Abbé Bosset, La Haye, 1779, Vol. IV, pp. 108-146 on pp. 108-9.

[77]"Nostre Capucin veut faire mettre en latin le petit traitté de Monsr. Pascal et imprimer car il fait bouclier de tout. Son principal dessein ne s'areste pas au vuide, ne voulant pas seulement qu'Aristote vuide les universitez, mais il veut qu'il soit excomunié", Pierre Desnoyers to Pascal, Warsaw, 4 December 1647, in Mersenne, *Correspondence*, XV, pp. 560-563 on p. 561, emphasis added.

[78]Valeriano Magni, *Commentarius ... De homine infami personato sub titulis M. Jocosi Severi Medii.* Prague: In Seminario Sancti Norberti; 1655. Magni wrote this work to answer an attack on his doctrine of the primacy and infallibility of the Roman pontiff written under the pseudonym of Jocosus Severus Medius, which Magni mistakenly thought to mask a Jesuit. In fact the author of the *Vertrauliches Gespräch zwischen vier päpstischen Scribenten* was a Lutheran.

[79][Blaise Pascal], *Les Provinciales ou les Lettres escrites par Louis de Montalte, à un Provincial de ses Amis, et aux R.R.P.P. Iesuites*, Cologne: Pierre de la Vallée [Amsterdam: D. Elzevier]; 1656/57, *Quinzième lettre*.

[80]"Il y avoit adjouté un chapitre qu'il adressoit au Pere Mercenne, qu'il intituloit de l'Ateisme d'Aristote, mais ses amis ausy tost qu'il fut imprimé luy firent suprimer, luy disant qu'il se feroit tant d'ennemis que peut estre cela pouroit empescher sa promotion en rouge qu'il espere a la premiere qui se fera", Desnoyers to Mersenne, 4 December 1647, cit., p. 561.

[81]See Pascal to Le Pailleur, February 1648, in Pascal, *Oeuvres Complètes*, cit., Vol. II, pp. 559-576, on p. 572: "Comme j'écrivais ces dernières lignes, le R.P. Noël m'a fait l'honneur de m'envoyer son livre sur notre sujet, qu'il intitule le Plein du Vide; et a donné charge à celui qui a pris la peine de l'apporter de m'assurer qu'il n'y avait rien contre moi, et que toutes les paroles qui paraissaient aigres ne s'adressaient pas à moi, mais au R.P. Valerianus Magnus, capucin. Et la raison qu'il m'en a donnée est que ce Père soutient affirmativement le vide, au lieu que je fais seulement profession de m'opposer à ceux qui décident sur ce sujet. Mais le R.P. Noël m'en aurait mieux déchargé s'il avait rendu ce témoignage aussi public que le soupçon qu'il en a donné".

Paris, Rome and Bologna were not the only centres from which the Jesuits attacked Magni's ocular demonstration. In distant Lithuania, two members of the Jesuit college in Vilnius responded to the *Demonstratio*. In 1648 the prolific philosophy professor and theologian Albertus Kojalowicz-Wijuk[82] composed his *Oculus ratione correctus* [83]- "The eye corrected by Reason", a 104 page treatise attacking Magni. Kojalowicz-Wijuk's older colleague, the mathematics professor at Vilnius, Oswald Krüger[84] published his *Dissertationes de vacuo* [85]in the same year.

Defending Jesuit educational hegemony in the Empire

The massive scale of the Jesuit reaction to Magni's version of the Torricellian experiment demands explanation. Vilnius is a case in point. The *Annual Letters* of the *Collegium Vilnensis* for the years 1646-1648 paint a harrowing picture of daily life:

> Two Jews were brought towards the sacred font, and well-disposed [for conversion]. In the areas withdrawn from the frequency of parishes, about twenty clandestine marriages were ratified. Many people were turned away from bestial habits, and shameful acts of sodomy, many more were called from the earnings of prostitution and disgracefully licentious lives back to a life worthy of a Christian [...] A certain woman, who was for a time pestered by the incessant and impudent molestations of an *incubus*, lost almost all her strength[86].

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[82]On Kojalowicz-Wijuk (Kowno 1609 - Vilnius 1677), see Sommervogel IV, 1166 (*s.v.*) and ARSI Lith. 9, f. 40r, n.21 (*Catalogus Primus et Secundus Collegij Nesuisien Soc. Iesu Anno 1639*): "P. Albertus Koialowicz. Lituan. Valetudinis infirmae, Annorum 31, Ingressus Sctm. 6 Aug. Anno 1627. In ea Philosophiam 3. Theologiam 4 annis audiuit. Docuit in Grammatica e Presi 1. anno nunc tertium annum finit. Boni est ingenii, iudicii et prudentiae, experientiae parvae. Optimi in his profecti Complexionis sanguiniae. Valet ad docendum Philosophiam et Theologiam et ad concedandum, ad gubernandum et conuersandum", ibid. f.109 v (no.23), and ibid f.237r (no. 3).

[83]Albert Kojalowicz Wijuk, *Oculus ratione correctus, seu refutatio demonstrationis vulgaris de vacuo*. Vilnae: typ. Acad. S.J.; 1648.

[84]Krüger (Ruthene 1598 - Grodno 1665) published a number of works in optics, geometry, arithmetic and astronomy (see Sommervogel, IV, 1261, 12). On Krüger, see ARSI Lith. 9, f. 25v (Catalogus Primus et Secundus Collegij Vilnensis. Anno 1639) no. 19 "ualet ad docendam Mathematicam, hebraeam, Philosophiam, casis ad concionandum et conversandum", ibid. f.108r, n.10 (Cat. primus et secundus personarum Collegij Vilnensis Ann. 1642), ibid. f.239v: n.23, (Cat. primus et Secundus Collegii Vilnensis Anni 1651): "Valet eximie ad docendas disciplinas Mathematicas ad gubernandum, ad universandum cum proximis.", and ARSI FG 660, f. 318r

[85]Oswald Kruger, *Dissertationes de vacuo*. Vilnae: Typ. Acad. S.J.; 1648.

[86]"Iudæi duo sacro fonti admoti, et bene collocati. In pagis a frequentia Parochorum subductis clandestina matrimonia viginti circiter ratificata. Multi a bestialitas consuetudine, et Sodomitico flagitio auersi, plures a meretricio quaestu et turpi vivendi licentia ad dignam

In the midst of this quotidian chaos, Krüger and Kojalowicz-Wijuk replicated and disputed Magni's experiments, and printed their refutations at the expense of the College. The situation in Münster is perhaps even more extraordinary - Fabio Chigi, papal nuncio and one of the key players in the Westphalia settlement, is spending valuable time writing letters about the consequences of Magni's experiment, and discussing it for hours in the company of the Jesuit fathers of the college in which he is lodged. In Bologna, shortly before he is sent on the crucial mission to Stockholm to convert Queen Christina, Paolo Casati is being "vigorously encouraged" to answer Magni's experiments. Zucchi, having failed to convert Kepler on a diplomatic visit to the court of Ferdinand II, is willing to take time off from his multiple duties as Rector of the Collegio Romano in order to conduct experiments with thermoscopes in caves, while preparing his refutation of Magni.

To say that these Jesuits were concerned to defend Aristotelian Physics against Magni's onslaughts is undeniably true, but does not account for the scale or violence of the reaction. The censures of philosophical propositions conserved in the Roman Jesuit archives allow one to document the attempts to police internal deviance from Aristotelian physics by the Roman College of *Revisores*. These reveal that propositions denying the "ineluctable bond' between substance and accident described by Casati and propounding the composition of the continuum of indivisibles, both foregrounded in Magni's interpretation of the vacuum experiment, were regarded with increasing suspicion by the Jesuit *Revisores* during the 1630s and 40s. In 1633, General Muzio Vitelleschi wrote to Ignace Cappon in Dole to emphasize his strong feelings on the issue:

> As regards the opinion on quantity made up of indivisibles, I have already written to the Provinces many times that it is in no way approved by me and up to now I have allowed nobody to propose it or defend it. If it has ever been explained or defended, it was done

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Christiano hominem vitam reuocatae [...] Mulier quaedam quo tempore vexata ab incubo continuis attrita molestiis, omnem prope valetudinem amiserat..."ARSI Lith. 39, f. 218v.

without my knowledge. Rather, I demonstrated clearly to Cardinal Giovanni de Lugo himself that I did not wish our members to treat or disseminate that opinion.[87]

De Lugo, who was a a significant opponent to Jesuit "Zenonism" - the term used to describe those who attempted to define the continuum intrinisically in terms of an infinity of indivisible points, and in opposition to Aristotle - had been Casati's old teacher at the Collegio Romano.[88] It was widely feared that such a theory of the continuum, as espoused by Galileo and later Cavalieri, was close to Wyclif's theory of the Eucharist as a "*corpus mathematicum*", and had been condemned by the Council of Constance in 1415. In February 1642, Mersenne worried that the Cartesian theory of body might be prone to such a theological attack, and forwarded Descartes a letter describing the propositions condemned at the Council of Constance.[89]

Ten years earlier, the Jesuit philosopher and theologian Roderigo de Arriaga had published his *Cursus Philosophicus*[90], which advocated a theory of the continuum as composed of indivisibles. Arriaga felt it necessary to distance himself from Wyclif explicitly, and included a chapter in which he denied that his theory of the continuum was among the condemned theses of Wyclif[91]. Although his theory contravened

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[87]"Quod attinet ad sententiam de quantitate constanti ex indivisibilibus, iam aliquoties scripsi ad Provincias, a me nullo modo probari et per me nulli hactenus licuisse illam proponere ac tueri. Si usquam explicata et defensa fuit, id me inscio factum est. Imo ipsi Cl. Ioanni de Lugo clare demonstravi nolle me ut nostris ea sententia tradatur et propugnetur." ARSI Gall. 117 p. 144 Resp. Muti. Vitelleschi, Romae, 13 ian. 1633, Dolam.

[88]*Elogio Storico scientifico del Padre Paolo Casati Piacentino della Compagnia di Giesu*, ARSI Ven. 121 II, ff. 388r-395v, on f.388v: "Dal Parmense Collegio de' Nobili, dove era stato Convittore, entrò nella Compagnia; e in essa, dopo compiti con gran lode d'ingegno gli studi di Filosofia e di Teologia, della quale ultima ebbe a Maestro in Roma il Padre Giovanni de Lugo, poi Cardinale di Santa Chiesa, insegnò per un sessennio la Filosofia in Bologna, poi in Roma, per un quadriennio la Mathematica ivi stesso per altrettanto tempo la Polemica Teologia".

[89]"Je vous remercie de ce que vous me mandez du Concile de Constance sur la condamnation de Wiclef; mais je ne voy point que cela fasse rien du tout contre moy. Car il auroit dû estre condamné en mesme façon, si tous ceux du Concile eussent suivy mon opinion; et en niant que la Substance du Pain et du Vin demeure, pour estre le sujet des Accidens, ils n'ont point pour cela determiné que ces Accidens fussent réels, qui est tout ce que j'ay écrit n'avoir point lû dans les Conciles", Descartes to Mersenne, Endegeest, March 1642, in Mersenne, *Correspondance*, Vol. XI, pp. 73-79, on p. 76. See also Durelle to Mersenne, 26 February 1642, in ibid., Vol. XI, p. 46 ff.

[90]Roderigo de Arriaga, *Cursus Philosophicus*. Antuerpiae: ex officina Plantiniana Balthazaris Moreti; 1632 (citations are from the second edition, Lugduni, Sumpt. Philip. Borde, Laurent Arnaud, & Petri Borde; 1669)

[91]The 15th session of the Council had allegedly condemned the proposition: "*Linea aliqua Mathematica componitur ex duobus aut quatuor punctis immediatis; aut solum ex punctis simpliciter finitis*" as being erroneous in philosophy. In questioning whether the council did

Vitelleschi's wishes, and went against the position adopted on the continuum by the *Revisores* in their censures of philosophical positions, successive editions of the work still contained the unorthodox treatment. In the 1659 edition, Arriaga included a preface which suggested a reason for his deviance, claiming that he had been permitted to publish his anti-Aristotelian opinions "in part because they are completely accepted here at the university of Prague"[92].

The Jesuits and the *Carolinum*: Roots of the conflict with Magni

Behind Arriaga's defense lies a deep tension. Since long before the 1618 rebellion, the University of Prague had been a "center of heresy, infecting all of Bohemia through the many lawyers, notaries, teachers and government officials it graduated"[93]. Jesuit control in the University dated from the negotiations of 1622-23, when Ferdinand II, advised by his Jesuit confessor Lamormaini, agreed to give the Jesuits responsibility for the teaching of philosophy and theology in the University, and direction of the new university, which was to be an amalgamation of the old Carolinum and the Jesuit Collegium Clementinum[94]. With the defeat of the Protestant forces at the Battle of

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in fact condemn the Zenonian proposition, Arriaga reminds his readers that, even if the council of Constance had been sanctioned by papal authority, which it was only retrospectively, it is not the role of the pope or the church fathers to define anything in purely philosophical matters. See Arriaga, *op. cit.*, p. 571 (Liber Quintus et Sextus Physicorum, Disputatio XVI, *De continui compositione* Subsectio VI). On this issue see also Hellyer, Marcus. *"Because the authority of my superiors commands": Censorship, physics and the German Jesuits.* Early Modern Science and Medicine. 1996; 1(3): 319-354.

[92]"Nihilominus tamen eas ego in hoc Auctario tradere non praesumpsissem, nisi Admodum R.P. Paulus Oliva Societatis nostrae dignissimus Vicarius Generalis, tum ob antiquam, quam dixi, in eis edendis meam bonam fidem, tum quia paucae illae & in hac Pragensi Universitate valde receptae, tum quia in materia pure Philosophica ad mysteria Fidei & morum nullatemus pertinentia, tum denique, quod mihi gloriosum est, ob singularem benevolentiam, qua[m] me licet omnino indignum a multis iam annis prosequitur, eas recudendi facultatem, humiliter a me rogatus, concessisset gratiosissimè"Roderigo de Arriaga, *Cursus Philosophicus*. Lugduni: Sumpt. Philip. Borde, Laurent. Arnaud, & Petri Borde, 1669 [First edn.: Antuerpiae: ex officina Plantiniana Balthazaris Moreti; 1632], pp. 3-4.

[93]Robert Bireley, *Religion and Politics in the Age of the Counterreformation: Emperor Ferdinand II, William Larmormaini, S.J., and the Formation of Imperial Policy*. Chapel Hill, NC: University of North Carolina Press; 1981, p. 32. See also Kroess, Alois, *Geschichte der Böhmischen Provinz der Gesellschaft Jesu*, Vienna, 1910-27 *passim*.

[94]Wenzel Wladiwoj Tomek, *Geschichte der Prager Universität*. Prague: Gottlieb Haase Söhne; 1849, pp. 249-270.

White Mountain, Ferdinand II revoked the brief of Rudolph II granting tolerance to Bohemian Protestants. The handing-over of the Carolinum to Jesuit control consolidated the new aggressively anti-Protestant imperial policy. Ferdinand's decision was not without its opponents, and one of the loudest critical voices was that of none other than Valeriano Magni, then the guardian of the Capuchin convent on the Hradschin and provincial superior of the Capuchins in Bohemia. Magni was the spokesman for the archbishop of Prague, Cardinal Ernst von Harrach, and began a zealous campaign to "liberate" the Carolinum from Jesuit control, and restore the autonomy that it had enjoyed since the bull of Boniface IX of 1397.

As Robert Bireley recounts, after 1622 the university was intended to become a "center for orthodoxy for all Bohemia", and a model for the Empire as a whole. The consequences included the banning of all non-Jesuits from the theological faculty of the university and Jesuit responsibility for the censorship of all books published anywhere in the kingdom. Lamormaini, the imperial confessor, took a hard-line on restoring the Catholic faith in the empire, and chastised even other Jesuits for moderacy. He wrote to General Vitelleschi to insist that "piety can only be restored in Bohemia by a powerful authority"[95], a position that was vigorously countered by Magni, who, with Von Harrach urged an independence of Church and Empire. Magni's conflicts with the Jesuits, which took many forms in the successive decades, date from this time.[96] While Lamormaini urged both Ferdinand II and Muzio Vitelleschi to extremes of religious intolerance, Magni preached accommodation and ecumenism, and attempted to curb Jesuit power by every means possible, including a letter to Muzio Vitelleschi to plead for the reform of the order. By the 1630s relations between Magni and the order were soured beyond repair. Arriaga wrote to Vitelleschi in 1628 to denounce Magni as a

[95]Cited in Bireley, *op. cit.*, p. 37

[96]Magni wrote much later, on 12 March 1658, that "The first root of this deep resentment [i.e. his unpopularity in Jesuit circles] lies in the fact that I defended the freedom of the Charles University in accordance with the special instructions of Urban VIII" (Archivio della S. Congregazione di Propaganda Fide, *Le Scritture originali riferite nelle Congregazioni Generali*, vol. 324, f. 389v, cited in Denzler, op. cit., p. 211).

mendacious slanderer, a near-apostate who was attempting to blacken the reputation of the Jesuits with Urban VIII[97]. Vitelleschi advised Lamormaini that Magni was "the chief author and inciter of every controversy and difficulty" between the Society and the Archbishop of Prague[98]. In 1631, Paolo Anastagi wrote from Prague to complain to Vitelleschi that "whoever wishes to be helped and promoted by Father Magni only needs to show himself to be disgusted with the Jesuits. I can say with good conscience that all of those here who have just left the Society have been promoted beyond their merits and capacities by Father Magni".[99]

By attempting to temper the new Jesuit hegemony over the oldest university of the Empire with the philosophical traditions of the Carolinum, Arriaga was running the risk of being accused of perverting his teachings with the Wyclifian and Hussite theses that had been embraced so warmly in the earlier history of the university[100]. Small wonder, then, that he should distance himself explicitly from Wyclif in his discussion of the composition of the continuum.

After the death of Ferdinand II in 1637, the alliance between the Jesuits and the emperor was substantially weakened. Although the new emperor Ferdinand III had himself been taught by Arriaga as a child, he did not nurture the strong political and ecclesiastical links with the Jesuits cultivated by his father. Lamormaini's projected coërcion of Bohemia into orthodoxy through a Jesuit order empowered by the Emperor lost force considerably with the Peace of Prague in 1635, and the terms of the Peace of Westphalia ended all hopes of religious unity within the empire, just a few months after

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[97]Arriaga to Vitelleschi, Prague, 1 July 1629, ARSI Austr. 23, ff. 66-7, cited in Cygan, op. cit., p. 238.
[98]Vitelleschi to Lamormaini, Rome, 29 July 1629, ARSI Austr. 4, ff. 2v-3r, cited in Cygan, op. cit. p. 238.
[99]"Chi vuol esser dal P. Magno aiutato e promosso, basta che si mostri disgustato dei Giesuiti. Tutti quelli che si trovano qui di fresco usciti della Compagnia sono stati dal P. Magno promossi, posso dir concienza sopra i meriti e capacità", Paolo Anastagi to Vitelleschi, Prague; 29 August 1631, ARSI FG 770 3 b, p. [2]
[100]Wenzel Wladiwoj Tomek, *Geschichte der Prager Universität*. Prague: Gottlieb Haase Söhne; 1849, esp. pp. 60-61.

Lamormaini's death. It was in this context that Magni, removed from the political power that he had enjoyed as Von Harrach's interlocutor, struck at the philosophical principles on which the legitimacy of Jesuit hegemony over education in the empire was based with the new metaphysics, expounded in the *De luce mentium* and the experimental physics of the *Demonstratio ocularis* and *Experimenta de incorruptibilitate aquae*.

Domesticating the Torricellian experiment

In contrast to the telescope, in dealing with the Torricellian experiment, and, later, Guericke's *antlia pneumatica*, Jesuit authors repeatedly insisted that you could not believe your eyes. In attempting to disable the device as a philosophical instrument, they recruited a host of invisible agents. These ranged from the sound of the bell discussed by Kircher (in an experiment that all but defied replication) and the sense of touch emphasized by Linus in his *Tractatus de corporum inseparabilitate*, to the minute pores in the glass of the tube invoked by Noël and later Schott[101], the subtle mercurial spirit of Zucchi, and the real presence in the Eucharist deployed by Casati.[102] The Jesuit theologian and natural philosopher Melchior Cornaeus expressed this position eloquently in his discussion of the new vacuum experiments of Magni and Guericke:

> And since the Vacuists appeal so earnestly to the judgement of the eyes in this business, why do they not see that this thing has itself been confectioned for the judgement of the eyes? Why will they not finally acknowledge that subtle air, drawn out by an occult fear, takes the place of the extracted denser air, or water or smoke and prevents a vacuum?[103]

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[101]See Gaspar Schott, *Technica Curiosa sive mirabilia artis*, Würzburg: Jobus Hertz; 1687 [1664], Liber IV, Cap. V §II, on pp. 250-253 (*Vitrum habet poros*).

