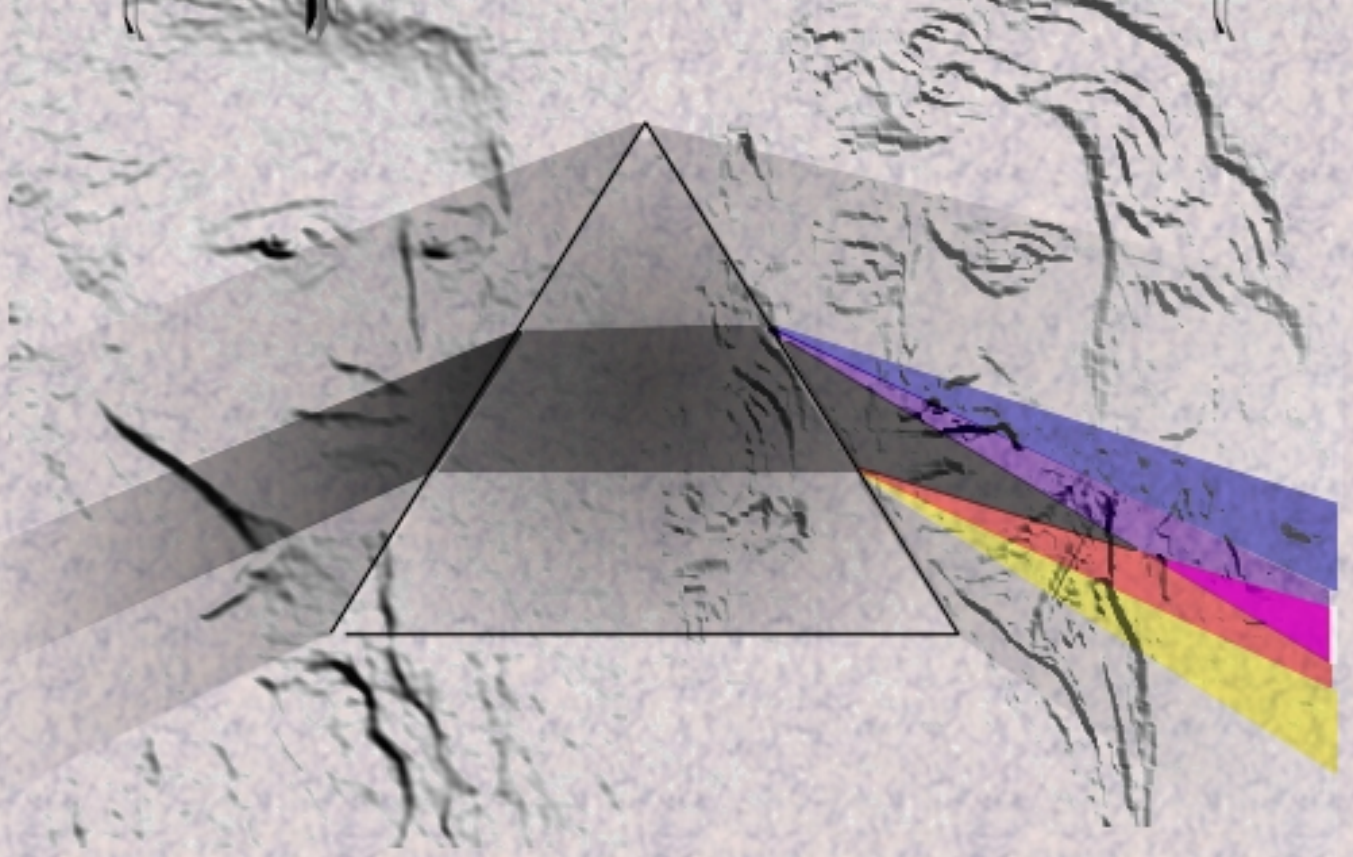
Emir Korkut

Newton through the Prism of Göethe



Newton through the Prism of Goethe

Overview of Newton's Color Theory through the Prism of Goethe's Teaching on Colors

E.Korkut "Newton through the Prism of Goethe"

Translation Author/Dunja Ferušić

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Preface

The year 2010 marked the exact two hundredth anniversary since the famous German poet, thinker, natural researcher J.W.Goethe published his capital work "Teaching on Colors".

"Teaching on Colors" is a book Goethe himself considered his most significant work. With this book, he wanted to provide his contemporaries with a comprehensive description of the color phenomena as contraposition to Newton's color theory. However, just what Goethe considered his greatest work, turned out his major life disappointment. Goethe's Teaching on Colors, was not just merely rejected by the then science, but quite the opposite – Newton's Color Theory reigns supremely over the whole culture to this day. And seemingly, stronger than ever.