[102]Schott's *Technica curiosa* provides a condensed litany of anti-vacuist readings of the various vacuum experiments (except the new Boylean air-pump, as Boyle himself "admits that he can never perfectly evacuate his vessel") in *op. cit.*, Liber IV, Cap. V, pp. 246-258.

[103]"Et quandoquidem Vacuistae tantopere ad oculorum judicium in hoc negotio appellant, cur non hic vel ipso oculorum judicio rem confectam vident? cur non tandem agnoscunt, aërem subtiliorem occulto metu, vel aëri crassiori, vel aquae, vel fumo extracto succedere, & vacuum impedire", Melchior Cornaeus, *De altero Experimento, quod per violentam aëris extractionem & exhaustionem sumitur*, published in Schott, *Mechanica Hydraulico-pneumatica,* p. 476. For Cornaeus' discussion of the Magni experiment, intended to precede this discussion, see his *Curriculum Philosophiae Peripateticae*, Herbipoli: Jobis Hertzi, 1675, pp. 384-394, "De priore experimento quod ab argento vivo per fistulam supra clausam delapso capitur".

A refusal to allow the instrument to produce new natural philosophy did not put an end to Jesuit discussions of hydraulics. Instead, the device was removed from circulation in the philosophical domain and relocated within the context of the *Wunderkammer*. Gaspar Schott's *Mechanica-Hydraulico Pneumatica* largely an account of the hydraulic devices present in Kircher's museum in the Collegio Romano[104], includes both the Torricelli/Magni experiment and the Berti experiment in a section entitled *De machinis hydraulicis variis*, where it is surrounded by a ball made to spin in the air, a perforated flask for carrying wine known as the "Sieve of the Vestal Virgin ", and a "phial for cooling tobacco smoke". Unhealthy philosophical readings of *Machina VI* (the Torricelli and Berti tubes) are dismissed by Schott, echoing his former teacher Kircher, as the writings of "*Neotherici Philosophastri*" and "insolent and unmannerly braggarts proclaiming a triumph before victory"[105]. To situate the Torricellian device in the context of trick fountains and water-vomiting seats was to insulate it from the Aristotelian philosophy taught in the classrooms of Jesuit colleges that Magni wished to "excommunicate". In the Prague context, a work on springs and fountains published by Jakob Dobrzensky de Nigro Ponte in 1657 included various refutations of the possibility of the vacuum by Jesuits and close supporters of the intellectual programme of the order including Joannes Marcus Marci[106] and Godefridius Aloysius Kinner[107].

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[104]"Scribendi occasio haec fuit. Est in supradicti Doctissimi Auctoris Museo sane celeberrimo, frequentatissimoque (quod brevi typis evulgabimus) non exigua Hydraulicarum ac Pneumaticarum Machinarum copia, quas summa animi voluptate spectant atque mirantur ij, quae ex omnibus Urbis & Orbis partibus ad ipsum visendum accurrunt Viri Principes ac LItterati, avideque scire desiderant, & Machinarum constructarum rationes, & machinalium motionum causas. Horum desiderio ut satisfacerem, omnium dicti Musei Machinarum fabricam & quasi anatomiam edocere, aut alicubi iam ab ipso Auctore edoctam enarrarem brevi opusculo aggressus sum" Schott, *Mechanica*, pp. 3-4.

[105]Schott, *Mechanica*, pp. 307-8, "Hinc veluti insolentes & importuni jactatores triumphum ante victoriam canebant, multa effutientes non tantum in Philosophia absurda, sed & in fide Orthodoxa periculosa, ut dum locatum sine loco, accidentia sine subjecto, naturaliter subsistere posse jactitant; nec defuit qui diceret, oculari demonstratione vacuum hoc Experimento comprobari".

[106]Johann Marcus Marci von Kronland carried out an intense correspondence with Kircher on hydraulic and other topics from Prague in the 1640s. On siphons see especially Marcus Marci to Kircher, Prague, 25 January 1642, APUG 557, f. 82r-v. See also John Fletcher, *Johann Marcus Marci writes to Athanasius Kircher.* Janus. 1972; 59: pp. 95-118.

[107]J. J. W. Dobrzensky de Nigro Ponte, *Nova, et amaenior de admirando fontium genio (ex abditis naturae claustris, in orbis lucem emanante) philosophia*. Ferrara: Alphonsum, & Io.

The work also contained numerous hydraulic machines and clocks designed by Prague-based Jesuits including Theodore Moretus and Valentin Stansel[108] and other Jesuit exponents of the hydraulic arts such as Niccolò Cabeo[109], Mario Bettini and Kircher. Later, as discussed below, Francesco Lana Terzi, another disciple of Kircher, was to suggest the use of globes evacuated by the Berti technique to make an airship, while sidestepping the issue of whether the globes were truly empty.[110]

The story of the Torricellian experiment is the story of a shrinking instrument. From Baliani's large-scale copper siphon, to Berti's unwieldy outdoor device to Magni's wooden tubes and Torricelli's glass-tubes, a messy, unstable, opaque, ambiguous phenomenon became reduced to a manageable size. In the hands of Magni and Pascal this mobile, transparent device was coupled to a militant anti-Aristotelian agenda that threatened to weaken the Jesuit grip on philosophical education in Catholic Europe, especially during a period in which Jesuit authors were being disciplined more strenuously than ever for departures from Aristotle in natural philosophy.[111]

Baptistam de Marestis; 1657. For a letter from Kinner referring to Marcus Marci's interpretation in terms of an invasion of the tube by "quintessence" and elucidating Kinner's own interpretation in terms of "aqua mercurialis" see pp. 27-8, and for a lengthier *Discursus* by Kinner arguing against nature's fear of the vacuum see pp. 34-9. On Dobrzensky see Evans, *The Making of the Habsburg Monarchy*, cit., pp. 337, 339-40, 356, 369-70, 390 and W.R. Weitenweber, *Beiträge zur Literärgeschichte Böhmens*, Sitzungsberichte der kaiserlich Akademie der Wissenschaften, philosophisch-historische Klasse, xix (1856), pp. 144-156.

[108]For a perpetual fountain synchronized with the "motion of the sun "designed by Moretus, see Dobrzensky, *op. cit*., pp. 106-8. Stansel is mentioned frequently throughout the work, and Dobrzensky refers to a hydro-magnetic clock-fountain seen in his *Museum Mathematicum* on p. 46.

[109]Cabeo discussed hydraulics at length in his monumental commentary on Aristotle's meteorology, *Nicolai Cabei Ferrariensis Societatis Iesu In quatuor libros Meteorologicorum Aristotelis commentaria*, Rome: Typis haer. Francisci Corbeletti; 1646, in which he criticised Benedetto Castelli's attempt to produce a mathematical model of liquid flow. See Massimo Bucciantini, *Atomi, Geometria e Teologia nella filosofia Galileiana di Benedetto Castelli*. in Bucciantini, Massimo and Maurizio Torrini (eds.), *Geometria e Atomismo nella Scuola Galileiana*. Florence: Olschki; 1993, pp.

[110]Francesco Lana Terzi, *Prodromo overo saggio di alcuni inventioni nuove* Brescia: Rizzardi; 1670, p. 54

[111]On increased Jesuit discipline during the 1640s see especially Costantini, C. Baliani e i Gesuiti. Florence: Olschki; 1969 esp. pp. 98 ff, Baldini, *Legem*, cit., pp. 75-119, Marcus Hellyer,*"Because the authority of my superiors commands": Censorship, physics and the German Jesuits.* Early Modern Science and Medicine. 1996; 1(3): 319-354.

Magni himself saw no clear boundary between his political dispute with the Jesuits and the vacuum debate. Writing to Mersenne in 1648 to describe his disgust at Albertus Kojalowicz-Wijuk's *Oculus ratione correctus* he added "this is not going to excite my love towards that Society"[112]. He dismissed the theological arguments adduced against the vacuum, writing of his accusers that "if they lack reasons, they adduce truths from theology, not revealed by God but commented to them in private, above those that we commonly believe."[113]

Much later, in his *Principia et specimen Philosophiae axiomata*, published in 1661 Magni was to return to the problem of reconciling his theory of the vacuum with the mystery of the Eucharist. His method consisted in placing the Eucharistic wafer itself inside the Torricellian tube:

> If bread is placed in the empty part of the tube, and light [*lumen*] shines on it, the light [*lux*] inhering in the bread will be affected by the size, shape and colour of the bread in such a way that this light will be distinguished to the eye from the remainder of the light shining through the tube, empty of any body. If God was to annihilate the substance of the bread, and the light that was in the bread was not annihilated, this light would remain, in the presence of the light source, without a miracle, but freed from the imperfections that are gathered together in the body of the bread. That is, the light would not bring back [*refere*] the size, shape and colour of the bread, and neither could that light conserve the species of size, shape and colour of the same bread without the bread as subject. By this I have explained in passing, that my opinion on light in the vacuum detracts neither from the creation by God nor from the miracle of the Most Holy Sacrament. Everything, however, is subject to ecclesiastical censure.[114]

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[112]"At ego non ob id mixturus [sum] meum amorem erga Societatem illam", Magni to Mersenne, Warsaw; 1648 Apr 14. ; BN, Fonds francais, nouvelles acquisitions, 6204, f. 36r-v, publ. in Mersenne, *Correspondance*, XVI, 223-225 , on p. 224 (the transcription contains several errors and Albertus Kojalowicz-Wijuk is incorrectly referred to as "Robertus Koralowicz"). See also Cygan, *op. cit.*, p. 293 (II A no. 48).

[113]"Si eis deficiunt rationes, evocant ex theologia non quidem veritates revelatas a Deo, sed propria ac privata commenta super his quae communiter credimus". ibid. p. 233

[114]" Si in parte tubi vitrei vacua ponatur panis, & lumen producatur in illo, Lux inhaerens pani afficitur mol, figura & colore ipsius panis ita ut ad oculum discernatur illa lux a reliqua quae lucet ex parte tubi, vacua ab omni corpore. Verum, si Deus annihilaret substantiam panis, non annihilata luce, quae illi inerat, ea, in praesentia lucentis, maneret sine miraculo, sed defecata a vitiis contractis in corpore panis, scilicet lux illa non referret molem, figuram, & colorem panis: neque sine miraculo, posset lux illa conservare, sine subjecto pane, speciem molis; figurae & coloris ejusdem panis. Hisce verò obiter explicaverim, quod mea sententia de lumine in vacuo non detrahat Deo creationem, nec SS Sacramento miracula. Omnia vero sunt subjecta censurae Ecclesiastice" Valeriano Magni,*Principia et specimen Philosophiae axiomata*. Coloniae: apud Jodocum Kalcovium; 1661, pp. 71-2.

Unfortunately for Magni, in the same year that this attempted marriage of the philosophy of vacuum with eucharistic dogma was published he was incarcerated in Vienna on the orders of Alexander VII because of his polemical writings against the Jesuits[115]. As the Jesuits confined the Torricellian tube to the *Wunderkammer*, their long-term ally Fabio Chigi confined its most outspoken exponent to a prison-cell.

The *Antlia Pneumatica*

Shortly after the Torricellian experiment had been domesticated, Jesuit plenism came under renewed threat. The manuscript for Gapar Schott's *Mechanica Hydraulico-Pneumatica* was submitted to the Roman *Revisores* by January 1654[116]. Schott had completed the body of the work in Rome, while still a "*Socius*" of Athanasius Kircher[117]. On Schott's return to Mainz[118], however, he heard word of a "new instrument to show that a vacuum can exist, or which wanted to show me this",[119] which he witnessed at first hand in Würzburg the following year in the residence of the Archbishop of Mainz, Johann Philipp von Schönborn. Although the *imprimatur* for his *Mechanica* had been issued by General Goswin Nickel on 23 January 1655, in view of the new experiments of Guericke, and sanctioned by both the written approval of Kircher[120] and a "*privilegi[um] Sacrae Cesarae Majestatis*"[121], Schott later added an appendix dealing with the new Magdeburg experiments that by-passed the Roman censors.

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[115]Jerzy Cygan, *Valerianus Magni (1586-1661). "Vita Prima"*, cit., p. 281.
[116]The reports of Gabriel Beatus (1st January 1655) and Paolo Casati (14 January 1654) on Schott's *Mechanica Hydraulico-Pneumatica* are in ARSI FG 661 ff. 482r-484r.
[117]ARSI Rom. 81, ff.64v, 88v, 114v: 1652-4: "P. Gaspar Sciot, socius P. Athanasii", "P. Athanasius Chircher, scribit imprimenda".
[118]ARSI Rh. Sup. 7, f.68, n.25
[119]Schott to Kircher, Mainz; 15 July 1655; "hanno un instrumento nuovo per mostrare quod possit dari vacuum, o che voleva mostrarmelo", APUG 567 f.47r.
[120]"Reverentia Vestra opportunissimè id praestare poterit in Hydraulica, ubi de vacuo tractat", Kircher to Schott, Rome, 26 February 1656, in Schott, *Mechanica*, p. 453.
[121]ibid., title-page.

Guericke's principal devices worked by extracting water from glass or copper receivers, a laborious process that required robust experimental assistants. Early trials with wooden casks had been inconclusive - after water was extracted from a cask by vigorous pumping, a noise was heard "like vigorously boiling water"[122], and the keg was later found to be filled with air. By the time of the Imperial Diet of 1653-4, Guericke, who had previously worked as an engineer for the Swedish army during the Thirty Years War, had ironed out his initial problems and produced a workable pump. Towards the end of the *Reichstag* Guericke demonstrated his experiments to various dignitaries, including Ferdinand III and Schönborn. Magni was also present at the Diet, and displayed his mercury experiments to Guericke, to whom he also presented a copy of his *Demonstratio ocularis*. Schönborn, whose period as Elector of Mainz represented the first real break with Viennese political hegemony in the Empire[123], was particularly impressed by Guericke's equipment and purchased the pump from him. When the device was reassembled in Schönborn's residence in Würzburg, the Jesuits from the local college, including Schott, had an opportunity to examine it carefully.

Schott sent a report of these examinations and further experiments to the German Assistant of the Jesuits, resident in Rome, in which he asked for the opinions of Kircher and Niccolò Zucchi. He published their replies, and a discussion of the experiment by Melchior Cornaeus, the local theology professor in the Jesuit college in Würzburg, in the appendix to his *Mechanica*, along with letters from Guericke giving his own interpretation of the experiment and answering Schott's queries. Schott writes: "There are some who attempt in every way by means of this engine [*machinamentum*] to affirm

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[122]Guericke, *Experimenta Nova*, p. 114, II, ch. 2.

[123]On the political career of Johann Philipp von Schönborn (elector of Mainz from 1647 to 1673) see G. Mentz, *Johann Philipp von Schönborn*, i-ii (Jena, 1896-9), Evans, *The Making of the Habsburg Monarchy*, pp. 278-9 and, especially, F. Jürgensmeier, *Johann Philipp von Schönborn (1605-1673) und die Römische Kurie: Ein Beitrag zur Kirchengeschichte des 17. Jahrhunderts*, Mainz: Selbstverlag der Gesellschaft für Mittelrheinische Kirchengeschichte; 1977. Schönborn was a keen supporter of Magni in the early 1650s and expressed sharp disapproval of the Jesuit anti-ecumenist stance at the close of the thirty years war, so Schott may have had important reasons for attempting to curry favour with him as he acquired power in the years after the Regensburg *Reichstag*. See Jürgensmeier, *op. cit.*, pp. 200-203.

vacuum (that was until now a phantasm either to think of or to hope for, being resisted by the plenitude of nature, invulnerable from even an angel). Others, on the other hand, affirm that [the possibility of a vacuum] cannot be eliminated by anything more effectively than by this experiment"[124].

Describing Guericke's machine in words and pictures (fig. 18), Schott allows his reader to be the judge between the opposing positions, as long as he will not be guided by his preconceptions[125]. Despite this posture of impartiality, it is telling that three of the "experts" to whom he refers the machine[126] are Jesuits, whereas the only voice in favour of the vacuum is that of Guericke himself, whose interpretation remains irredeemably tied to his person. Kircher's response to Schott's enquiry emphasises the labour involved in the experiment:

> If there is a vacuum there, I ask, what should make such difficulty? Certainly not air, as it has been extracted, so therefore that "nothing" that has been left after the extraction of the air. But who can conceive of nothing causing resistance, or has ever heard of this in Philosophy?[127]

Zucchi's response refers to the virtue in bodies preserving unity and contiguity in the universe that he had described in his letter to Grandamy.[128] Cornaeus refused to admit that such an experiment was sufficient to refute the authority of antiquity and described

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[124] Schott, op. cit., p. 444. "Sunt qui huiusmodi Machinamento vacuum (quod hactenus phantasma fuit sive tentasse, sive sperasse, obsistente invulnerabili, vel ab Angelo, plenitudine Naturae) modis omnibus evincere tentant; alij vero non alio efficacius quam hoc ipso Experimento eliminari id posse autumant".

[125]"Machinam ipsam quà verbis, quà pictura subjicio, pugnantium utrimque argumenta affero, judicem Lectorem meum constituo, si modo nulla praeoccupatus opinione accesserit." ibid.

[126]The language used by Schott - "*machinamentum*", "*machina*" - to describe the *antlia*, and even his description of Guericke as "*ingeniosus*", emphasise the artificiality of the experiment and its pertinence to the domain of engineering rather than natural philosophy.

[127]"Si enim vacuum est ibi, quaero, quid faciat tantam difficultatem? Certe non aer, quia inde extractus est; Ergo nihilum illud, quod post aëris extractionem relictum est: Sed nihilum resistentiam facere, quis concipiat? aut qui in Philosophia unquam audivit?", Schott, op. cit., p. 452

[128]"Ex quibus comprobatur virtus, quam in litteris impressis ad Patrem Grandamy probavi inesse corporibus, pro servanda [sic, for preservanda?] unitate contiguitatis in universo, ad sistendum corpus proximum, quoties ad remotionem illius non potest succedere aliud", ibid. p. 464

the collapse of the sides of a well built in the Jesuit college in Paderborn, demonstrating the triumph of nature over all human efforts to produce a vacuum[129].

Although Guericke approved of Schott's wishes to publish the first account of his experiments and their various interpretations[130], the way in which the experiments were published arguably reinforced the status of both the Collegio Romano and the Jesuit college in Würzburg as centres of expertise in matters both philosophical and hydraulic. Schott dedicated the appendix of his work to Kircher, praising his immense erudition at some length, and thus lending further authority to his opinion of the experiment as presented in the body of the text. Schott anticipates Kircher's reaction to the appendix in the letter of dedication:

> But do you offer me a vacuum? - you ask - On the contrary, not a vacuum at all, even by your own calculation.[131]

Kircher's letter reinforced his familiarity with hydraulic techniques, stating that he had experienced nature's enormous resistance to rarefaction "hundreds of times in similar machines"[132], but regretted that he "didn't have more time to refute the whole contraption [*machinatione*] from first principles"[133]. Kircher also sends Schott greetings from his new "*socius*", the Jesuit Valentin Stansel, "also most versed in

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[129]"Vidi ego Paderbornae ante annos 37. talem Naturae victoriam. Paraverant Nostri in Collegio puteum ingentis prorsus profunditatis, ex quo per machinas multasque rotas arduo molimine aqua hauriebatur. Ergo compendii studio, constructa est antlia, eximo fundo erecta, arboribus integris in tubos excavatis, & invicem innexis. Quia vero profunditas aquae erat major, quam pro consueto Naturae modulo, & quam ut aër extrahi, per pistilla & assaria posset; nulla vi moveri illa potuere. Comque demum & lateris & machinis homines plurimi & robustissimi extreme contenderent, hoc effecerunt, ut tubi, licet densissimi, ex truncis arborum confecti, cum terribili fragore crepuerint, aërique viam patefecerint", ibid. p. 474

[130]"Caeterum quoniam varij rerum curiosarum Amatores mecum de dicto Experimento per Litteras egerunt, variaque responsa extorserunt; existimo ea, praesertim quae praestanti Philosopho cuidam non ita pridem communicavi, non contraria fore ijs quae RV. imprimenda curat", ibid. p. 455.

[131]"At vacuum mihi offers, inquis? Imò minimè vacuum Tuo etiam calculo", ibid., p. 443

[132]"Resistentia itaque & reluctantis Naturae impetus potius in rarefactionem aëris, quam in aliam rem conferendus est, ut centies ego in similibus Machinis expertus sum", ibid., p. 452.

[133]"Sed doleo non mihi tempus superesse, ad totam machinationem ex fundamentis confutandam", ibid., p. 453

Hydrostatics".[134] Zucchi's letter thanks Schott for his letter seeking opinions on Guericke's device "both from me and from other more expert people"[135].

In the case of the Guericke experiment, we see the poles of Würzburg and Rome functioning as a split laboratory. The experiments performed in Würzburg do not need to be repeated in Rome, due to the highly conductive channels of information between the two colleges. Although a diagram of the Guericke device is present among Niccolò Zucchi's papers in Rome[136], the fact that he suggests that the Würzburg Jesuits attempt the experiment in a darkened room to see if any glowing rays or flashes of light appear in the empty space confirm that he did not undertake any replication of the experiment[137]. The faithful reports of the Würzburg experiments undertaken by Schott and his fellow Jesuits were deemed to be sufficient grounds for his expert opinion.

Expert knowledge of matters other than religion had come to be highly expedient to the apostolic goals of the Society of Jesus during the course of the seventeenth century. Jesuits who attained privileged status through various types of consultancy were in strong positions for encouraging piety and advancing the wider interests of the order. As Orazio Grassi suggested in 1619[138] and Fabio Chigi confirmed in 1648[139], Jesuit colleges were perceived as sites to which a curious elite could travel in order to find answers to arcane questions, whether concerning comets or the Torricellian tube.

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[134]"Caeterum salutat Reverentiam Vestram P. Valentinus Stansel Socius meus, ac is quoque in Hydrostatica versatissimus", ibid. loc. cit.
[135]"Reverende in Christo Pater, Pax Christi. Cum inaudissem, scriptas Reverentia Vestra litteras ad Patrem Assistentem, quibus tum a peritioribus, tum a me quoque judicium requirebat de novis Experimentis, ad exhibendum vacuum istic propositis", Schott, *Mechanica*, p. 463.
[136]BNR F.G. 1323, f. 127r
[137]"Cuperem ut Vestra Reverentia curaret experimentum postremum retentari, sed in tenebris revolvi clavem colli in vase aereo, & in eo aquam e vitreo descendere, ut notari posset, an in illis radiis candicantibus fulgor aliquis appareret", Schott, *Mechanica*, p. 465.
[138]Grassi, Orazio, *Libra astronomica ac philosophica....*, Perugia (1619), OG VI: pp.109-179. "But why was it so readily believed that this Gregoriana of ours, renowned for the many interests of its academicians should be considered as, among other things, the eyes of all, and that it ought especially to be consulted and its answers awaited?", transl. Drake and O' Malley, *The Controversy on the Comets of 1618*, Philadelphia: University of Pennsylvania Press;1960, p. 69.
[139]Chigi to Kircher, Münster; 29 May 1648, cit. above note 50.

The tight epistolary links between colleges, so clearly evinced by the appendix to Schott's *Mechanica* meant that even if the requisite expert knowledge was unavailable locally, distant specialists could be mobilised with little difficulty. Such a presentation of the Jesuit college could come under threat from both within and without.

Inidividuals or groups outside the order, who laid claim to privileged access to arcane knowledge, could undermine Jesuit authority, and attacks on Paracelsus, Van Helmont, the Rosicrucians, Jansenists, alchemists, astrologers, Galileo and Magni by Jesuit authors must in part be read as attempts to defend the authority of the Jesuit order over erudite questions regarding the natural world[140]. As Sforza Pallavicino said of philosophy, "the monopoly on that precious commodity is not conceded to certain people who, in the guise of necromancers, with certain horrendous and obscure words, make the common people venerate them for their singular wisdom"[141]. The material corollaries of expertise included mathematical instruments and machines.

One resource for individuals and groups competing with the Jesuits as consultants in different arcane areas was to claim that the supposedly objective information provided by Jesuit "experts" was not the product of disinterested enquiry, but was instead highly coloured by the religious goals of the order[142]. In the case of the vacuum, Boyle's response to Linus accounted for the popularity of an explanation of the Torricellian

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[140]On alchemy and the Jesuits see Martha Baldwin, *Alchemy in the Society of Jesus*. in Z.R.W.M. von Martels, ed. *Alchemy revisited: Proceedings of the International conference on the history of alchemy at the University of Groningen; 1989 Apr 17*; Groningen. Leiden: Brill; 1990: pp. 182-187. For a Jesuit response to van Helmont's teachings on the weapon-salve see J. Roberti, *Curationis Magneticae, & Unguenti Armarii Magica Impostura...Modesta Responsio Ad perniciosam Disputationem Io. Baptistae ab Helmont Bruxellensis Medici Pyrotechnici* Luxemburgi: Excudebat Hubertus Reuland; 1621, on the Rosicrucians see Kircher, *Mundus subterraneus*, Amsterdam: Joannem Janssonius & Eliseum Weyerstraten; 1665, Tom. 2, p. 280, on judicial astrologers see Benito Pereira, *Adversus fallaces & superstitiosas artes*, Venice: Apud Ioan. Baptistam Ciottum, Senensem.; 1592 pp. 164 ff.

[141]"Il monopolio di questa preziosa merce non è conceduto ad alcuni, che, a guisa a punto de' negromanti, con certi vocaboli orrendi ed oscuri si rendono venerabili al volgo per singolarità di sapienza"Pallavicino, Sforza. *Del Bene. Libri Quattro*. Venice: Lorenzo Basegio; 1648.

[142]On disinterestedness, see Peter Dear, *From Truth to Disinterestedness in the Seventeenth century*. Social studies of science. 1992; 22: pp.619-631.

experiment in terms of some rarified substance among Jesuits in terms of "perhaps its congruity to some articles of their religion".[143] The series of moves to enforce adherence to Aristotle in the order on many fundamental physical matters during the 1630s and 40s, culminating in the 1651 *Ordinatio pro studiis superioribus*, made it increasingly difficult for Jesuit natural philosophers to strike a disinterested pose when such points were at stake, hence the very real danger represented by someone such as Magni.

The *Collegio Romano* occupied a special place in the network of Jesuit colleges, and in Kircher it had a resident expert on all types of arcana. Kircher's reputed knowledge of hieroglyphics, his mechanical expertise and learned publications on an immense variety of topics encouraged numerous people to write to him "as to the oracle" to ask for his solutions to "difficult questions from all of the sciences"[144]. Rather than shirk visitors who might interrupt his labours[145], Kircher positively encouraged the learned caller by building a speaking tube that allowed the porters of the college to announce his guests to him in his bedroom, so that he might invite them up to see his his machines and curiosities. Kircher's museum further legitimated the presence of the "curious" visitor in the college[146]. In the museum, the speaking tube became attached to a statue, commonly described as the "Delphic oracle". Speaking through the tube from a different room, as

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[143]Boyle, *Defence ... against the Objections of Franciscus Linus*, in Boyle, *Works*, I, pp. 118 ff. "this opinion [i.e. the presence of an extremely rarefied substance in the Torricellian space] being approved by many eminent scholars, especially of that most learned order of the Jesuits (to whom perhaps its congruity to some articles of their religion chiefly recommends it)".

[144] "Continentur praeterea in *Musaeo Kircheriano* Epistolarum 12 Tomi in Folio à 40 Annis ad eum datarum annuatim collecti, quos non solum Pontifices, Imperatores, Cardinales & Principes Imperii, sed & literati Philosophi, Mathematici, Physiologi ex toto orbe ad eum variis linguis, tum honoris causa, tum veluti ad oraculum, de difficillimarum quaestionum ex omnia scientia propositarum solutione exaratas miserunt", G. de Sepibus, *Romanii Collegii Musaeum Celeberrimum cuius magnae antiquariae rei...* Amsterdam: Ex Officina Janssonio-Waesbergiana; 1678. p. 65

[145]For a contrast, see Steven Shapin, *"The mind is its own place": science and solitude in 17th century England.* Science in Context. 1990; 4(1): 191-218.

[146]See e.g. Kircher to General Oliva, Rome; 1672 May 5. ARSI Rom. 38 f. 172r, "Ego sane huiusmodi legato immensa et omnigena rerum curiosarum multitudine et varietate instructo locoque constituto animatus, nihil non egi quam ut locum condigna magnificentia expensis, viribus meis etiam superioribus, qua picturis qua machinis aliisque rebus necessariis pro mea paupertate exornarem. Accidit autem ut successu temporis (Deo sit honor et gloria) Collegium Romanum per universam Europam tantam huius occasione Musaei nominis celebritatem adeptum fuerit, ut nemo exterorum, qui Collegii Romani Musaeum non vidisset, Romae se fuisse testari posse videretur."

his museum's most spectacular exhibit, Kircher would answer the questions of his curious visitors on abstruse topics, while making its eyes roll.[147]

Lorenzo Magalotti remarked in a letter to Francesco Maria de' Medici that "a Jesuit mathematician is a rarity worthy of being put into a museum"[148], and indeed a museum was one space in which Jesuit instrumental expertise might not conflict with the institutional position of the order on controversial questions of natural philosophy.

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[147]"...Kircher had a tube in the workshop of his bedroom, arranged in such a way that the porters, in order to call him to the door when business demanded it, used not have to take the trouble to go all the way to his bedroom, but merely called him in a normal voice at the door that gave access to the open-air garden. He heard their words as clearly as if they had been present in his bedroom, and answered in the same way, through the tube... Later he transferred this tube to the Museum, and inserted it into a statue in such away that the statue, almost breathing life, is seen to speak with its mouth open, and its eyes moving. He named this statue the Delphic oracle, as it was in the same way, by the ingenious trick of stuffing tubes into the mouths of idols, that the ancient priests of the Egyptians and Greeks deceived the people consulting the oracle and made superstitious men give valuable offerings", Sepi, G. de. *Romanii Collegii Musaeum Celeberrimum cuius magnae antiquariae rei...* Amsterdam: Ex Officina Janssonio-Waesbergiana; 1678; also Kircher, *Phonurgia nova*, Campidonae: Dreherr; 1673, p. 112. On the museum, see especially Findlen, Paula. *Scientific Spectacle in Baroque Rome: Athanasius Kircher and the Roman College Museum*. Roma Moderna e Contemporanea. 1995; 3: 625-665 and Lugli, Adalgisa. *Inquiry as collection: The Athanasius Kircher Museum in Rome*. RES. 1986; 12: 109-124.

[148]Cit. in Cochrane, Eric. *Florence in the forgotten centuries 1527-1800*. Chicago and London: The University of Chicago Press; 1973, p. 253

CHAPTER 7

THEATRICALITY AND THE FAILURE OF REPLICATION

Mathematics and theatricality in the *Collegio Romano*

> Kircherus, Scheinerus etc. apply Mathematics to Experiments and Mechanicks etc. They are right Iesuits to make a great blaze of all things etc so as to attract more admirers and contributors to their Order.
>
> Samuel Hartlib, *Ephemerides* 1648 Part 1 (January 1648)[1]

Machines, instruments and experiments occupied an ambiguous space at the boundary between theatrical and mathematical practices in the seventeenth century Jesuit college. This chapter seeks to explore that space further, taking as its point of departure the ceremonial visit made by Queen Christina of Sweden to the *Collegio Romano* in 1656. I will suggest that the disciplinary proceedings of the 1640s and 50s, discussed in the previous chapter, made the role of machinery and instrumentation in producing innovative natural philosophy highly problematic. The emblematic, performative and magical capabilities of mechanical devices and mathematical instruments were thus increasingly emphasized over their roles in forging an alternative to Aristotelian natural philosophy, complicating Jesuit relations with the emerging scientific societies of mid-seventeenth century Europe.

The extremely popular works of Athanasius Kircher and two of his disciples Gaspar Schott and Francesco Lana Terzi are particularly representative of this celebration of technical *mirabilia* in Jesuit culture[2]. Whilst the Jesuit *Revisores* were increasingly

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[1]Hartlib Papers, Sheffield, 31/22/1A-B, digital edition, ed. Mark Greengrass et al., Ann Arbor: UMI, 1995.

[2]See especially Athanasius Kircher, *Magnes, sive de arte magnetica opus tripartitum*, Rome: H. Scheus, 1641 (further editions: Cologne: J. Kalcoven, 1643[2]; Rome, B. Deversin and Z. Masotti, 1654[3]), idem., *Ars Magna lucis et umbrae*. Romae: H. Scheus; 1646 (further edition:

sensitive to departures from Aristotelian teachings in physics in the years after the *Ordinatio pro studiis superioribus* of 1651[3], the same years witnessed an explosion of publications on mechanical and mathematical magic[4], explicitly divorced from the *physica* taught in Jesuit colleges. Kircher and his disciples responded to the disciplinary crisis by reducing mathematics to pure instrumentation and manipulation, retreating from the strong cognitive claims made for mathematical knowledge by Clavius, Grienberger and Biancani in the early years of the seventeenth century.

The transformation of the Jesuit *mathematicus* into an impresario had detrimental consequences for the credibility he enjoyed in scientific circles. The *artificialia* paraded in the ceremonial displays and printed works of Kircher and his disciples Francesco Lana Terzi and Gaspar Schott were difficult to replicate in other geographical and political contexts, as witnessed by the futile efforts of the Royal Society to repeat Kircher's experimental performances, discussed below. The failure of replication brought the fragile credibility of the Jesuit mathematical practitioner under close scrutiny in the

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Amsterdam: J. Jansson van Waesberghe, 1671[2]), idem., *Musurgia universalis sive ars magna consoni et dissoni*, Rome: heirs of F. Corbelletti, 1650, idem., *Mundus subterraneus*, Amsterdam: J. Jansson van Waesberghe, 1664-5 (further edition: Amsterdam: J. Jansson van Waesberghe, 1678), idem., *Magneticum naturae regnum*, Rome: I. de Lazaris, 1667 (further edition: Amsterdam: J. Jansson van Waesberghe, 1667), idem., *Phonurgia nova*, Kempten: R. Dreher, 1673 (for a full bibliography of Kircher's works, see John Fletcher, ed., *Athanasius Kircher und seine Beziehungen zum gelehrten Europa seiner Zeit*. Wiesbaden: Harrassowitz; 1988, pp. 179-190), [Kaspar Schott], *Joco-seriorum naturae et artis, sive Magicae naturalis centuriae tres*. Frankfurt: Apud Ioannem Arnoldum Cholinum; 1667, idem., *Magia Universalis naturae et artis*. Herbipoli: Excudebat Henricus Pigrin; 1657-1659 (4 vols.), idem., *Mechanica hydraulico-pneumatica.*. Würzburg: H. Pigrin ; 1657, and idem.,*Technica Curiosa sive mirabilia artis, Libris XII. comprehensa.* Würzburg 1664 (further edition: Würzburg: Jobus Hertz; 1687[2]), Francesco Lana Terzi, *Prodromo overo saggio di alcuni inventioni nuove premesso all'arte Maestra* . Brescia: Rizzardi, 1670, idem., *Magisterium naturae et artis, opus physico-mathematicum*. Brescia: Rizzardi; 1684.

[3]See Claudio Costantini, *Baliani e i Gesuiti*. Florence: Giunti Barbèra; 1969.

[4]On the background of mathematical magic in England in this period see Jack Peter Zetterberg, *"Mathematical Magick" in England: 1550-1650*. PhD dissertation, University of Wisconsin-Madison; 1976. On the European context, see especially William Eamon, *Science and the secrets of nature: Books of secrets in medieval and early modern culture*. Princeton: Princeton University Press; 1994 and R. J. W. Evans, *The Making of the Habsburg Monarchy: An Interpretation*. Oxford: Clarendon Press; 1979, especially chapters 9-12. The discussion of the natural and artificial magic of Athanasius Kircher and Kaspar Schott in Wayne Shumaker, *Natural magic and Modern science, Four treatises 1590-1657*. New York: Center for medieval and early Renaissance studies, State University of New York at Binghamton; 1989 is inadequate.

late seventeenth century, as the boundary between ludic or edifying display and natural investigation was negotiated between Jesuits and members of the emerging scientific societies of the 1660s.

Courting Queen Christina

On 11 November 1651, Athanasius Kircher wrote a letter to Queen Christina in Stockholm:

> Your Majesty will know that our Society not only holds you in intimate affection, as is fitting, but also esteems and admires above all other things those rare and sublime treasures bestowed by heaven that divine bounty has hoarded up in your breast. This is especially true of this Roman College of our Society, both of the famous men and writers and of the novices, who have come from all of the nations of the world, where we speak 35 different languages, some native to Europe, Africa and Asia, the remainder to the Indies and America. And all of them are excited by the fame of your majesty's wisdom, and attracted by some unknown sympathetic magnetism, and their only ambition is to paint the extraordinary example of all virtues that your Majesty exhibits to the world in all the colours that it deserves.[5]

Queen Christina's tour of the Collegio Romano in 1656 was the culmination of a lengthy process of rapprochement between the Queen and the Jesuit order which had begun in February 1652 when two Italian gentleman travellers, going by the names of Don Bonifacio Ponginibio and Don Lucio Bonanni, had arrived in the Royal court in Stockholm[6]. The two gentlemen, as Christina quickly divined, were in reality Jesuits, carefully disguised by long hair and beards. Paolo Casati and Francesco Malines, both

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[5]"Noverit autem S. M.tas V.a Societatem nostram non tantum, ei ut par est, intime affectum esse; sed et rares illes, simblimesque caeletium dotium thesauros, quos divina bonitas cordi eius recondidit, cum primis et prae caeteris omnibus revereri, suspicere, et admirari, potissimum in hoc Romanum Societatis nostrae Collegium [sic], tum viris scriptoribus celeberrimis tum Tyronibus ex omnibus mundi nationibus conflatum; ubi loquimur 35 diversis et nativis linguis partim Europae, Africae et Asiae, partim Indiae et Americae peculiaribus; atque hi omnes summa sapientiae maiestatis vestrae agitati, et nescio quo magnetismo sympathico tracti, in hoc unico ambitiosi videntur ut tam insolutum virtutum omnium exemplar, quod M.V. exhibet, dignis virtutum coloribus depingant", Athanasius Kircher to Queen Christina of Sweden, Rome, 11 November 1651, APUG 561 ff. 50r-v (autograph draft), on 50r.

[6]There is a vast bibliography on Christina, but see especially Susanna Åkerman, *Queen Christina of Sweden and her circle: The transformation of a seventeenth-century philosophical libertine,* Leiden: Brill, 1991, idem., *Cristina di Svezia: scienza ed alchimia nella Roma barocca*. Bari: Dedalo, 1990, Jeanne Bignami Odier and Anna Maria Partini, 'Cristina di Svezia e le scienze occulte', *Physis* 1983, A. 25(fasc. 2): 251-278. Georgina Masson, *Queen Christina* London: Secker & Warburg, 1968, though a popularised presentation, remains useful as an overview.

highly trained in mathematics and theology, had set off from Venice on 8th December on their important mission to convert "Don Teofilo", as Goswin Nickel, the Vicar General of the order, had instructed them to call Christina in their letters. Christina had specially asked the General for mathematically skilled Jesuits, and spent as much time with her visitors discussing Galileo's *Dialogo*, atomism, and the latest books by Bartoli and Kircher[7] as the matters of faith that were the ostensible reason for the meeting. She received a copy of Bartoli's *Dell'huomo di lettere*[8] from her Italian visitors, and probably availed of their services to send a letter to Kircher in Rome in which she expressed a desire to have a chance to talk to the famous polymath more freely in the future[9].

Curiosity played a central role in Christina's abdication and relocation in Rome. The image of Rome which the Jesuit missionary mathematicians nurtured in the Queen's mind was one of a city in which the secrets of the natural world could be investigated under conditions of utter intellectual freedom, in stark contrast to the ascetic Lutheranism that reigned in Stockholm. Paradoxically, the very book that Kircher was to dedicate to Christina, the *Iter Exstaticum*, ran into serious difficulties on account of the atomist matter-theory which it sanctioned and which Christina also favoured[10]. The receptions of the Queen in the *Collegio Romano* were intended to continue to convey the image of the Jesuits' showpiece college as the home of cultivated Catholic curiosity.