The intention of this book is to show that in the last two hundred years, Goethe's Teaching on Colors has not only preserved its value, but the ideas as well as insights presented there are more actual than ever.

Travnik, B&H, summer 2010.

Introductory note

The book you hold in your hands represents an attempt to provide an overview of a different approach in studying the natural phenomena, with the task to show how we can observe the natural phenomena from a completely different position than the one cultivated by the official physics, and how different positions of observation allow a deduction of completely different conclusions, than those of official statements of physics.

That is why, this book should be read as a book of philosophy, which tries to exercise a different way of thinking through an unconventional approach to physics, with an aim to open a dialogue on the topic – what is the essence of modern natural science and should we really consider with blind faith that this or that claim of modern science is indeed an undeniable fact.

If the book is to be read in that way, then there might probably be much less disagreement with the claims, the book sometimes discloses in a very radical way, even ironic at times.

I INTRODUCTION

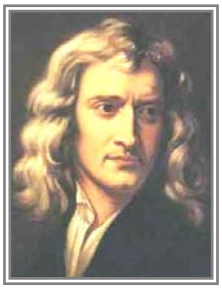
Historical Overview

"Whether what we believe is true or deceptive, such will remain; we are allowed to defend our opinions during the life. And after our life, they, who are children nowadays, will be our judges".

Initial quote from Goethe's "Farbenlehre", Book II.

For the beginning, we will sketch brief biographies of Sir Isaac Newton and Johann Wolfgang von Goethe. Since the purpose of those overviews is not to provide material for biographical studies, but to depict the mind frame, which determined the life path of two great thinkers of European culture, only the basic biographical data will be mentioned.

1) Sir Isaac Newton



Born on 4 January 1643 in the hamlet of Woolsthorpe Manor Lincolnshire County, England. Isaac Newton was an English physicist, mathematician, astronomer, philosopher, alchemist, theologian, and by most of the modern naturalists is considered as one of the most influential people in human history.

At the age of twelve, he began attending "The King's School", Grantham, where his mathematical talent was noticed very early. At that time, the college's teachings were based on those of Aristotle, but Newton prefers reading more advanced ideas of modern physicist and philosophers, such as Galileo or Descartes, and of astronomers, such as Copernicus or Kepler. Newton published his first scientific work in mathematics, in the area of infinitesimal calculus. In 1665, he obtained a degree at the "Trinity Collage" Cambridge University, with which he cooperated until the end of life. Later he moves to London, where he corresponded with elite mathematicians and physicists of the time as an eminent person.

In 1687, he published the book "Mathematical Principles of Natural Philosophy", which is considered as one of the most important books on nature of all times. In this work, Newton sets the foundations of classical mechanics by introducing the principle of universal attractive force between the material bodies, a so-called "gravity". Based on Kepler's laws of planetary motion, he puts forward the three laws of mechanical motion, which dominated a scientific thought throughout the next three centuries. Thus, as it is considered, the last doubts concerning the justification of geocentric versus heliocentric planetary system were removed.

In 1704, he published the book "Optics", where he treats the problems of geometrical optics, questions about the essence of light and puts forward a theory of colors in which colors are considered to be exclusively contained in white light – the theory that sovereignly governs the accepted view to this date. Based on these presumptions, he constructs the first reflecting

telescope, a so-called "Newtonian telescope". At the same time, he studies the speed of sound and formulates an empirical law of body's cooling. Together with Gottfried Leibniz, Newton is considered the father of the infinitesimal calculus and significantly contributed the development of mathematics in various fields.

Later, Newton lost all interest in physics, mathematics as well as in destiny and consequences of his works. He turned towards alchemy and the occult, and supported the idea of the existence of occult forces that attract and repel small particles. As a deeply religious person, he also published a variety of theological writings dealing with the interpretation of the Bible and opposing the Christian doctrine of the Holy Trinity.

Newton was a member of the English Parliament from 1689 to 1701, but his role remains anecdotal, since all he ever said in Parliament was "Close the window, here's a draft! "

As the President of the Royal Society, a member of the French Academy of Sciences, Newton achieved international fame during his lifetime. Newton was the first scientist who was knighted. Shortly before he passed away, he compared his life to a day, where a child is playing with sand and mussels no longer aware of the cosmos at his back.

Newton died in sleep in London on 31 March 1727 as a highly respected person. [I]

2) Johann Wolfgang von Goethe

Born on 28 August 1749 in Frankfurt am Main. J. W. Goethe was a German poet, playwright, writer, polyglot, translator, naturalist, and is considered the most important writer in the German language and one of the most important figures of European culture in general. His contribution to the development of German culture is so deep and comprehensive that the majority of German writers, philosophers, artists, even scientists, consider Goethe the spiritual father of German culture.