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[7]Kircher had arranged for a copy of his *Musurgia Universalis* to be sent to Christina in 1650. See Louys Elzevier to Athanasius Kircher, Amsterdam; 14 November 1650, APUG 568, f. 238 r-v

[8]Daniello Bartoli, *Dell'huomo di lettere difeso & emendato*, Bologna: Heredi di E. Dozza, 1646.

[9]See the undated letter to Kircher in APUG 556 f. 173r, in a more legible Italian translation on f. 174r: "Spero che hormai havremo un occasione più libera, e fedele di corrispondenza mutua, e per poter communicarmi gli più sicuramente". Kircher eventually dedicated his 1656 *Itinerarium Exstaticum* to Christina, who mentions his plan to do so in the same letter: "Desiderei ancor sapere, se me giudichi ancor degna a dedicarmi la sua incomparibile opera".

[10]See Carlos Ziller Camenietzki, *L'Extase interplanetaire d'Athanasius Kircher: Philosophie, Cosmologie et discipline dans la Compagnie de Jésus au XVIIe siècle*, Nuncius, 1995, X(1): 3-32.

On 18th January 1656, Queen Christina made her first visit to the *Collegio Romano* (fig. 27)[11]. 20 Swiss guards were placed at the door, preventing anyone from entering the building except the pupils of the lower classes, who were all meant to await the Queen in their classrooms. When the Queen arrived, the bells rang twice, and all of the Fathers, wearing cloaks, lined up inside the main door to receive her. The Queen entered the college with her entourage and the door was closed. In each class that the queen visited a pupil came forward to recite an epigram, and then presented her with a piece of printed satin brocaded with golden lace. When she had finished visiting the classes, she returned to the entrance, and went to visit the Church, where she prayed to Saint Ignatius and at the altar of Blessed Aloysius Gonzaga, while musicians sang some motets.

As she had been unable to see everything during this first visit, Christina returned to the college on 30th January. She entered by the side door, where she was received by the General, the Roman Provincial, the Rector of the College and other members of the order. Her subsequent perambulations are described meticulously in Galeazzo Gualdo Priorato's biography of the queen, and I cite from the 1658 English translation:

> She quickly went into the Library [...] Here her Majesty entertaining her self for some time, in viewing the many volumes, took pleasure too in looking on the Modell and Platforme of the City of Jerusalem, which was left by Father Villalpando, with the description of the streets, and holy places, consecrated by the journeys and passions of our Lord Jesus Christ. She then, going about the other sides, discovered some Greek and Latin Manuscripts lying open on a Table, and could judge of the Authors, shewing very great learning.
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> She went thence into the gallery, that was near, where Father Athanasius Kircherus the great Mathematician had prepared many curious and remarkable things, as well in nature, as art, which were in so great a number, that her Majesty said, more time was required, and less company to consider them with due attention. However she stayed some time to consider the herb called Phoenix, which resembling the Phoenix grew up in the waters perpetually out of its own ashes. She saw the fountains and clocks, which, by vertue of the load-stone turn about with secret force. Then passing through the Hall, where she looked on some Pictures well done, she went through the walkes and the garden, into the Apothecaries shop, where she saw the preparation of the ingredients of herbs, plants, metalls, gemms, and other rare things, for the making of Treacle [i.e. Theriac] and balsome of life. She saw them distill with the fire of the same furnace sixty five sorts of herbs in as many distinct limbecks. She saw the philosophical calcination of ivorie, and the like. She saw extracted the spirits of Vitriol, Salt, and Aqua fortis, as likewise a jarre of pure water, which with two single drops of the quintessence of milke, was turned into true milk, the only medicine for the shortness of the breath, and affections of the breast. In fine being presented

[11]APUG 142 ff.81r-83r

> with Treacle [i.e. Theriac] and pretious oyles, she went into the sacristy, where they opened all the presses, where they keep the Plate and reliques of the Church, with the great candlesticks, and vases given them by the deceased Cardinall Lodowick Lodowiso the founder of the Church. She honoured particularly the blood of St. Esuperantia a Virgin and Martyr, which, after a thousand and three hundred years, is as liquid as if newly shed. Then going into the Church she heard Mass, and at her departure, gave testimonies to the Fathers of her great satisfaction and content.[12]

The accounts of Christina's visits to the *Collegio Romano* resonate with the image of the College as both a *theatrum mundi* and repository of universal knowledge suggested in Kircher's letters to the Queen before her departure for Rome. Although Christina's case is conspicuous for its dramatic charge, the pattern is far from unique, and there are innumerable other examples of monarchs and aristocrats, Catholic and Protestant, being enticed into metropolitan Jesuit colleges throughout Europe rather as Chinese *literati* were initially enticed into Matteo Ricci's house, by the promise of arcane knowledge, curiosities, maps and mathematical instruments.[13] A manuscript chronicle of the *Collegio Romano* describes a large number of such ceremonial visits[14].

The transformation of the *Collegio Romano* into a theatre of curiosity had numerous precedents throughout the century. During the festivities to mark the canonization of Saints Ignatius and Francis Xavier in 1622, the College was transformed into ancient Rome, to echo the solemn ecclesiastical rites with "erudite allusion and ancient Apotheosis"[15]. The *Atrium* and entrances of the Collegio were decorated to represent

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[12]Galeazzo Gualdo Priorato, *History of her majesty Christina Alessandra, queen of Swedland*. London: Printed for T.W., 1658, pp. 428-431.

[13]See Jonathan D. Spence, *The memory palace of Matteo Ricci*, London: Faber and Faber, 1985, Pasquale M. D'Elia, *Galileo in China. Relations through the Roman College between Galileo and the Jesuit Scientist-Missionaries (1610-1640).* Cambridge, MA: Harvard University Press, 1960, Jacques Gernet, *China and the Christian impact: a conflict of cultures*, trans. Janet Lloyd, Cambridge: Cambridge University Press, 1985, p. 22.

[14][Anon.], *Origine del Collegio Romano e suoi progressi*, APUG: 142. This manuscript forms the basis of the descriptions of ceremonial receptions given in the Collegio Romano provided in R. Garcia Villoslada, *Storia del Collegio Romano dal suo inizio all soppressione della Compagnia di Gesù*. Rome: Typis Pontificiae Universitatis Gregorianae, 1954, pp. 263-296.

[15]Famiano Strada, *Saggio delle Feste che si apparecchiano nel Collegio Romano in honore de' Santi Ignatio et Francesco da N. S. Gregorio XV Canonizati All'Illustrissimo, & Eccellentissimo Signor Principe di Venosa.* Roma: Appresso Alessandro Zannetti; 1622, sig. A2 recto. On theatrical productions in the Collegio Romano during this time, see Irene Mamczarz, *La trattatistica dei Gesuiti e la pratica teatrale al Collegio Romano: Maciej Sarbiewski, Jean Dubreuil e Andrea Pozzo*. in M. Chiabò and F. Doglio, eds., *I Gesuiti e i Primordi del Teatro Barocco in Europa*. Roma: Torre d'Orfeo; 1995: 349-387 and Jean-Yves Boriaud, *La Poésie et le Théâtre latins au Collegio Romano d'après les manuscrits du Fondo Gesuitico de la*

the Roman forum, while the Aula Magna became the Campus Martius, scene of the apotheoses of the Roman Emperors. Two large globes, at the main entrance, represented the old and new worlds, divided into thirty-four Jesuit provinces, with their colleges and houses marked on *tesserae*. Plays representing important events in the lives of Xavier and Ignatius were staged by the Parthenian academicians of the College and the members of the Roman seminary. The mathematics professor Orazio Grassi staged an opera in the transformed *Aula Magna* for the occasion, the *Apotheosis of Saints Ignatius and Xavier*, set to music by Kapsberger, with elaborate stage-machinery[16]. Grassi also provided geographical demonstrations (*ragioni Geografiche*) that St. Francis Xavier was responsible for a larger amount of territory than any apostolic preacher, much as he had provided public mathematical demonstrations for the supra-lunary location of the comets of 1618[17].

By the time of Christina's visit in 1656, as Gualdo Priorato's account reveals, the College could boast two further sites of courtly display: the College pharmacy and the *Museum Kircherianum*. Building of the college pharmacy commenced on 5 July 1627, shortly after the commencement of work on Orazio Grassi's church of St. Ignatius[18], but the existence of *Spetiali* is evident from the Catalogues of the College back to 1598 and beyond[19]. In 1609 the category becomes "Aromatarius"[20], before the title of

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Bibliothèque Nationale Vittorio Emanuele II. Mélanges de l'École Française de Rome, Italie et Mediterranée. 1990; 102(1): 77-96.

[16]See Emilio Sala and Federico Marincola, *La Musica nei Drammi Gesuitici: Il Caso dell'Apotheosis sive Consecratio Sanctorum Ignatii et Franciscii Xaverii (1622)*, in in M. Chiabò and F. Doglio, eds., *I Gesuiti e i Primordi del Teatro Barocco in Europa*, cit., pp. 389-439. For a rich contemporary Italian discussion of theatrical machinery see Nicola Sabbattini, *Pratica di fabricar scene, e machine ne' teatri* Ravenna: Per Pietro de' Paoli, e Gio. Battista Giouanelli Stampatori Camerali; 1638.

[17]Strada, op. cit., p. 9, and, for the cometary presentation, [Orazio Grassi], *De tribus cometis anni MDCXVIII Disputatio astronomica publice habita in Collegio Romano Societatis Iesu ab uno ex Patribus eiusdem Societatis.* Romae: ex typographia Iacobi Mascardi; 1619, OG VI pp. 21-35, translated in Stillman Drake and C.D. O'Malley, *The Controversy on the Comets of 1618*, Philadelphia: University of Pennsylvania Press; 1960, pp. 3-19.

[18]APUG 142 ff.1r-8v: *Nota delle spese fatte nella Fabrica del Collegio Romano* f. 4r :" Dal 1627 fino a tutto il 1632 furono spesi [scudi] sedicimila dugento novanta due per la fabrica della spezieria, cominciata a di 5 Luglio 1627"

[19]ARSI Rom. 79 f.11v and BNR FG 1526 f.35r

[20]ARSI Rom. 110 f.51v

pharmocopolae was bestowed upon Francesco Vagioli and Francesco Savelli in the *Catalogi* of 1624-5[21]. The walls of the pharmacy were decorated with a series of (surviving) frescoed lunettes by Andrea Sarti and Emilio Savonanzi in 1629, depicting Galen, Hippocrates, Mesue, Andromachus and other authorities in medicine, botany and pharmacy (fig. 28). A painted panel at the centre of the ceiling depicted the patron saints of medicine, Cosmas and Damien, in the company of Saints Francis Xavier and Ignatius and the Madonna and child, a grouping lent legitimacy by the coincidence that the bull of foundation of the Jesuit order (27 September 1540) fell on the feast day of the medical saints[22]. A manuscript ground-floor plan of the Collegio[23] apparently dating from the mid-seventeenth century depicts the pharmacy as occupying at least five rooms. As well as producing the balsam of life, theriac and various other precious substances that could be distributed to potential patrons of the order[24], the numerous books of secrets that survive suggest that the pharmacy was used for alchemical operations as well as the production of candle-wax and even substances for combatting "*carnosità*", or carnality, clearly a dangerous enemy to the Jesuit way of life[25] . As a site of display, the pharmacy played a part in a visit made by Urban VIII to the Collegio Romano as early as 1631[26]. On Vincenzo Carafa's first visit to the college as

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[21]Idem. f.121r

[22]See *Imago Primi Saeculi Societatis Iesu A Provincia Flandro-Belgica eiusdem Societatis Repraesentata*. Antwerp: Balthasar Moretus; 1640, p. 12.

[23]APUG 134, XVI, *Abbozzo iconografico del Collegio Romano*.

[24]See e.g. Athanasius Kircher to Duke August of Brunswick-Lüneburg, Rome, 25 July 25, HAB BA n. 366, and the other medical gifts discussed in John Fletcher *Athanasius Kircher and Duke August of Brunswick-Lüneburg. A chronicle of friendship* in John Fletcher, John, ed., *Athanasius Kircher und seine Beziehungen zum gelehrten Europa seiner Zeit*. Wiesbaden: Harrassowitz; 1988: pp. 99-139.

[25]Some manuscript books of secrets originating in the Collegio Romano are listed in *Il Fiore dell'arte di sanare,* Rome: Edizione Paracelso, 1992, pp. 565-570. The Fondo Curia of APUG also contains numerous manuscript books of secrets, including APUG: FC 2087, APUG: FC 1381, APUG: FC 562, APUG: FC 1860/2, APUG: FC 2200. The "ceroto per la carnosità", accompanied by a crude drawing of a phallus, is described in APUG FC 2193, f. [40v]. On candlewax see APUG 134, XIV. For a study of the contents of another Jesuit pharmacy see Carmen Ravanelli Guidotti, *La Farmacia dei Gesuiti di Novellara*, Faenza: Edit Faenza, 1994. On the tradition of books of secrets during this period, see William Eamon, *Science and the secrets of nature: Books of secrets in medieval and early modern culture*. Princeton: Princeton University Press; 1994.

[26]APUG 142 f. 71r, Villoslada, cit., p. 275. In 1646 Vincenzo Carafa visited the college and was shown a highly decorated parchment containing recipes for medicines produced in the

General in 1646 he was shown a large parchment bearing the recipes of the theriac and other medicines produced in the Jesuit pharmacy, which had been lavishly frescoed with portraits of ancient medical writers in 1629. The enormous spagyrical furnace shown to Christina was depicted graphically (see fig. 20) in Kircher's *Mundus Subterraneus*,[27] where it bolstered Kircher's attack on alchemical charlatans.

The *Museum Kircherianum* (fig. 19) only received official recognition with arrival of the antiquarian collection bequeathed to the College by the Roman Senator Alfonso Donnini 1651[28]. Before then, following in the tradition of the previous senior mathematicians of the College, Clavius and Grienberger, Kircher's own *cubiculum* had functioned as a *Musaeum Mathematicum*, in which he built and stored machines and instruments, conducted experiments with magnets, consulted mathematical manuscripts, engaged in correspondence with other mathematicians and performed astronomical observations. As Clavius had gathered mathematical disciples, Kircher recruited technicians of the curious, both from the laity and from the Jesuit order. After brief periods of apprenticeship with Kircher in Rome, two of his most prolific Jesuit disciples Gaspar Schott and Francesco Lana Terzi redistributed Kircherian artificial magic to the provinces.[29]

The Museum attracted numerous foreign visitors to the College, a point that Kircher was careful to emphasize in negotiating with General Oliva in 1672 to attempt to avoid

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pharmacy (BNR FG 1382). For the Rospigliosi family's visit to the pharmacy in 1668, see Villoslada, cit., p. 277.

[27]Athanasius Kircher, *Mundus Subterraneus*, Amsterdam: Janssonius, 1665, Vol. 2 p. 392

[28]On Kircher's museum, the focus of much recent scholarship, see especially Paula Findlen, *Scientific Spectacle in Baroque Rome: Athanasius Kircher and the Roman College Museum.* Roma Moderna e Contemporanea, 1995; 3: 625-665 and Adalgisa Lugli, *Inquiry as collection: The Athanasius Kircher Museum in Rome.* RES. 1986; 12: 109-124.

[29]On the works of Schott and Lana Terzi and their consumers, see R.J.W. Evans, *The Making of the Habsburg Monarchy: An Interpretation*, Oxford: Clarendon Press; 1979. On Lana Terzi see also Clelia Pighetti, ed., *Immagini del '600 Bresciano. L'Opera Scientifica di Francesco Lana Terzi S.I., 1631-1687*, Brescia: Comune di Brescia, 1989, idem., *Francesco Lana Terzi e la Scienza Barocca*, in Commentari dell'Ateneo di Brescia, 1985, Anno CLXXXIV, 97-117, and Andrea Battistini's critical edition of Lana's *Prodromo* (Milan: Longanesi, 1977).

the relocation of the museum in a dark corridor due to the expansion of the college library[30].

The vegetable phoenix admired by the Queen in Kircher's museum was immediately the object of learned curiosity elsewhere in Europe, and its fate illustrates the complex constraints placed on credibility by the collision of the theatrical world of the ceremonial visit and the sober world of natural investigation in the Jesuit college. In 1657 Henry Oldenburg planned a trip to Italy, hoping to bring back to England news of Kircher's "vegetable phaenix's resurrection out of its own dust by y^{e} warmth of y^{e} Sun", along with other Kircherian secrets and "remarquable things, one might have the satisfaction to be punctually informed about"[31]. Oldenburg never made the trip, and the next news about Kircher's phoenix had to wait until Robert Southwell encountered an English traveller returning from Italy. Southwell reported to Oldenburg "[H]e gives me some incouragement yt when I come to Rome I shall be able fully to satisfy you concerning Kerchers plant. he told me he was wth him and remembers to have seene in a glasse half as bigg as his head (close luted) a plant glowne up ye length of his finger with a kind of asshes at ye bottome but I found he had not beene Curious in the observation of it"[32]. When Southwell was preparing to make his intellectual pilgrimage to Rome, he marked in his diary:

> Agenda
> A Romà
> To Enquire for Kircherus, and give Mr. Oldenburg notice concerning a powder in a glass Hermetically sealed, w.ch before ye Sun formes its selfe into a plant and in ye shade falls.[33]

On accomplishing his mission, he brought disappointing news about the phoenix: "As to the flower growing from its ashes, he had such a thing, but it is now spoiled; he made it

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[30]"Accidit autem ut successu temporis (Deo sit honor et gloria) Collegium Romanum per universam Europam tantam huius occasione Musaei nominis celebritatem adeptum fuerit, ut nemo exterorum, qui Collegii Romani Musaeum non vidisset, Romae se fuisse testari posse videretur", Kircher to Oliva, Rome, 5 May 1672, published in R. Garrucci, *Origini e vicende del Museo Kircheriano dal 1651 al 1773*. La Civiltà Cattolica. 1879; Serie X Vol. XII(Quaderno 703): pp. 727-739.
[31]Oldenburg to Boyle, Saumur, 19 March 1657, OC I pp.155-156.
[32]Southwell to Oldenburg, Montpellier; 20 October 1659, OC I, pp. 323-325.
[33]Robert Southwell, [Diary and Commonplace Book, 1659-1660?], BL. Add. 58219, f. 36r

not himself, but it was given him"[34]. Southwell nonetheless acquired "the receipt thereof, upon a swop, wrote with his own hand; it is long and intricate, and of a nice preparation"[35]. We have no record of whether the Royal Society suceeded in reproducing the vegetable phoenix[36], but generally attempts to replicate Kircherian wonders in London and Oxford met with little success. The trouble was not limited to England. John Bargrave recounted in graphic terms the price of failure for a Nuremberg optician: "I bought this glass of Myn Here Westleius, an eminent man for optics at Nurenburg, and it cost me 3 pistolls, which is about 50S English. This gentleman spoke bitterly to me against Father Kercherius, a Jesuit at Rome (of my acquaintance), saying that it had cost him above a thousand pounds to put his optic speculations in practice, but he found his principles false, and showed me a great basket of glasses of his failings"[37]. A moment of tension occurred when it seemed that the Royal Society would have to stage its own royal show for Charles II in 1663. Christopher Wren warned the President, Lord Brouncker, that "to produce knacks only, and things to raise wonder, such as Kircher, Schottus, and even jugglers abound with, will scarce become the gravity of the occasion"[38]. The credibility of the Jesuit *mathematicus* and the credibility of his religious order in a particular local context were inextricably linked. Whereas Clavius had initially suggested that mathematical celebrity would contribute to the credibility of the order as a whole in treating spiritual matters, reactions to the work of Kircher and his disciples suggested that the reverse was also true - the credibility of the Jesuit mathematical practitioner on matters of experiment and observation might be adversely affected by his membership of the order. The global Jesuit information network exercised its complex charm over the emerging scientific societies of the mid-seventeenth

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[34]Southwell to Boyle, n.p., 30 March 1661, in Boyle, *Works*, VI, pp. 297-300.
[35]ibid.
[36]Boyle did however allude to the palingenetic experiment in *A Discourse about the possibility of the resurrection* (1675) in Boyle, *Works*, 4, p. 194.
[37]Quoted in John Bargrave, *Pope Alexander the Seventh and the College of Cardinals, with a Catalogue of Dr. Bargrave's Museum, ed. J.C. Robertson.* London; 1867.
[38]Wren to Lord Brouncker, Oxford, 30 July 1663 in Thomas Birch, *The history of the Royal Society of London*, 4 vols., London, 1756, Vol. 1, p. 288. On the popular topos of Catholics (and especially Jesuits) as jugglers, see Rob Iliffe, 'Lying wonders and juggling tricks: Religion, Nature and Imposture in Early Modern England', forthcoming in D. Katz and J. Force, eds., *'Everything Connects': Essays in Honor of Richard H. Popkin*, Dordrecht: Kluwer, 1998.

century. As Mersenne had attempted to recruit the order for the measurement of global magnetic variation, John Beale, despite regarding the Jesuits as "our most dangerous enemies"[39] suggested to Samuel Hartlib that it would be beneficial to "provoke the Iesuites to transport the best Telescopes to their Peru, & other Southerne plantations, and from thence to make their discoveryes", in order to reap profit for the commonwealth of learning from the observations made by Jesuit astronomers[40]. A similar proposal was actually put into practice by the *Académie des Sciences* in Paris in the 1680s, when it employed Jesuits to perform astronomical observations on the China mission with a view to solving the problem of longitude[41]. Boyle's remark to Oldenburg that "I am glad you are like to settle a correspondence with Rome, that being the chief centre of intelligence"[42] is indicative of the tension between respect and suspicion that characterised the relationship between the Royal Society and the Society of Jesus at this point.