Throughout childhood and youth, Goethe received a basic education from all the classic subjects of that age, with special emphasis on languages. He showed a significant affinity for painting, but his talent remained undeveloped. It is being considered that one of the compensations for this neglected talent is his subsequent engagement with colors in the book "Teaching on Colors". At sixteen, he enrolled the law school in Leipzig, but the law did not enthuse him much, so he devoted to poetry. Later, he will leave a lawyer career, after just a few months of practice. At the age of just 25, Goethe achieved international fame with his novel "The Sorrows of Young Werther". After that, at the invitation of Duke Karl August, he went to Weimar, where he remained – with the exception of several shorter and longer journeys – practically the entire life.

As an endeavor of the synthesis of diverse national literature (English, French, classical Greek, the Balkans, Persia, etc.), Goethe becomes the founder of the "world literature" concept. He was a key figure in different cultural and literary movements (enlightenment, sentimentalism, romanticism). His presence in Weimar promotes this small town in the center of cultural activities of the then Germany, and one might say, of the then Europe.

Together with Friedrich Schiller, Goethe is involved in the reconstruction of dramatic art through active participation in the work of the Weimar Theatre. In 1805, he published the first part of Faust, a literary work that, in the opinion of many writers, placed Goethe alongside anthological literary greats such as Homer or Shakespeare.

At the same time, Goethe has never lost interest in natural sciences. Through his travels, as well as through active collaboration with the University of Jena, he is intensively engaged in botany, animal and human morphology, meteorology, mineralogy, and optics. His works in the field of morphology were undertaken and extended by the 19th century naturalists, including Charles Darwin. In 1810, he published his "Teaching on Colors" as a criticism of Newton's color theory. He was ennobled in 1782 spending his last years engaged in public official jobs.

Although he dealt with philosophy, he failed to form his thoughts and ideas in an organized philosophical system, so Goethe's ideas remained in many scattered notes, taken down interviews, diaries and allegations. Therefore, the editors of Goethe's work have spent a lot of time collecting all referred.

Goethe died in Weimar on 21 March 1832 as a highly respected person. [II]

3) Summary Overview of the Optics Development before Newton

It is considered that a sense of sight is the most important organ of sensory perception and the one that provides most of the content of the external world. Countless people used to speak about vision; philosophers, physicists, artists, laymen, educated and less educated, wise and less wise. There were various kinds of opposing or less opposing opinions regarding seeing and the seen, and undoubtedly, the same will be in the future. However, in one thing they all agree – light is necessary for vision. Certainly, what is light or what is vision, is the question that is as old as human thinking itself.

As far as written history is concerned, the first interpretations of light are the legacy of the ancient Greeks. Also, they invented a word that nowadays means the branch of physics – "Optics" (όπτκός) i.e. what concerns seeing, observation. The Greeks studied nature entirely, philosophically, and not as we do nowadays, separately, specifically. Therefore, in ancient Greece, philosophy could not be detached from physics. Perception of external images or colors of nature – which we now study with the help of psychology and aesthetics, on the one hand; and light as a natural phenomenon – which we now study with the help of physics, on the other hand – represented unity. After all, for the Greeks physics was "philosophy of nature".

Without any intention to provide a complete account of ancient philosophy or physics here, and because of the topic that is dealt with in the book, here will be provided an uncommon division of philosophical schools of antiquity. Ancient philosophical schools will be divided according to the interpretation of light and phenomena related to light – the ones which considered colors in nature a reality, and opposite school – which considered colors in nature an illusion.

The first direction, light related in association to vision, with the capability that belongs to the human eye. To this group belongs Pythagoras (570–495 BC), due to the interpretation that vision extends from the eye to an object, having encounter its density or smoothness, it turns back into itself, just as the outstretched arm reverts back to shoulder again. Then Empedocles (490 – 430 BC), who – according to one source – claimed that Aphrodite ignited the divine light in the human eye that exits from the eye allowing vision; and – according to another source – vision occurs in inlet-outlet of light from the eye and the object observed. Then, there is Plato (428– 348 BC), with the interpretation that the divine fire emanates from eyes encountering the light of object. And by all means, Aristotle (384–322 BC), with the interpretation that the appearance of color is based on the interaction of the stimulus brightness and the ambient light level. He based this view on the perception that the color of a sunset changes as the darkness set in. [1]

The interpretation of both, Plato and Aristotle, is that colors cannot appear only out of light, but in the interpenetration of light and darkness. [III] *Light is a medium allowing transparency to our vision, and is opposite to darkness that is opaque. Light itself is colorless and belongs to the realm that is rarer than the four terrestrial elements. Light is of aethereal nature, and since aether is all-pervading medium that is not of a material kind, light has no speed of propagation.* [IV]

[1] Aristotle's sequence of colors can be observed during the course of the day: the white light of noon becomes tinged with yellow gradually changing to orange, and then to red. After sunset, evening red becomes a purple violet, changing to a night sky which appears as dark blue. In accordance with such notions, the two colors gain a special place: yellow - the color of bright daylight and dark blue – the color of midnight darkness.