The Jesuit net drew in too much, according to unsympathetic English commentators in the 1650s. Robert Payne's remarks on Kircher *qua* Jesuit in 1650, while complaining about an experiment on roasted worms reported in the *Ars Magna Lucis et Umbrae* emphasize precisely this point:

> The truth is, this Jesuit, as generally the most of his order, have a great ambition to be thoughte the greate and learned men of the world; and to that end writes greate volumes, on all subjects, with gay pictures and diagrams to set them forth, for ostentation And to fill up those volumes, they draw in all things, by head and shoulders; and these too for the most part, stolen from other authors. So that if that little, which is their owne, were separated from what is borrowed from others, or impertinent to their present arguments, their swollen volumes would shrink up to the size of our Almanacks. But enough of these Mountebankes[43].

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[39]Beale to Boyle,Yeovell, 30 July 1666, in *Works*, VI pp. 408-410. On Beale's involvement with the early Royal Society, see Mayling Stubbs, ' John Beale, Philosophical Gardener of Herefordshire Part II.', *Annals of Science*, 1989, 46: 323-363, although Stubbs does not discuss Beale's interest in the Jesuits.

[40]Beale to Hartlib, 18 January 1658, Hartlib Papers, Sheffield, 51/55A

[41]Florence Hsia, paper given at the conference *The Jesuits: Culture, Learning, and the Arts, 1540-1773*, May 28 - June 1 1997, Boston College, Chestnut Hill, MA.

[42]Boyle to Oldenburg, n.p., 3 April 1668, OC IV: 299, cit. in John L. Heilbron, *Electricity in the 17th and 18th centuries. A study in early modern physics*, Berkeley, California: University of California Press; 1979, p. 108.

[43]R[obert] P[ayne] to Gilbert Sheldon, Oxford, 16 December 1650, BL Ms. Lansdowne 841 ff. 33r-v, on 33v.

In similar vein, on sending Descartes a copy of Kircher's *Magnes*, Constantijn Huygens had remarked that the former would find in it "more grimaces than good material, as is normal for the Jesuits. These scribblers, however, can be useful to you in those things *quae facti sunt, non juris*." [44]

Sir Robert Moray, later one of the prime movers in acquiring a charter from Charles II for the foundation of the Royal Society and its first president[45], entered into close correspondence with Kircher in 1644, after admiring the *Magnes.*[46] While in the services of the French army in Germany, Moray consumed Kircher's books avidly and discussed their contents with Jesuits in Cologne and Ingolstadt.[47] On his return to the royal court in Whitehall, he informed Kircher of the foundation of the Royal Society, and continued to send scholars, such as the mathematician James Gregory, the naturalist Francis Willughby and others to seek Kircher's company in Rome.[48] Moray,

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[44]"Voycy d'ailleurs l'Aymant de Kircherus, où vous trouuerez plus de grimace que de bonne estoffe, qui est l'ordinaire des Iesuites. Ces escrivasseurs pourant vous peuuent servir en des choses quae facti sunt, non juris. Ils ont plus de loisir que vous à se pourveoir d'experiences", Constantyn Huygens to Descartes, n.p., 7 January 1643, published in Leon Roth, ed., *Correspondence of Descartes and Constantyn Huygens 1635-1647*, Oxford, Clarendon Press, 1926, pp. 185-6, cited in John L. Heilbron, *Electricity in the 17th and 18th centuries. A study in early modern physics*, Berkeley, California: University of California Press; 1979, p. 106.

[45]On Moray see Alexander Robertson, *The Life of Sir Robert Moray. Soldier, Statesman and Man of Science (1608-1673)*, London, 1922.

[46]Moray to Kircher, Ingolstadt, 1 June 1644, APUG 557 363r-v, "Novum Magnetis Tui, et duplex, ecce, miraculum. Agit potenter in distans; et subiectum aniam humanam fortitus est. Portentum hoc vero non tam a Tuo Magnete quam a Te Magnete editum est. Quod enim per se inermis nunquam fecisset Magnes, te obsetricante, immo noviter □□□□□□□□□primo quoque affrictu perficit. Ipso igitur mediante me longe diffitum, ferreum forsan, quia militem, vinculis nescio quibus Magneticis, Tibi vehementer astrinxisti".

[47]Moray to Kircher, Ingolstadt, 7 September 1644, APUG 557 323ar-av, Moray to Kircher Ingolstadt, 24 January 1645; APUG 568 ff. 74r - 75v, Moray to Kircher, Paris, 12 March 1645, APUG 557 ff. 271r-v, Moray to Kircher, Cologne, 21 November 1655; APUG 568 ff. 39r-v, Moray to Kircher, Cologne, 28 January 1656; APUG 568 ff. 20r-21v, Moray to Kircher, Rotterdam, 6 August 1657; APUG 568 ff. 196r-197v.

[48]Moray to Kircher, Whitehall, 25 July 1663, APUG 563 ff. 212 r-v: "Je me sers maintenant de l'opportunité avantageuse qui se presente de ce docte personage Monsieur Pope qui non seulement vous rendra cette lettre, mais vous entretiendra de plusieurs choses que vous ne serez pas fasché de sçavoir, plus amplement que je ne sçauroit faire. particulierement touchant la Societé Royalle pour la philosophie Naturelle, que Nostre Roy a, depuis Deux Ans erigé icy: dont j'ay longtemps eu l'intention de vous informer; mais l'ay toujours remis à l'opportunité d'un plus avantageuz recit, que je ne vous en auroit pû faire. Ce qu'ayant maintenant rencontré par le moyen de ce porteur, qui est un des membres de la Societé, je l'ay pris de me communiquer tout ce qui la touche. Il vous dira aussi quelqu'autre chose de ma part touchant la Musique: au reste il faut que vous me permettiez de vous supplier de luy faire voir par vos civilités, que la recommendation que je vous en fais, vive est en consideration: je dis la mesme chose pour un autre Gentilhomme Anglais nommé Willoughby, qui se donnera aussi l'honneur de vous voir",

who occupied his spare moments in Whitehall with alchemical investigations[49], was confident that Kircher's agglomeration of information could be filtered, or threshed, to separate the wheat from the chaff:

> Whatsoever Mr. Hugens & others say of Kercher, I assure you I am one of those that think the Commonwealth of learning is much beholding to him, though there wants not chaff in his heap of stuff composted in his severall peaces, yet there is wheat to be found almost every where in them. And though he doth not handle most things fully, nor accurately, yet yt furnishes matter to others to do it. I reckon him as usefull Quarries in philosophy and good literature. Curious workmen may finish what hee but blocks and rough hewes. Hee meddles with too many things to do any exquisitely, yet in some that I can name I know none goes beyond him, at least as to grasping of variety: and even that is not onely often pleasure but usefull.[50]

Moray changed his tune in his following letter to the secretary of the Royal Society, demonstrating the increasing fragility of Jesuit scientific credibility, and linking the failure of an experiment involving the focusing of moonbeams on substances with a powerful burning-glass to Kircher's membership of the Jesuit order explicitly:

> You will I think scarce find any thing in my letter to kercher[51] whereupon hee had cause to use those expressions you mention. I do not remember I ever communicated that story of those heteroclite Tubes before I wrote to him, to any from whom I might reasonably expect a plausible account of the cause of it: what civility I may have exprest to him I do not remember but *hee does but lyke other birds of his feather*. Thom saw no such matter in the experiment as kircher promises in his 2. nights observation.[52]

Boyle wrote to Oldenburg in 1665 to complain about the problem:

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and Moray to Kircher, Whitehall, 16 February 1664, APUG 563 ff. 16r-17v: "Et puisque quelques uns de mes amis croyent que mes recommendations leur peuvent estre utile pour leur donner l'opportunité de vous saluer, vous me permettez aussi de vous prier quelque fois de vous faire bon accueil. C'est pourquoy je vous fais ce mot à present, en faveur de quelques uns de mes compatriotes qui se donneront le bien de vous voir en compagnie de Monsieur Gregorie [i.e. James Gregory] porteur de la presente, une persone qui a fort bien estudié, et est de plus sçavante en mathematique qu'on puisse trouver de son age. La faveur que vous leur ferez en consideration de la prise que je vous en fais, me sera une nouvelle obligation. Je n'entre pas à present en matiere scientifique, de peur de vous estre importun, mais si eux qui sont membres de la societé royalle, qui vous avoint salué, ne vous en ont fait sçavoir l'institution et de quelle façon on s'y mesle de la philosophie, la mathematique et la mechanique, à la première instance que vous m'en ferez / / je tascheray de vous en informer. Mais comme quelques uns de ces Messieurs vous auront sans doubte entretenu sur ce fait là, comme le chevalier Finch, Mess.rs Bains, Willoughby, Pope et autres dont quelques uns se seront peut estre servy de mon nom envers vous, je ne doubte pas que vous n'en soyez dessus bien informé".

[49]Robertson, op. cit, *Dictionary of National Biography* (repr. London: Oxford University Press, 1949-1950), 13, 1298-9.

[50] Moray to Oldenburg, Oxford; 19 October 1665; OC II: 574-576.

[51]This letter has been lost.

[52]Moray to Oldenburg, Oxford, 16 November 1665 in OC II: 608-611

> I suppose Sr. Rob. Murry has told you, that the Expt about Salt & Nitrous water exposed to the Beames of the moone did not succeed as Kircher promises, but as I foretold. And for the same Author's Expts with Quicksilver & sea water seald up in a ring, though the want of fit glasses will, till the commerce with London be free, keepe mee unable to try: yet besides it is at most the same, but not soe probable as that wch he publishd in his *Ars Magnetica*, 20 or 30 year ago. I cannot but think it unlikely that it will succeed at least in our Climate, where by concentrating the Beames of the Moone with a large Burning-glasse, I was not able to produce any sensible Alteration, in Bodys that seeme very easily susceptible of them. [53]

Commenting to Boyle on the matter, Oldenburg wrote darkly that "'Tis an ill Omen, me thinks, yt ye very first Experiment singled out by us out of Kircher, failes, and yt 'tis likely, the next will doe so too"[54].

John Dodington, secretary to the English ambassador to the Venetian republic, also endeavored to mediate between Kircher and the Royal Society. While entrusting the education of his son to Kircher's care, even in matters of religion, Dodington asked Kircher to procure telescopes and microscopes for the use of the Society from the rival instrument makers Eustachio Divini and Giuseppe Campani[55].

By the 1660s, as the epicentre of European institutionalised science shifted away from Italy towards the economic centres of England, France and Holland, experiments and claims about nature were finding it ever more difficult to travel beyond the walls of the *Collegio Romano* to gain currency in wider scientific circles. The environments in which

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[53]Boyle to Oldenburg, Oxford [?]; 18 November 1665, OC II: 613-614.

[54]Oldenburg to Boyle, London, 21 November 1665, OC II: 615-617

[55]Dodington to Kircher, Venice, 6 December 1670, APUG 559 ff. 37r-38v: "Et essendomi abastanza noto, la sua rara e vertuosa qualità sono importuno a pregarla che si degni a farmi noto se havesse la P. S. A. qualche Istrumento mechanico curioso, o qualche isperienza degna di consideratione, o qualche libro, desiderando restarmi favorito senza sua spesa, per poterli inviare al Sigr. Cav. Roberto Murry overo alla Società Reale, in Inghilterra, venendomi da questi S[ignor]i fatta frequente instanza", Dodington to Kircher, Venice, 17 January 1671, APUG 559, ff. 21r-22v "Prego in oltre la P. S. d'informarsi quale delli Doi Artefici Eustachio Divini o Gioseppe Campani sia più perfetto nell'edificio de Telescopij e Microscopi, e con l'informatione inviarmiene due per sorte presi d'ambedue l'Artefici, e perche devono servire per l'uso della Società Reale in Londra sono a supplicarla de più perfetti". See also Dodington to Kircher, Venice, 30 August 1670, APUG 559 ff. 19r-20v, Dodington to Kircher, Venice, 3 January 1671; APUG 560 ff. 23r, 24v, Dodington to Kircher, Venice, 21 March 1671; APUG 560 ff. 97rv, 98v, Dodington to Kircher, Venice, 24 October 1671; APUG 560 ff. 104r-105r. On Divini and Campani see Maria Luisa Righini Bonelli and Albert van Helden. *Divini and Campani: A forgotten chapter in the history of the Accademia del Cimento.* Annali dell'Istituto e Museo di Storia della Scienza (Supplemento). 1981; Monografia N.5 (Fasc. 1).

the Jesuit mathematician worked -- including classroom, court and Curia -- demanded different modes of self-presentation, and required the Jesuit scientist to acquire fluency in different 'languages' and the facility with which Jesuit scientists adapted their work to these many different environments had serious consequences for the way in which Jesuit statements about the natural world were evaluated by natural philosophers outside the order. During a period of disciplinary formation, when institutions were arising around Europe that ostensibly wish to insulate the investigation of the natural world from other forms of human activity, the cultural ferment characteristic of the Jesuit collegiate network was perceived by many members of the new societies and academies of the seventeenth century as a polluting force, notwithstanding the considerable material and social resources wielded by the order. The mixing of clerical, courtly, theatrical and scientific forms of life was particularly frowned upon by the members of the early Royal Society, where Jesuit natural philosophers were perceived as 'jugglers', using sleight of hand to deceive and impress courtly patrons, whether during ceremonial visits or in folio volumes of mathematical and experimental wonders. When the 'chaff' was removed from their experimental reports, the practices they described had to be sanitized and deprived of the clerical and emblematic overtones that supposedly coloured the motives of the Jesuit experimenter, rendering him a passable reader, but not a reliable interpreter, of the book of nature.

The relationships between the emerging scientific societies and academies of the 1650s and 1660s were frequently characterised by a desire to harness the information-gathering capacities of the Jesuits while avoiding the pollution entailed by admitting Jesuits as members or surrendering information to the services of Jesuit print-culture. In the case of the Parisian *Académie des Sciences*, John Milton Hirschfield has suggested that strong Jansenist influences on the early *académie* were responsible for Jesuit exclusion, although Florence Hsia has demonstrated that the relationship of the early *académie* with the Jesuits requires a more nuanced treatment[56]. In the case of the Royal Society,

[56]John Milton Hirschfield, *The Académie Royale des Sciences 1666-1683*, New York: Arno Press; 1981, Chapter 2, Hsia, op. cit..

Gaspar Schott's attempt to enter into an epistolary exchange of unpublished experimental and technical secrets with Robert Boyle was carefully deflected by the latter, who replied to Schott to say "That I long to see his works increased by the accession of his Technica Curiosa; towards which, I fear, I shall not contribute much, both because of my being no better stocked with rarities than I am, and because I know not what particular subjects he treats of in it".[57] Boyle's cautiousness is to be contrasted with the exuberance with which Kircher showered visiting virtuosi with curiosities, as witnessed by Robert Southwell's surprised exclamation that Kircher was "very easy to communicate whatever he knows; doing it, as it were, by a maxim he has"[58].

[57]Boyle to Schott, undated draft, in Boyle, *Works*, VI: 62-3.
[58]Southwell to Boyle, n.p., 30 March 1661, in Boyle, *Works*, VI: 297-300.

Francesco Lana Terzi: A dysfunctional Jesuit academician

On the 9th May 1668 Francesco Lana Terzi wrote a letter from Brescia which he addressed to the "*Nobil[issi]mi et Ingegnosiss[i]mi Sig[no]ri P[ad]roni Cel[siss]imi*" of the Accademia del Cimento in Florence[59]. Lana's letter responded to the invitation published in the *Proemio* of the *Saggi di naturali esperienze* published in Florence the previous year:

> Thus, to complete such a noble and joyous enterprise, the only thing that would be necessary would be a free communication between the different assemblies that are now dispersed in the most illustrious and important regions of Europe. Sharing the same objective of attaining such significant goals, by opening themselves to such a profitable commerce these [assemblies] would then search and participate in the truth together, as much as is possible.[60]

Lana's letter congratulates the learned Academicians on the most accurate experiments reported in the *Saggi di Naturali Esperienze,* and informs them that he too is about to publish a similar work, a collection of experiments carried out by him in his own "academy".[61] The remainder of the letter reports Lana's experimental investigations on the pendulum in great detail, suggesting a possible method of exploring the parallel between magnetic attraction and gravity, while praising Galileo's investigation of falling bodies.[62] He was unable to pursue his research for the want of a sufficiently powerful lodestone.[63]

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[59]Francesco Lana Terzi to the Accademici del Cimento, Brescia 9 May 1668, BNCF Ms. Gal. 284 ff.11r-13r.

[60]"Anzi per dare il suo pieno a così nobile e giovevole intraprendimento, niun'altra cosa vi vorrebbe, che una libera communicazione di diverse adunanze sparse, come oggi sono, per le più illustri e più cospicue regioni d'Europa; le quali con l'istessa mira di giugnere a fini si relevanti, aprendosi a vicenda un si profittevol commercio, andassero l'una l'altra colla medesima libertà ricercando per quanto si può, e partecipandosi il vero",*Saggi di naturali esperienze fatte nell'Accademia del Cimento sotto la protezione del serenissimo Principe Leopoldo di Toscana e descritte dal segretario di essa Accademia*. Florence: Giusseppe Cocchini all'insegna della Stella; 1667, *Proemio*.

[61]"Havendo perciò io fatto qualche studio in esse con l'occasione di un'accademia da me promossa in questa mia patria, reputomi fortunatissimo l'adito che mi porgono di poterli communicare alcuna cosa per mero desiderio di poter discerner meglio la verità con il lume più vivo delle loro accurate esperienze", Lana to the *Accademici del Cimento*, cit., f. 11r.

[62]"Un altro esperienza ho io fatta a fine di conoscere se la gravità sia una qualità intrinseca, o pure solo estrinseca, cioè a dire un' attratione magnetica della terra, overo contro di essa, con la quale stimo di rendere legitima ragione della velocità accelerata nello scendere delle cose al suo centro con quella mirabile proportione avvertita dall'ingegnosissimo loro Galileo"

On the surface, this letter would appear to constitute an exemplary case of the altruistic epistolary exchange of scientific knowledge. It suggests a desire to share the fruits of experimental labours, and to establish selfless diplomatic relations between two communities of devoted natural investigators: Lana's academy in Brescia and the famous academy of Prince Leopold in Florence. Lana's lack of a strong magnet suggests a disparity in financial resources between the two academies, but nonetheless the letter propagates the impression of two thriving groups of scientific practitioners, continually devising new ways of investigating natural processes.

Things are not as they seem, however. When Lana sent his letter, the Accademia del Cimento had been almost completely inactive for over six years.[64] Moreover, by 1668, the original members of the academy were dispersed throughout the peninsula. Prince Leopold was in Rome, after having been created a Cardinal on 12 December 1667. Giovanni Alfonso Borelli was in Messina, Rinaldini was in Padua and Uliva was in Rome, subsequently to be imprisoned and tortured by the Inquisition and to hurl himself to his death from a window of the Palace of the Holy Office[65]. The only academician who seems to have been left in Florence was Vincenzo Viviani. In view of this, it is somewhat ironic that Lana's letter seems to be the only letter ever written to the Accademia del Cimento as an institution.

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ibid., f. 12v. Galileo was still a highly controversial figure amongst the Jesuits after the condemnation of 1633. In 1637 a book by the Sicilian Jesuit Vincenzo Fassari (1599-1663) was rejected by Pietro Salerno, Revisor generalis, "quod carpatur Galileus expresso nomine" ARSI Fondo Gesuitico 661 f. 338r. In the scientific relations between Jesuits and the Grand Duchy of Tuscany after Galileo's death, however, highly favourable citations of Galileo are often found despite the official position of the order.

[63]"Quest'ultime esperienze non ho potuto fare per mancamento di calamita efficacia" ibid., f.12v

[64]See Paolo Galluzzi, *L'Accademia del Cimento: "Gusti del Principe, filosofia e ideologia dell' esperimento.* Quaderni Storici. 1981; 48: pp.788-845, and Mario Biagioli, *Scientific revolution, social bricolage and etiquette* in R. S. Porter and M. Teich (eds.), *The scientific revolution in national context*. Cambridge: Cambridge University Press; 1992, pp. 11-54.

[65]See W. E. Knowles Middleton, *The experimenters: A study of the Accademia del Cimento*. Baltimore: The Johns Hopkins Press; 1971 and, for Oliva, Ugo Baldini, *Un libertino accademico del Cimento : Antonio Oliva* Florence: Olschki, 1977.

This invitation from the Accademia del Cimento, as we have seen, was clearly more closely related to the desire to propagate an image of harmonious scientific activity than to any real prospect of collaboration. The empty rhetoric of community on the part of the Cimento suggests that we should examine Lana's own talk of his "academy" more closely. It may yet turn out that rather than a gesture of solidarity between social embodiments of the new scientific order, his letter was a communication between two non-existent entities, a peculiar by-product of the compelling rhetoric of scientific sociability.

By 1668 Lana had been teaching in the Jesuit college in his native town of Brescia for almost four years.[66] His early studies had been carried out in the Collegio Romano[67] where he had met Athanasius Kircher[68], no longer teaching at the college, but busy organizing the museum founded to contain the collection bequeathed by Alfonso Donnini in 1651.[69] During Lana Terzi's stay in the Collegio Romano, Kircher was composing his monumental treatise on Egypt, the *Oedipus Aegyptiacus* [70], following the publication of his musical encyclopedia, the *Musurgia Universalis*[71].

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[66]See ARSI Ven. 73b f.6, ARSI Ital. 15 ff.33-34, ARSI Ven. 73b ff.71, 120, 202

[67]Lana studied rhetoric in the Collegio Romano in 1650 (ARSI Rom. 81 f.8), before commencing the philosophy course in 1651, studying logic (ARSI Rom. 81 f. 37) and moving on to physics in 1652 (ARSI Rom. 81 f.68) and metaphysics in 1653 (ARSI Rom. 81 f.91).

[68]To judge from the lack of letters between Lana Terzi and Kircher after the former's departure from Rome, the relationship between them is unlikely to have been particularly close, unlike the intimate alliance formed between Kircher and Schott.

[69] On the museum, see Maristella Casciato, Maria Grazia Ianniello, Maria Vitale (eds.) *Enciclopedismo in Roma barocca: Athanasius Kircher e il museo del Collegio Romano tra Wunderkammer e museo scientifico*. Venice: Marsilio; 1986. For the documents concerning the foundation, see APUG 35-VII-(c) and ARSI Rom. 138, ff. 172-189

[70]*Oedipus Aegyptiacus hoc est universalis hieroglyphicae veterum doctrinae temporum iniuria abolitae instauratio*. Rome: Vitalis Mascardi, 1652-4. 3 tom., 4 vols. On this work see Joscelyn Godwin, *Athanasius Kircher and the Occult*, in John Fletcher (ed.), *Athanasius Kircher und seine Beziehungen zum gelehrten Europa seiner Zeit*. Wiesbaden: Harrassowitz; 1988: pp. 17-36.

[71]*Musurgia Universalis sive ars magna consoni et dissoni in X libros digesta*, Rome: Francesco Corbelleti, 1650. On this work see Eberhard Knobloch, *Musurgia Universalis: Unknown combinatorial Studies in the age of baroque Absolutism*. History of Science. 1979; 27: pp.258-275 and, especially, Ulf Scharlau, *Athanasius Kircher, 1601-1680, als Musikschriftsteller. Ein Beitrag zur Musikanschauung des Barock*. Marburg: Studien zur hessischen Musikgeschichte; 1969.

The *Museum Kircherianum* rapidly became a space for the demonstration of perpetual motion machines[72] and microcosmic representations of the natural and political orders of the world inhabited by Kircher[73]. Additionally, this space, between a Wunderkammer and an experimental laboratory, allowed the group of natural investigators surrounding Kircher (including Gaspar Schott[74], Gioseffo Petrucci[75] and Giorgio de' Sepi[76]) to carry out experiments together and construct elaborate machines. Before the creation of the museum, such activities were carried out in the *Ergasterium* of Kircher's bedroom.[77]

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[72]For an interpretation of the cultural role of perpetual motion machines in Habsburg Europe, see Simon Schaffer, *The show that never ends: perpetual motion in the early eighteenth century.* British Journal of the History of Science. 1995; 28: 157-189.

[73]See Adalgisa Lugli, *Inquiry as collection: The Athanasius Kircher Museum in Rome.* RES. 1986; 12: 109-124 and Paula Findlen, *Scientific Spectacle in Baroque Rome: Athanasius Kircher and the Roman College Museum.* Roma Moderna e Contemporanea. 1995; 3: 625-665.

[74]On Schott see ARSI Rom. 81, f.64v, 88v, 114v "P. Gaspar Sciot, socius P. Athanasii", and Schott, *Mechanica hydraulico-pneumatica*, cit., *Ad lectorem* , p. 3: "Scribendi occasio haec fuit. Est in supradicti Doctissimi Auctoris Museo sane celeberrimo, frequentatissimoque (quod brevi typis evulgabimus) non exigua Hydraulicarum ac Pneumaticarum Machinarum copia, quas summa [p. 4] animi voluptate spectant atque mirantur ij, quae ex omnibus Urbis & Orbis partibus ad ipsum visendum accurrunt Viri Principes ac Litterati, avideque scire desiderant, & Machinarum constructarum rationes, & machinalium motionum causas". Schott later edited editions of Kircher's *Itinerarium exstaticum* and *Magnes*, and corresponded extensively from Palermo, Würzburg and Mainz between 1650 and 1664 (APUG 561 ff. 37r-v, 40r-v, 275r-276v, 277r-v, 278r-v, 280r-v, 281r-282v, 283r-v, 284r-v, 285r-v, 287r-v, 288r-v, 289r-v, 291r-v, 293r-294v, APUG 562, f. 110r-v, APUG 563 f. 157r-v, APUG 567 ff. 45r-v, 46r-v, 47r-48v, 49r-v, 50r-v, 51r-v, 52r-v).

[75]Gioseffo Petrucci translated Kircher's treatise on the comet of 1664 (*Fisiologia nuova della natura delle comete*, Rome: Varese 1665) into Italian, and Kircher used his name as a pseudonym to avoid trouble with the *Revisores*. Writing to Duke August of Braunschweig-Lüneburg, Kircher describes Petrucci as "un[um] ex privatis meis Auditoribus". In a letter to Stanislas Lubienietzki, Kircher added that Petrucci was "subtilis ingenii iuvenem meum privatum Academicum". See Kircher to Duke August, Rome, 27 March 1665, HAB BA n. 363, and Kircher to anon., undated draft, APUG 563 f. 76r.

[76]Sepi was Kircher's machine-operator and the editor/author of his first museum catalogue (G. de Sepi, *Romanii Collegii Musaeum Celeberrimum cuius magnae antiquariae rei*, Amsterdam: Ex Officina Janssonio-Waesbergiana; 1678). His relations with Kircher are difficult to trace elsewhere, but he is mentioned in letters sent to Kircher by the Oratorian Francesco Gizzio (e.g. Gizzio to Kircher, Naples, 27 October 1668, APUG ff. 156r-v, Gizzio to Kircher, Naples, 24 December 1672, APUG 565 ff. 174r-v, Gizzio to Kircher, Naples, 23 December 1673, APUG 565 ff. 121r-v).

[77] The English diarist, John Evelyn, visited Kircher in 1644, before the foundation of the museum, and reports that "Father Kercherus [...] shew'd us many singular courtesies [...] with Dutch patience shew'd us his perpetual motions [...] and a thousand other crotchets and devises", E.S. de Beer (ed.), *The diary of John Evelyn*, Oxford 1955, II, p. 230. On the *Ergasterium* [workshop] in Kircher's *cubiculum*, see G. de Sepi, *Romanii Collegii Musaeum,* cit., p. 60.

Together, the works of these three Jesuits, Kircher, Schott and Lana Terzi, present immense problems of interpretation. They display an eclecticism and even an incoherence that lead to them often being bracketed together under the umbrella-term of "Baroque", serving more as a convenient anti-definition than as a key to the "mentality" of this triumvirate of Jesuit experimenters. There are many similarities in form and content between the works of Kircher and those of his disciples: both Lana and Schott shared Kircher's passion for secret writing or steganography, both were extremely interested in the experimental investigation of hydrostatics instigated by the 1644 Torricellian experiment, and both frequently adopted the literary genre of the book of secrets, traditionally more closely associated with medicine and alchemy than with natural philosophy, which was still largely presented in Jesuit circles in the form of commentaries to Aristotle's *Physics*.

However, rather than regarding the internal structure of the works of Lana Terzi as the expression of some nebulous "Baroque mentality", I wish to consider the contradictory aspects of the works as the consequences of a clash of conflicting cultural agendas. All three authors were members of the Society of Jesus, as already mentioned. Additionally, all three courted the patronage of the pre-eminent members of the Habsburg dynasty, and played significant roles in the Jesuit domination of Imperial scientific culture between the reigns of Ferdinand III and Leopold I. In the case of Lana, I wish to suggest that the attempt to reconcile the interests of Leopold I with the cultural programme of the Jesuits shaped both the content and form of his work. Additionally, the image of community labour propagated by Lana was itself carefully positioned in the nexus of patronage in which he found himself. Such a sceptical approach to Lana's talk of his "academy" may seem unjustified. After all, his *Prodromo overo saggio di alcuni inventioni nuove premesso all'arte Maestra*, published in 1670 apparently fulfilled his promise to publish its collective experimental investigations. Suspending our scepticism regarding the existence of his academy, we might hope to find important clues as to the range of its activities within the pages of this lavishly illustrated work.

The content of Lana's book, put forward as a taste of things to come in the *Magisterium*, describes processes of alchemical transmutation, perpetual motion machines, ciphers, thermoscopes, techniques for painting, engraving and drawing, and Lana's famous airship. I wish to suggest that the eclectic contents of this book were largely dictated by the demands of Habsburg patronage, and that the literary form chosen provided a way of reconciling the increasingly strict practises of doctrinal censorship within the order with Lana's desire to impress his patron with exotic novelties.

Lana's work was dedicated to the Emperor, Leopold I. The dedication is a masterpiece in courtly rhetoric: "The book is vile, the gift is nothing, but it is proper for the Sun to raise vapours from the vileness of mud with its heat and to make nothingness come forward from the shadows with its splendours".[78] Despite this apparent humility, some of the claims made in the work are highly audacious to say the least, leading Henry Oldenburg, Secretary of the Royal Society to write to his interlocutor in Italy, John Dodington that

> I wish only yt ye Authour would be sparing in the publication of such Arguments, as seem to be above ye reach of human contrivance, as sayling through ye Air, ye perpetual motion, the Philosopher's stone, and ye like; such undertakings being rather like to prove a disadvantage to his writings and credit, yn otherwise.[79]

Dodington replied that "His discourses on the perpetual Motion & Philosophers stone, are modest & not so vaynglorious as you imagine, when you have read it you will say so"[80], but did not succeed in convincing the secretary of the Royal Society, who inquired further about the credibility of the Jesuit from Brescia. Marcello Malpighi,

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[78]"Il libro è vile, il dono, è niente, ma è proprio del Sole con il suo calore sollevare i vapori dalla viltà del fango, e colli suoi splendori far comparire il niente dell'ombre", Francesco Lana Terzi, *Prodromo overo saggio di alcuni inventioni nuove premesso all'arte Maestra Opera*, Brescia: Rizzardi; 1670, dedication to Leopold I (the dedication is absent from Battistini's edition of the *Prodromo*).
[79]Oldenburg to John Dodington, London, 2 December 1670, OC VII pp. 334-5.
[80]Dodington to Oldenburg, Venice; 13 January 1670/1, OC VII p. 381-3.

whom Oldenburg canvassed for an opinion on Lana in 1671, responded that "I do not know Fr. Lana of the Society of Jesus, but I gather from his servants [*domesticis*] that he does not possess the acumen of mind necessary to complete those things that he announces in the *Prodromo*".[81]

As Oldenburg and Dodington suggest, many of the claims of the *Prodromo* concerned alchemy. Lana insists on the possibility of the alchemical transmutation of metals, and proceeds to describe the means of producing the philosopher's stone. He suggests that he has seen all the experiments that he reports "with [his] own eyes", and that he thus cannot doubt the possibility of transmutation.[82] To understand Lana's position on alchemy, it is necessary to look at his immediate intellectual context.

Under the Emperor Ferdinand III (1637-1657), the Habsburg court in Vienna was characterised by a veritable obsession with alchemy. Ferdinand corresponded daily with Archduke Leopold Wilhelm, Kircher's patron, to describe various new alchemical recipes. Affairs of state were frequently brushed aside with the words "*Iam ad chymica*"[83]. After the death of Ferdinand III in 1657 Leopold Wilhelm carried on his investigations alone until he too died, in 1662. At this point there was a temporary lull in Habsburg interest in alchemy. The young emperor, Leopold I, was more interested in theological matters, and trained for the priesthood. It was in this context, in 1665, that Athanasius Kircher dedicated to Leopold the second volume of his *Mundus Subterraneus,* which conained a caustic attack agains false alchemists[84]. Rather than

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[81]"Patrem Lanam e Societate Jesu non novi; Audio tamen ab eiusdem domesticis, ipsum non tanta iudicij acie pollere, quante forte exigitur pro complendis iis, quae in Prodromo iactantur" Malpighi to Oldenburg, Bologna; 31 January 1670/1; OC VII pp. 429-439

[82]Lana Terzi,*Prodromo* , edn. cit., p. 196: "Questa ed altre simili sperienze ho provate e vedute con gli occhi miei, onde non mi rimane alcun dubbio intorno alla possibilità della trasmutazione de' metalli".

[83]See R. J. W. Evans, *The Making of the Habsburg Monarchy: An Interpretation*. Oxford: Clarendon Press; 1979, p. 364.

[84]Athanasius Kircher, *Mundus Subterraneus, in XII libros digestus; quo divinum subterrestris mundi opificium, mira ergasteriorum naturae in eo distributio...*, Amsterdam: Janssonium et Weyerstraten, 1664-5.Vol. II liber 11 pp. 231-325. On this work, see Lynn Thorndike, *A History of Magic and Experimental science*. New York: Columbia University Press; 1958 Vol. VII pp. 567-589

condemning alchemical practices in general, Kircher provided a table to allow the prince to distinguish the good alchemist from the bad, while continuing to deny the possibility of producing real gold by alchemical means. This table arguably constituted something of a pocket guide for the young Leopold, who otherwise risked falling prey to alchemical charlatans. According to Kircher, "For his work the pseudo-alchimist requires gold, silver, copper, iron, tin, lead and mercury. True alchemists affirm that none of the common metals (common gold, silver, iron, copper, tin, lead or mercury) enter into the secret of the confection of the [philosopher's] Stone"[85] Moreover, "false alchemists claim that the gold that they produce is true gold", while "true alchemists [say] that it is not true gold, but similar and analagous to gold".[86] "False alchemists", Kircher continues, "speak materially of alchemical gold. True [alchemists] speak of it in a mystical and allegorical manner, and state that it is nothing other than an igneous power [*vis*] or a natural fire diffused through all of the parts of the world".[87] True alchemy was thus mystical alchemy, permitting a deepened understanding of the mysteries of the universe, and was not driven by the thirst for gold, in Kircher's presentation.[88]

Anticipating the attacks of alchemists furious about the decommercialisation of their work, Kircher submits his reputation as an experimenter to the reader.[89] Using a play on words he associates his intellectual credibility to his allegiance to the Viennese court:

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[85]"Pseudo-Alchymistae ad opus suum requirunt aurum, argentum, cuprum, ferrum, stannum, plumbum, mercurium. Veri Alchymistae ajunt, nullum ex vulgaribus metallis ingredi arcanam lapidis confectionem, non aurum, argentum, non ferrum, non cuprum, stannum, plumbum, aut mercurium vulgi", Kircher, *Mundus Subterraneus* (cit.) Vol. II pp. 318-9

[86]"Falsi Alchymistae aurum, quod faciunt, verum aurum dicunt. Veri Alchymistae id non verum aurum esse, sed simile, & analogum auro vero esse" ibid., loc. cit.

[87]"Falsi Alchymistae de auro Alchymico loquuntur materialiter. Veri de eo loquuntur mystice, & allegorice, neque quicquam alliud esse dicunt, quam vim quandam igneam, sive ignem Naturae per universi Mundi semitas diffusum", ibid.

[88]For a contrasting interpretation of Kircher's position, see Martha Baldwin, *Alchemy in the Society of Jesus*. Z.R.W.M. von Martels (ed.), *Alchemy revisited: Proceedings of the International conference on the history of alchemy at the University of Groningen*; 1989 Apr 17; Groningen. Leiden: Brill; 1990: pp. 182-187.

[89]"[M]eam in empyrica philosophia existimationem Orbi Literario ex operibus qualiacunque tandem ex ingenii mei imbecillitate hucusque prodierunt, decidendam committo", Kircher, *Mundus subterraneus*, loc. cit.

"Germanus sum et germano pectore veritatem profiteor"[90]. Leopold could appreciate the scientific qualifications of Kircher - the Emperor's personal library contained 13 books by the Jesuit savant. However, despite Kircher's advice it wasn't long before he was taken with the alchemical bug, and acquired his own "semi-official alchemical counsellor", Johann Joachim Becher, a recent convert from Calvinism.[91] Becher's *Physica Subterranea*, published in 1669 just before his arrival at the Leopoldine court, viewed Kircher's position as representive of the official position of the Society, stating that Kircher was prevented from alchemical experimentation "*ob Ordinis suis conditiones*"[92] Shortly afterwards, Becher wrote directly to Leopold to offer his services as counsellor, suggesting that without him the emperor might easily be deceived by fraudulent alchemists.[93] Becher's high standing with Leopold, thus gravely threatened the niche created by Kircher for the Jesuits as imperial investigators of the esoteric.[94] The anti-institutional pedagogical method expounded by Becher in his *Methodus Didactica*[95] was also directly opposed to the educational activities of the Jesuits in the Empire.

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[90] " I am sincere [German] and I profess the truth with a sincere heart", ibid. II p. 320[b].

[91]On Becher see Pamela Smith, *The business of alchemy: Science and Culture in the Holy Roman Empire*. Princeton: Princeton University Press; 1994. Becher's opportune conversion can easily be related to his courtly aspirations. In any case, he was bold enough to include a lauditory comparison between Luther and Paracelsus in his *Physica Subterranea*: "His necdum tamen quidem contenti, ad alias speculationes confugerunt, praesertim ab illo tempore, quo Paracelsus innotescer einceperat, post quem valde ferax seculum Chymicorum fuit, sicut post Coetaneum suum Lutherum magna Theologorum copia pullulavit" Johann Joachim Becher, *Actorum laboratorii Chymici Monacensis, seu Physica subterranea..*, Francofurti, Zunneri; 1669, p. 121

[92]Becher, *Actorum laboratorii Chymici Monacensis* (cit.),p. [x] [Decication]:."Iliada quidem post Homerum scribere videor, qui post Maximi Viri R.P. Kircherum Mundum subterraneum haec scribo, possemque suspicionem incurrere, quod nonnulla ab eo mutuaverim, quod non factum esse ipsa res docet, aliam enim viam et methodum sequutus sum, nempe *praxin*, quâ R.P. Kircherum carere, ob Ordinis suis conditiones, necesse, & cujque deflectu saepius impingi consequens est" In a later edition of his *Physica,* Becher elaborated that *"regula Societatis Alchymiam prohibet*" See Evans, op. cit., p. 378 note 83.

[93]See Smith, op. cit., p. 78

[94]The question of the rivalry between the Jesuits and other members of the cultural entourage of the courts of Ferdinand III and Leopold I merits further analysis. An important source for such a study would constitute in the numerous letters from Leopold's Jesuit confessors to Kircher, conserved in the archives of the Gregorian University in Rome.

[95]Johann Joachim Becher, *Methodus didactica*, Munich: Maria Magdalena Schellen, 1668. See Smith, op. cit., pp. 80-92.

From this point of view, Lana's revival of Jesuit alchemy, published the year after Becher's *Physica Subterranea*, can be read as an answer to Becher, and a play for the Imperial patronage of Jesuit alchemical investigations.[96] As a recent historian has said about Johann Zwelfer, another of Kircher's opponents, "Zwelfer may have erred monstrously in fact when he asserted that many great monasteries grew through donations made possible by the philosophers' stone, but his words may be true in a transferred, symbolic sense which he could hardly have apprehended"[97]. Lana, then, wished to present Jesuit colleges as sites of communal alchemical endeavour, and refute Becher's dangerous suggestion that the strict rule of the Society prevented the search for the philosopher's stone. He aims to demonstrate the possibility of transmutation with a series of arguments of varying force:

> The third argument in favour of the possibility of transmutation can be the consideration that many animals, even those that are perfect, are born of inanimate things, such as bees from cow-dung, snakes from hair, and others, as we will see below. Thus, to argue *a fortiori*, it apears that if bees can be formed from a substance very different from their own, such as the dung of cattle or bulls, it is all the more easy for gold to be formed from iron or copper, from which it is less dissimilar. [98]

The social model of the alchemical laboratory is not identical to that of the scientific academy, as can be seen from a description of an alchemical transmutation sent by Lana Terzi to Leibniz shortly before the publication of his *Prodromo*:

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[96] In 1592, the influential Jesuit natural philosopher Benito Pereira had denied that the transmutation of metals could be demonstrated to be impossible, while warning his readers of the dangers of the errors of alchemists (Pereira, *Adversus fallaces & superstitiosas artes, id est, De magia, de observatione somniorum, et de divinatione astrologica. Libri tres.*. Venice: Apud Ioan. Baptistam Ciottum, Senensem; 1592). In his public thesis-defence, *De Universa philosophia a Marchione Sfortia Pallavicino Publice asserta in Collegio Romano Societ. Iesu libri tres ad Urbanum VIII P.M.* Romae; 1625, Sforza Pallavicino sustained the same position in the Collegio Romano: Thesis 379: "Credam & ego saltem ut probabile, factum iam, vel posse fieri verum aurum per artem chimicam: nullam enim video causam, propter quam, si non homo, saltem Angelus, non possit ad auri generationem applicare, quae debentur; fateor tamen hominibus hanc artem in hac vita difficilem adeo esse; ut tamquam fallax, & noxia merito a sacris Canonibus damnata sit".

[97] Evans,*op. cit.*, p. 380.

[98]"La terza ragione per prova della possibilità della tramutazione de' metalli può essere il considerare che molti animali anche perfetti si generano con l'arte da cose eziandio inanimate, come le api dal fimo bovino, i serpenti da' capelli e simili, come vedremo a suo luogo, poiché, argomentando *a fortiori,* pare che se le api si formano da una sostanza tanto dissomogliante da sé quanto è il fimo de' buovi o tori, molto più l'oro si potrà formare dal ferro o dal rame, a cui non è tanto dissomogliante", Lana, *Prodromo*, ed. Battistini, cit., p. 197.

> I have made the transmutation of tin into silver using some of my manipulators, and there are ocular witnesses who then made the same experiment with their own hands[99]

The distinction between the alchemist and his manipulators is a common topos of alchemical iconography. The *Ordinall of Alchemy* of the fifteenth century English alchemist, Thomas Norton, printed in the *Theatrum Chemicum Britannicum* of Elias Ashmole in 1652, depicts the author in his laboratory reflecting on the mysteries of transmutation while his *manipulatores* occupy themselves with the furnaces and stills. The anonymous witnesses mentioned by Lana, largely absent from the traditional iconography of alchemical practice, answer the new demands of scientific credibility of his period. The replication of the experiment by these witnesses tends towards the demystification of the body of the alchemist, and conforms to the importance Lana invests in the repetition of experiments in his *Prodromo*[100]. In his attach on false alchemists in the *Mundus Subterraneus*, Athanasius Kircher elaborates on the role of manipulators in the Jesuit context:

> I insist that I have always surrounded myself with experimental matters, not those that reeked of the smoke, dyes and coals of some kitchen or barbershop, but those that did not oppose honest labour. I have, however, by no means shirked the egceirhseiV [undertaking] of those most repulsive labours, but I took care, not without small expense, that these were done by German, Polish, French and Italian "Manipulators", as they are called, in my presence in the Ergasterium of the Collegio Romano, lavishly equipped with all of the apparatus necessary to carry out chemical experiments. Thus, I would certainly like to persuade you that I have reported nothing in this work of experiments that has not been established, either by myself or by those experienced Chemists in my presence. It has been up to me to order and to prescribe the method, and their duty to accomplish the investigations that were thus ordered and prescribed. In such a way it ill befits physicians to make mixtures of medicines, to open veins and to administer enemas; so they tend to command these tasks in part to pharmacists and in part to Surgeons, to whom it is fitting.

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[99]"Transmutationem ♃ in ☽ feci per quendam meum manipulatorem, et sunt hic testes oculati, qui deinde suis-met manibus illud idem fecerunt experimentum", Lana Terzi to Gottfried Wilhelm Leibniz, Brescia; Summer 1671, in G.W. Leibniz, *Philosophischer Briefwechsel herausgeben von der Akademie der Wissenschaften der DDR*, Erster Band, 1663-1685. Akademie-Verlag Berlin, 1987. pp. 141-142

[100]"[S]i deve avvertire di non fondare mai alcun principio sopra isperienze che non siano certe, e provate; procurando di stabilire la verità non sopra una sola, ma sopra molte isperienze se sia possibile; Et osservando se il principio, e verità stabilita si confaccia ad altre simili esperienze; poiche all'hora si dovera stimare infallibile un principio, quando coerentemente a quello caminano tutte le altre cose della medesima, o simile materia", Lana Terzi, *Prodromo*, cit., p. 12.

> Similarly, an Architect does not prepare lime and cement, and polish rocks, but, in his instructions, entrusts the quarriers and builders to act together according to his plan.[101]

The *Ergasterium*[102] described by Kircher was, in reality, the pharmacy (or *Spezieria*) of the Collegio Romano, mentioned above. Lana's reference to his *manipulatores* in his letter to Leibniz appears to suggest a strategy to exploit similar resources in Brescia to accomplish his experiments, and reveals another sense of the form of sociability hidden behind his use of the word "academy".

Although the letter of dedication of his work to Emperor Leopold I admitted that people would only be able to fly all over the world "when held up by the great wings of that eagle that rules the universe"[103], alluding to the Habsburg eagle, the book described a procedure for making an airship (fig. 21) by means of evacuated copper spheres attached to a conventional sailing vessel. "While I describe this thing I laugh to myself", Lana wrote, " as it seems a fable no less incredible and strange than those that come from the deliberately mad fantasy of the most witty head of Lucian"[104]. The spheres were to be evacuated using water, according to the technique developed by Gasparo Berti in the early 1640s, already rather dated by 1670, since the development of von Guericke's *Antlia pneumatica* and the Boylean air-pump. Given the fact that an

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[101]"Ego experimenta rerum unice semper me ambisse fateor, ea tamen, quae fumos, lutum, carbones, quaeque culinam, tonstrinamque non olerent, verum quae honesto labore non adversarentur, illas tamen vilissimi laboris □□□□□□□□□ nequaquam repudiandas duxi, sed eas non sine exiguis expensis a Manipulatoribus, ut vocant, me praesente in Collegii Romani Ergasterio, rebus omnibus ad Chymica experimenta perficienda necessariis instructissimo, conductis in hunc finem, uti paulo ante dixi, Manipulatoribus Germanis, Polonis, Gallis, Italis, fieri, curavi, adeoque certo tibi persuadeas velim, nil in hoc opere experimentorum adferri, quod partim per memet, partim per dictos laborum peritos Chymicos in mea praesentia, non comprobatum sit. Meum erat jubere, modum praescribere; illorum, jussa praescriptaqie executioni mandare, quemadmodum medicos dedecet compositiones medicamentorum facere, venam aperire, clysteres inferre; sed id partim pharmacopoeis, partim Chirurgis, quorum id proprium est, commendare assolent. Architectus calcem, & caementum non praeparat, saxa non expolit, sed in sua praescriptione Latomis, & murariis juxta prototypon coagmentanda committit", Kircher, *Mundus Subterraneus*, Amsterdam: Jansson van Waesberghe, 1665, Vol. 2 pp. 320b-321a

[102]On spatio-political models of the laboratory in the seventeenth century, see especially Owen Hannaway, *Laboratory Design and the aim of science: Andreas Libavius versus Tycho Brahe.* Isis. 1986; 77: 585-610.

[103]"[A]ll'hora solo potranno volare per tutto il mondo, quando saranno sostenuti dalle grand'alo di quell'Aquila, che impera nell'Universo", Lana Terzi, *Prodromo*, cit., sig. A verso.

[104]"Ma mentre riferisco questa cosa rido trà me stesso parendomi che sia una favola non meno incredibile, e strana di quelle, che uscirono dalla voluntariamente pazza fantasia del lepidissimo capo di Luciano..."Lana Terzi, *Prodromo*, cit., p. 55.

evacuated glass globe was lighter than a non-evacuated globe, it followed that the air in a sufficiently large copper globe might be heavier than the copper making up the globe, producing an upward thrust on evacuation, and allowing human passengers to be raised into the air, "who could use the sails and oars at will to go extremely quickly to any point, even above the highest mountains".[105] Lana additionally emphasized on two occasions that he did not want to be drawn into a discussion about whether or not the copper globes were truly empty[106], recalling the vacuum debate of the 1640s and 50s, which still held its grip on Jesuit natural philosophy. The people to whom Lana described his invention immediately asked to see a demonstration in the form of a single airborne globe. Lana would have happily satisfied them, he claimed, "if the religious poverty that I profess had allowed me to spend around a hundred ducats".[107]

Although no physical difficulty seemed to obstruct the construction of Lana's flying-boat, a moral problem, in addition to his financial shortcomings, seemed insurmountable to the Jesuit technician:

> [T]his is that God will never allow such a machine to be realized in practice, to prevent the many consequences that would disturb the civil and political government amongst men. For who does not see that no city would be safe from surprises, as the ship could be brought at any moment above the town squares, and deposit its passengers on landing. The same would happen for the courtyards of private houses, and for boats on the sea. The ship, by descending from high in the air to the level of the sails of the boat, could break its masts; and, even without going any lower, could break vessels, kill men and set boats on fire with fireworks, cannonballs and bombs.[108]

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[105]"[C]osì la barca si solleverà sopra l'aria, e portera seco molti huomini piu, o meno conforme la grandezza delle palle; i quali potranno servirsi delle vele, e de remi a suo piacere per andare velocissimamente in ogni luogho sino sopra alle montagne più alte", Lana Terzi, *Prodromo*, cit., p. 57.

[106]Lana, *Prodromo*, cit., pp. 54, 59.

[107]"[H]anno solo desiderato di poter vedere la prova in una palla, che da se stessa salisse in aria; quale haverei fatta volontieri prima di publicare questa mia inventione, se la poverta religiosa che professo mi havesse permesso lo spendere un centinaio di ducati, che sarebbero d'avantaggio per sodisfare a si dilettevole curiosità", Lana, *Prodromo*, cit., p. 57.

[108]"Altre difficoltà non vedo che si possano oppore a questa inventione, toltane una, che a me sembra maggiore di tutte le altre, & è che Dio non sia per mai permettere, che una tale machina sia per riuscire nella prattica, per impedire molte conseguenze, che perturbarebbero il governo civile, e politico tra gl'huomini: Impercioche chi non vede, che niuna Città sarebbe sicura dalle sorprese, potendosi ad ogn'hora portar la nave a dirittura sopra la piazza di esse, e lasciatala calare a terra descendere la gente? l'istesso accaderebbe nelle corti delle case private; e nelle navi che scorrono il mare, anzi con solo descendere la nave dall'alteza dell'aria, sino alle vele della nave maritima potrebbe troncarle le funi; & anche senza descendere, con ferri, che dalla nave si gettassero a basso sconvolgere i vascelli, uccider gl'huomini, & incendiare le navi con fuochi artificiati, con palle, e bombe", Lana Terzi, *Prodromo*, p. 61.

Lana's native town of Brescia boasted a long tradition of production and traffic in fire-arms, and included the Austrian Habsburgs and the Holy See amongst its most prestigious clients. In 1669 the position of the Jesuits in Brescia was unstable, as in all of the territories governed by the Venitian republic after the interdict of 1606[109]. An attempt during this year to stage a theatrical pageant, *La Candia sospirante*, to lament the recent capture of the Venetian fortress of Candia (Iraklion) by the Ottomans was abandoned because of a fire in the Jesuit college, leading to rumours that the incident was provoked by the anger of the Holy Sacrament at being displaced for the performance in the college church.[110] The publication of Lana's *Prodromo*, thus, coincided with a moment of intense insecurity in the Venetian Republic and the flying boat, even presented in a facetious manner, was a possibility to be taken seriously both by the Venetian authorities who doubted the value of the Jesuit presence in their territories[111] and by the imperial eagle.

Unlike Lana Terzi, the Royal Society apparently had no moral qualms about constructing a working model of his flying-machine, and was unbound by religious vows. On 22 November 1673 Robert Hooke demonstrated an attempt to make a vessel that would float in the air according to Lana Terzi's method[112]. Hooke returned to the problem in 1679, producing a demonstration of the impossibility of Lana's flying boat, due to the necessity of increasing the thickness of the copper disproportionately for

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[109]On the interdict, see G. Cappelleti, *I Gesuiti e la Repubblica di Venezia. Documenti diplomatici relativi alla societa gesuitica raccolti per decreto del Senato, 14 giugno 1606*. Venice; 1873. Whereas other clerics were permitted to return to Venice in 1607, the Jesuits had to wait another fifty years before being readmitted.

[110]See P. Guerrini, *Cronache bresciane inedite*, II p. 166, which reports that the event appeared "come se si vendicasse il S[antissimo] S[acramento] d'haverlo sloggiato da esso per sole curiosità e leggierezza", cited in *Storia di Brescia promossa e diretta da G.T. degli Alfieri,*Brescia: Morcelliana; 1961. Vol. 3, p. 75 n. 5.

[111]On the history of the Jesuits in the Venetian territories see *I gesuiti e Venezia: momenti e problemi di storia veneziana della Compagniadi Gesù : atti del convegno di studi, Venezia, 2-5 ottobre 1990* ed. Mario Zanardi. Padova: Gregoriana libreria editrice; 1994.

[112]Birch III, p. 111.

larger globes to resist implosion[113], a conclusion that had also been reached by Leibniz, who had nonetheless cited Lana's attempt approvingly in his *Hypothesis Physica Nova*[114].

In private correspondence Leibniz chided Lana for his reluctance to establish general physical principles in his *Prodromo*. The Jesuit replied that

> until now I have determined no hypothesis, and I am entirely engrossed in attempting to lay hold of experiments in all types of natural matters, by which I could then establish some hypothesis not repugnant to them[115]

He continued

> Accordingly, before I have published the work which I promise in the Prodromo, or at least some of its parts, which I have already completed, I have shrunk before confirming some principle by means of experiments, from which others can be deduced.[116]

In 1677, Lana left Brescia for Ferrara, where he was was chosen to occupy the newly created chair in mathematics at the university. During this period he entered into intense correspondence with his fellow Jesuit Daniello Bartoli. To Bartoli, as to the Cimento, he continued to speak of experiments "that I demonstrated even today in my

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[113]Birch III, p. 489: 5 June 1679: "Mr. Hooke read a farther discourse of Padre Lana concerning flying, which he had translated; and added to it a discourse of the impossibility of that attempt by that means; and also shewed wherein the author had been greatly mistaken in the grounds and suppositions of his demonstration, viz. in supposing the same thickness of metal to be sufficient to resist the pressure of the air inward in a ball of twenty-four feet diameter as in a ball of one foot diameter: whereas on the constrary it is necessary to increase the weight of the shell more than according to the solidity or capacity of the ball".

[114]Gottfried Wilhelm Leibniz, *Hypothesis Physica Nova, qua Phaenomenorum naturae plerorumque caussae ab unico quodam Universali motu, in globo nostro supposito, neque Tychonicis, neque Copernicanis aspernando, repetuntur* (Mainz, 1671) in G.W. Leibniz, *Opera Omnia.* Dutens, L., ed. Hildesheim: Georg Olms Verlag; 1989; II: Part II pp. 3-34, on p. 13: "Si quid ergo arte humana parari queat aëre levius, spes est, perveniri ad artem volandi posse. Parabitur acutissimi Lanae, tum et Vossi sententia; si detur vas concavum tam grande, ut aër intus conclusus, continenti, seu vasi per se sumpto, praeponderet: Aere igitur noto iam artificio, exhausto, & hermetice sigillato vase, (pone vitrum esse) erit totum vas aëre aequalis spatii levius".

[115]Lana Terzi to Leibniz, n.p., Summer 1671, in G.W. Leibniz, *Philosophischer Briefwechsel herausgeben von der Akademie der Wissenschaften der DDR*, Erster Band, 1663-1685. Akademie-Verlag Berlin, 1987. pp. 141-142: ""Et quamuis nullam adhuc hypothesim determinauerim, totusque nunc sim in captandis experimentis in omni rerum naturalium genere, quibus deinde aliquam hypothesim stabilire possim, ijsdem non repugnantem; tua tamen mihi maximè arridet, cum per illam summa rerum capita facile explicentur".

[116]"Itaque antequam opus a me promissum in prodromo, in lucem edam, vel saltem aliquam eius partem, quam iam in promptu habeo, decrevi prius aliqua principia experimentis firmare, ex quibus caetera deducantur. Interim ne otiari videar libellam fortasse typis mandabo, in quo noua quaedem", ibid.

Academy"[117]. The experiments discussed in this correspondence concerned a wide range of topics, from sound propagation to anatomy. One of the letters sent to him by Bartoli is highly revealing of the difficulties experienced by Jesuits who wished to engage with the academic movement of the period. "While I was in the Collegio Romano", Bartoli wrote on 30 January 1677, "I wished to found an experimental academy to allow one to study these matters, but I was not permitted to do so and I realized that if we began to turn our eyes to modern things, our teachings would have no public and the pupils would abandon their master".[118]

Responding to this letter, Lana offered his experimental services to Bartoli, writing "if I can help you by conducting some experiment or anatomical observation, you have only to tell me". In exchange, he desired "some fine object for my Gallery, which is beginning to be not unattractive", in particular a pendulum clock, suggesting that he hoped to reproduce the Kircherian museum in Ferrara[119].

Following this exchange with Bartoli, Lana tried to establish a relationship with the Royal Society in London, previously dampened through the efforts of Malpighi. In the letter written directly to Oldenburg by Lana in 1677[120], Lana makes no reference to his "academy", choosing instead to present himself as an isolated investigator of the secrets

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[117]"I *Paradossi Idrostatici* del Boile meritano d'esser letti, e quella sua esperienza (che hoggi appunto ho fatto vedere nella mia Accademia) di far che un fluido v.g. l'argento vivo premuto da un altro piu leggero, scorra per una sifone, ancor che questo nella sua curvatura sia aperto, et habbia communicatione libera con l'aria, mostra evidentemente che non vi ha luogo il timore del vuoto", Lana Terzi to Bartoli, Ferrara, 10 March 1677, APUG 1358 ff.90r-91v , published in G. Boero, ed., *Lettere edite e inedite del Padre Daniello Bartoli D.C.D.G. e di uomini illustri scritte al medesimo*, Bologna: Alessandro Mareggiani; 1865 pp. 85-87.

[118]" Mentre io ero in Collegio Romano volli mettere in piedi un accademia di sperienze, e che ci si studiasse intorno, ma non mi potè venir fatto, e ben m'accorgeva, che se si comminciava ad aprir gli occhi intorno alle cose moderne le nostre ciancie non havrebbero spaccio e gli scolari abbandonerebbero il maestro", Daniello Bartoli to Francesco Lana-Terzi, Rome, 30 January 1677, ARSI EPP. NN. 96 f. 4r (copy)

[119] "Ma ella che mi darà in contracambio? altre ciancie? no: vorrei qualche bella cosa per la mia galleria, che comincia a non esser brutta. Averei bisogno (con pagarla però) di una mostra d'oriuolo col pendolo: non mi curo che sia bella nè di gran lavoro, anzi la vorrei grossolana e soda, ma buona e giusta [...] la supplico a favorirmi di trovarne un tale, ed avvisarmi del prezzo", Lana Terzi to Daniello Bartoli, Ferrara, 9 June 1677, APUG 1358 ff.75r-76v, published in Boero, op. cit., pp. 94-96

[120]Lana Terzi to Henry Oldenburg, Ferrara; 19 July 1677, OC XIII pp. 314-316

of nature. Declaring himself to be a faithful disciple of Bacon[121], Digby[122] and Boyle, Lana asks for information about the research of the English practitioners:

> [W]hat is my poor mind worth in the enormous treasure-house of literati if I do not first go from door to door to ask for alms from these same people?[123]

Lana's religious poverty is thus transformed into a metaphor for his spatial instability in the Republic of Letters. The peripatetic, or even mendicant, model of the commerce between savants proposed here by Lana, linked to both material poverty and intellectual modesty, is in stark contrast with the image he transmits to Bartoli of his academy as a site of production of natural knowledge. This image is further problematised when it becomes clear that Lana Terzi's career was running into crisis during his stay in Ferrara. His self-fashioning as a Jesuit philosopher of the curious could not have been less compatibile with a university position founded to give pupils a practical knowledge of water-management. Lana's departure from the university of Ferrara, precipitated by an unpleasant polemic with Marquis Tassoni, provoked a severe restatement of the tasks of the mathematics professor, forbidding precisely "the distraction of the attention of the students with more amusing subjects, which diminish their concentration on the Elements of Euclid and other less curious subjects".[124]

Lana was thus condemned to return to Brescia, where he was excluded from teaching charges and made a confessor. This position did not prevent him from continuing his textual production, as can be seen from the imposing volumes of his *Magisterium*

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[121]Although he avoids citing Bacon by name, the preface of Lana's *Prodromo* is very reminiscent of certain passages in Bacon's *Novum Organum* especially in Lana's caricature of the speculative philosopher as a spider, whose web might be easily destroyed by the smallest fly, i.e. an experiment. See Francis Bacon, *Novum Organum* (1620) I xcv. For a discussion of the preface to the *Prodromo* , also influenced by Bacon's *De augmentis scientiarum*, see Vasoli, *Sperimentalismo e tradizione* , cit.

[122]On Digby's natural philosophy, see B.J.T. Dobbs, *Studies in the natural philosophy of Sir Kenelm Digby*, Ambix, 18; 1971, pp. 1-25, 20; 1973, pp. 143-163, 21; 1974, pp. 1-28, as well as J. Henry, *Atomism and Eschatology: Catholicism and Natural Philosophy in the Interregnum.* British Journal for the History of Science. 1982; 15: pp. 211-239.

[123]"[Q]uid enim pauperes ingenij mei census in Amplissimum litteratorum aerarium confessi valeant, nisi prius sipem ostiatim (ut ita dicam) ab ijs ipsis emenditaverim", Lana Terzi to Henry Oldenburg, Ferrara; 19 July 1677, cit.

[124]Archivio Universitario di Ferrara. 247. Car. E., N. 45, cit. in Marcella Mantovani, *Una Lezione a Ferrara con Francesco Lana Terzi; S.I.* in Clelia Pighetti, ed., *Immagini del '600 Bresciano.* cit., pp. 23-30.

Naturae et Artis[125]. Nonetheless it is clear that he continued to encounter difficulties in his project to create a social space for experimentation in the Jesuit context. In the letter to the reader of the first volume (1684) of his *Magisterium*, he complains bitterly of the

> lack of the companions who are often necessary when one conducts experiments, the impossibility for a man constrained to religious poverty to spend the immense quantity of money necessary, and, finally, of the enormous amount of time that [I must] spend pursuing the habitual tasks of [my] Order[126]

The difficulty in reconciling the institutional constraints of his order with his desire to participate in experimental research is evident from this remark, and once again the reference to religious poverty may be read both as revealing of an unfortunate obstacle to Jesuit engagement with the experimental life of the late seventeenth century and, perhaps, as a bid for further Imperial donations to the Jesuits.

In 1686, during the last year of his life, Lana Terzi attempted once again to found an academy, the *Academia Philexoticorum Naturae et Artis*[127]. The "acts" of this academy[128], which ceased to exist two days after Lana's death, do not suggest a space devoted to collectal experimental production. From this work alone, it is not possible to demonstrate the participation of more than one other person besides Lana Terzi himself in the meetings of the academy -- the physician Bernardino Boni. The "acts" are, for the most part, either letters received by Lana from distant savants or local anecdotes of a medical nature. The anonymity of many of the pieces published, often dedicated to alchemical transmutation or the construction of military machines, is plausibly a mask for Lana's own writings.[129] In a letter to Francesco Carli of 10 November 1686, Lana

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[125]Francesco Lana Terzi, *Magisterium naturae et artis, opus physico-mathematicum*. Brescia: Io. Maria Ricciardi; 1684-92 (3 vols.).

[126]"Caeterum veniam facile me impetraturum speraverim, si perpendas operus, quod ausu fortasse temerario aggressus sum, immensitatem; socij in sumendis experimentis saepè necessarij defectum; immodici sumptus in viro religiosa paupertate obstricto incapacitatem; temporis demum in consuetis nostro Ordini oneribus obeundis non levem occupationem" ibid. Tom. I pp. [4]-[5].

[127]See Michele Maylender, *Storia delle Accademie d'Italia*, Vol. II, pp. 415-418.

[128]*Acta novae Academiae Philaexoticorum Naturae et Artis.* Brescia: Jo. Maria Ricciardi; 1687 [copy consulted: Biblioteca Nazionale Braidense, Milan : SS.8. 10].

[129]E.g. p. 114: "Amantissimus Noster (cuius nomen ab ipso iussi, sub silentio praeterimus) ", p.161 "Pulvis fulminans non vulgaris efficaci ad usus bellicos aptandus Anonymi Nostri Academici", p. 170, "Transmutationis Metallica effectus Anonijmi nostri Academici".

gives a clue to his conception of the "proceedings" of his academy when he asks Carli to send him "qualche bel segreto, o alcuna cosa curiosa da inserire ne i fogli dell'Accademia"[130].

By the 1660s and 1670s, a number of indications suggest that for Jesuits who did not enjoy the peculiarly felicitous patronage situation of Riccioli in Bologna, it was becoming extremely difficult to use the Jesuit college as the institutional locus for protracted experimentation and observation. Without the financial backing of a family like the Grimaldi, Jesuit colleges were apparently unwilling to allocate funding to the costs of building instruments and machines. Orazio Grassi, better known for his polemic with Galileo, only succeeded in having a working model made of an unsinkable ship that he designed by submitting the design to the Genoese maritime authorities. In return for the invention, Grassi pleaded for "some help for our poor College of Savona", financial assistance that would also "stimulate me to mature some other ideas of even greater utility in navigation"[131]. In the Roman centre, despite the vast literary productions of Kircher and his acolytes the situation for intra-collegiate experimentation was also apparently troubled in the 1650s and 1660s. There are frequent allusions in the works of Kircher and his disciples to both the barriers placed on their curiosity by religious poverty and the demands on their time made by other aspects of the Jesuit ministry.

Sending his "mathematical organ", an instrument which allowed all types of mathematical operations to be carried out with the aid of moveable slats[132], to the young

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[130]Lana Terzi to Francesco Carli, Brescia; 10 November 1686, Biblioteca Laurenziana-Medicea, Florence, Ms. Ashburnam 1450 ff.193r-v.

[131]Grassi to the Genoese Senate, Savona, 25 August 1652, Archivio di Stato di Genova, Archivio Segreto, Litterarum, 1988, in Claudio Costantini, *Un Batello Insommergibile Ideato da Orazio Grassi.* Nuova Rivista Storica. 1966; 50: 731-737, on p. 734.

[132]See Mara Miniati, *Les* cistae mathematicae *et l'organisation des connaissances au XVIIe siècle*, in *Studies in the History of scientific instruments*, London: Turner books, 1989, pp. 43-51. In the years from 1649 to 1663 Kircher produced a number of related instruments, commencing with the *Arca Musurgica* (1649-50) and continuing with the *Organum mathematicum* (1661), the *Cista steganographica* (1663) and the *Arca Glottotatica* (1663). On the *Arca Musurgica* see Kircher, *Musurgia Universalis*, Rome: Ex Typographia Haeredum Francisci Corbelletti;

Archduke Karl Josef of Austria, Kircher asked to be excused for "my poverty in constructing the organ", which was made of wood, rather than the gold, silver and gems that a young prince deserved[133]. The mathematical organ reveals something of the audience and place of Jesuit mathematical productions in the changed situation. Devised to contain within a single box all of the knowledge required by a young prince in the fields of arithmetic, geometry, "Poliorcetica, sive Fortificatoria", "Computus [...] ecclesiasticus", "gnomonica", "sphericam, seu primi mobilis doctrinam", "doctrina secundorum mobilium", "steganographia" and music. Schott elaborated, in a series of "preludes" on the mathematical organ that it was made in the shape of "the pneumatic organs that are used in our [Jesuit] churches"[134]. By "playing" on the *organum mathematicum*, arithmetic operations could be carried out (using a system based on Napier's bones), music could be composed, letters could be written in cypher and astronomical knowledge could be acquired. In the hands of Kircher, Schott and Lana Terzi, mathematics could be transformed from the essential tool of the natural philosopher, as it was represented by Clavius and Grienberger previously in the century, to the toy of a Baroque prince. Ironically, the "manual" composed by Schott for the use of the organ ran to two volumes and over 850 pages in length, requiring the memorisation of long Latin poems for the performance of many of its operations[135]. The collegiate mathematical space inherited by Kircher from Clavius and Grienberger had changed its function dramatically. Leibniz's Prague-based interlocutor with the Jesuits, Adam Adamandus Kochanski, expressed the transformation of the insulated space of mathematical apprenticeship to a theatrical space for the display of wonders when he wrote of Kircher in 1670 that "Mathematics cannot be treated by him, as it

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1650, II, 184/5, Iconism. XIV *Arcae Musurgicae novum inventum*, and Johann Gans to Kircher, Vienna, 6 February 1649, APUG 561, f. 133. On the *arca glottotactica* and *cista steganographica* see Kircher, *Polygraphia nova,* Rome: Ex typographia Varesij, 1663, pp. 85, 128 respectively.

[133]Kircher to Archduke Karl Josef, Rome, 7 August 1661, APUG 555, f. 98r (draft).

[134]Gaspar Schott, *Organum Mathematicum Libris IX. explicatum a P. Gaspare Schotto e Societate Jesu, quo per paucas ac facillime paraboles Tabellas, intra cistulam ad modum Organi pneumatici constructam reconditas, pleraeque Mathematicae Disciplinae, modo novo ac facili traduntur... Opus posthumum.* Herbipoli: Jobus Hertz; 1668,

[135]Schott, op. cit., p. 54, *Praeludium I.*

requires a devotion that it cannot receive from a man who is distracted by the constant visits of foreigners and the interruptions of the dignitaries of the Roman Curia".[136]

[136]"Mathematica enim ab eo tractari non possunt, ut quae applicationem aliquam requirunt, quam ille obtinere non potest, quotidianis visitationibus Exterorum, et interpellationibus Magnatum Curiae Romanae distractus", Adam Adamandus Kochanski to Leibniz, 7 June 1670, in Leibniz, *Philosophischer Briefwechsel herausgeben von der Akademie der Wissenschaften der DDR,* Erster Band, 1663-1685. Akademie-Verlag Berlin, 1987, pp. 46-48.

Documenting Public Mathematics in the Collegio Romano: Christoph Grienberger's mathematical *Problemata*

The order in which the documents are listed here is a possible (though by no means certain) chronological ordering. More information regarding the dating and the content of the documents can be found in the notes accompanying each *Problema*. Asterisks denote problems that are not published here in full. After Orazio Grassi's arrival in Rome in 1616-17,[1[1]] Grienberger seems to have been relieved of the duty of writing the public *Problemata*,[2[2]] to allow him to concentrate on his other duties as *Revisor* of mathematical works, *consuliarius aedificorum*, director of the private mathematical academy for the training of future Jesuit mathematics teachers and designer of mathematical instruments.

I Anon. [Christoph Grienberger], *Praefatio* in praise of the mathematical disciplines, undated [November 1591?], APUG Fondo Curia 2052 VIII 67r-70v

II Anon. [Christoph Grienberger], Optical problem: *... fieri posse ... in aliqua mensa lumine, et e directo luminis ultra quoddam foramen vel rimam homine; Homo quidem ille, a lumine illo illuminetur, ipse tamen licet quae ad utramque sunt partem luminis videat, lumen tamen ipsum videre non possit*, recited in the *Collegio Romano*, 23 December 1591, APUG Fondo Curia 2052 VIII, ff. 11r-16r, 22v-23r.

III* Anon. [Christoph Grienberger], *Problema. Datis lateribus Aream trianguli inquirere*, recited in the Collegio Romano by Benedictus Ceronius, 1 March 1594, APUG Fondo Curia 2052 VIII 17v-21r.

IV Anon. [Christoph Grienberger], *Problema: De Dimensione Circuli* recited in the Collegio Romano, [between 27 October and 24 November 1595?], APUG Fondo Curia 2052 VIII 125v-129v

V Anon. [Christoph Grienberger], *Problema Circa motus caelorum*, undated, APUG Fondo Curia 2052 VIII 110v-117r

VI Anon. [Christoph Grienberger], *Problema Mechanicum Circa motus Ponderum*, undated [January 1596?], unfinished, APUG Fondo Curia 2052 VIII 7r-8v

VII Anon. [Christoph Grienberger] *Problema. Datis excessibus quibus diameter Quadrati aut figurae altera parte longioris, excedit latera; ipsam Diametrum ac Latera efficere nota*, undated [before 1601?], recited in the Collegio Romano by Augustus Palavicina, APUG Fondo Curia 2052 VIII 122r-124v

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[1[1]] ARSI Rom. 110, f.58r

[2[2]] See, e.g. [Orazio Grassi], *De Iride disputatio optica a Galeatio Mariscotto publice habita In Collegio Romano Societatis Iesu*. Romae: Ex Typographia Iacobi Mascardi; 1617. Grassi's authorship of this problem, accepted by Sommervogel, is acknowledged by the Neapolitan Jesuit, Giovanni Giacomo Staserio. See Staserio to Guldin, Naples 11 August 1617: "Il Problema del P. Grassi è arrivato in Napoli..." (in Romano Gatto, *Tra scienza e imaginazione. Le matematiche presso il collegio gesuitico napoletano (1552-1670 ca.).* Florence: Olschki; 1994, pp. 317-8, on p. 317). See also C. Costantini, *Baliani e i Gesuiti*. Florence: Giunti Barbèra; 1969, p. 73.

VIII Anon. [Christoph Grienberger], *De errore qui in denominandis numerandisque diebus in Indicae navigatione committitur*, undated [after Summer 1602?], unfinished, APUG Fondo Curia 2052 VIII 2r-6r

IX Anon. [Christoph Grienberger], *Problema: Terram auream, Talenti potentia mouere*, recited in the Collegio Romano, 5 November 1603, APUG Fondo Curia 2052 VIII 101r-110r

X* Anon. [Christoph Grienberger], *Problema de Stellis novis in quo impressiones aereae ab aethereis discernuntur*, recited in the Collegio Romano, 23 December 1604 BNR Fondo Gesuitico 1186, ff. 108r-114v, published in Ugo Baldini, *Legem impone subactis. Studi su filosofia e scienza dei gesuiti in Italia, 1540- 1632*. Rome: Bulzoni; 1992, pp. 158-167.

XI* Anon. [Christoph Grienberger] *De dimensione Pyramida. Problema*, recited in the *Collegio Romano* by Augustino Donà, 6 July 1605, APUG Fondo Curia 2052 VIII 25r-29v

XII* Anon. [Christoph Grienberger], *Ad ostentationem Algebrae. Problema*, undated [Spring 1608?], APUG Fondo Curia 2052 VIII 60r-65r

XIII* Anon. [Christoph Grienberger?], Oration initiating studies in 1612, sent to Galileo, published in *Le Opere di Galileo Galilei*, Edizione Nazionale, ed. Antonio Favaro, Vol. XI, p. 274

XIV* Francisco de Ghevara [Christoph Grienberger], *Speculum Ustorium verae ac Primigeniae suae formae restitutum*. Romae: Apud Batholomaeum Zannettum; 1613.

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II/ Two loose printed pages, containing optical diagrams (incl. rainbow), 18th century.

III/ *De Sphaera in Plano* . Problema 8^{um} Dato tempore Solis declinationem inuenire.

IV/*Tractatus De Sphaera Armillari* . Caput primum: Explicans partes sphaerae et alia circa eas annotandam. Caput Secundum. De usus Sphaerae Armillarius. Problema primum. Collocare data planum ut sit horizonti parallelum. Problema Secundum. In dato plana Horizonti Parallelo lineam meridianam describere.

V/ Anon. [Christoph Grienberger], [*Astrolabium Describendorum tractatus*]

VB/ 2 ff. (loose), [Christoph Clavius], 3 theorems on spherical geometry. Incipit: Theor. 23 Propos. 25. Si fuerint duo triangula sphaerica, quae unu. latus unilateri h.eant aequale..."

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17. The Catholic Horoscope of the Society of Jesus, from Athanasius Kircher, *Ars Magna lucis et umbrae.* Romae: Ludovico Grignani; 1646, facing p. 553

18. Otto von Guericke's *antlia pneumatica*, from Gaspar Schott, *Mechanica hydraulico-pneumatica,* Würzburg; 1657

19. The *Museum Kircherianum*, from G. de Sepibus, *Romanii Collegii Musaeum Celeberrimum cuius magnae antiquariae rei...* Amsterdam: Ex Officina Janssonio-Waesbergiana; 1678

20. The spagyrical furnace of the *Collegio Romano*, from Athanasius Kircher, *Mundus Subterraneus*, Amsterdam: Janssonium et Weyerstraten;1664-5.

21. Francesco Lana Terzi's flying boat, from Lana Terzi, *Prodromo*, Brescia: Rizzardi; 1670.

22. Earth-moving machine, from Gaspar Schott, *Magia universalis,* Bamberg: J. M. Schönwetter, 1677^2

23. Putti performing optical experiments, engraving designed by Pieter Paul Rubens for François de Aguilón, *Opticorum liber sex*, Antwerp: Plantin-Moretus, 1613.

24 . Portrait of Athanasius Kircher by C. Bloemart, ARSI Hist. Soc. 149 f. 126r.

25. Table of magnetic declinations from Athanasius Kircher, *Magnes, sive de arte magnetica opus tripartitum,* Romae: Ex Typographia Ludovici Grignani; 1641, providing details of informants.

26. Letter from Antoine Lalouvère, S.J. to Kircher, Tournon, 22 March 1640, APUG 567 f. 78r.

27. Ground-floor plan of the Collegio Romano, from Filippo Bonanni, *Numismata pontificum romanorum* (2 vols., Rome, 1699), vol. 1, p. 352. Bonanni indicates the functions of the different spaces. The pharmacy (A) was located on the bottom-right hand side. At the time of Christina's visit, Kircher's museum was situated above the corridor B, which corresponds to the space illustrated in fig. 19.

28. Portrait of "Mesue, pharmacorum artifex", frescoed lunette by Andrea Sarti and Emilio Savonanzi carried out in 1629, in the *Palazzo del Collegio Romano*.

29. An example of Kircher's *organum mathematicum* conserved in the Museo di Storia della Scienza, Florence (photograph: Franca Principe)