On the other hand, there is the Atomistic School the notions of which are much closer to the modern interpretation of light and color. To atomists, light is not strictly related to the capability of the eye, but is a phenomenon of external nature, more or less independent of the human eye. It is considered that the founder of this school was Leucippus (first half of 5th century BC), with his pupil Democritus (460 – 370 BC), who was of the view that vision occurs as a result of the atoms' stream acting upon the eyes, and like all sensory perceptions, the seen is subjective. [V] *"Color is not a natural necessity, but something that is supposed and determined by the law, convention and habit. Color itself is not reality, only realities are atoms and void (between atoms)". Democritus associates the color of the surface with the tactile properties of the surface: "We feel surfaces as smooth, rough, sharp, angular and spiky, and thus colors arise from these different states of surface". The followers of Democritus have similar attitudes. Epicurus (341–270 BC), "The body does not have a color, colors occur due to certain positions of the object in relation to the human eye", or Lucretius (99 – 55 BC), with the attitude that both light and heat consist of colorless atoms.* [VI]

Aristotle refers to Democritus saying that he turns all perceptual into touchable, i.e. bodily, which he considers the only reality. [VII]

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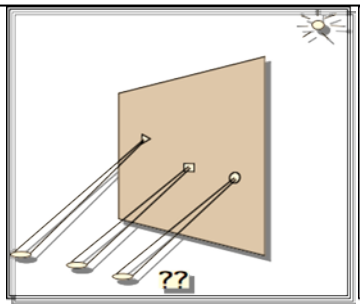
In ancient physics, tools are used for better studying of a luminous phenomenon. E.g. the quartz crystals or the spheres filled with water were used as lenses. The Greeks investigated the properties of mirrors, both flat and curved, that can "bring near or move away" objects. [VIII] *Camera obscura was known to Aristotle.* [IX]

The Greeks knew that the inverted image can be projected by openings. Aristotle questions how the sun can make a circular image when it shines through a square hole.
Greek mathematician and geometer Diocles (240 –180 BC), in his book "On burning mirrors", studies the focal property of a parabolic mirror. The original is not preserved, and the book comes from Arabic sources.



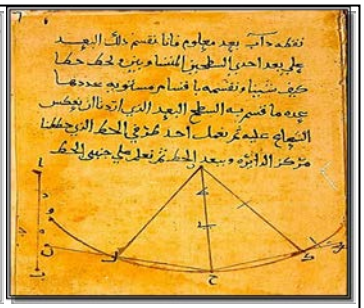


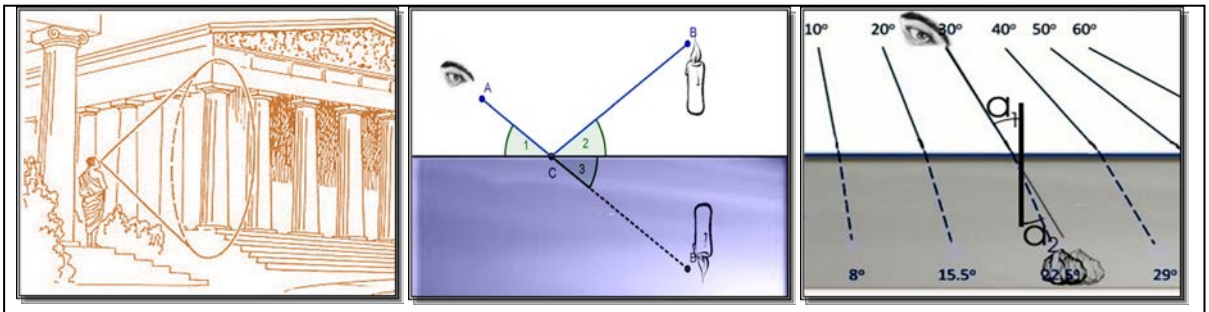
Figure 1 – Problems of ancient optics

Geometry was used as help in better understanding of light. Notions of light used to be presented geometrically, as straight lines. Euclid (c. 300 BC) is one of the first who examined the principles of geometrical optics making certain postulates.

For example:

- *That rectilinear rays proceeding from the eye diverge indefinitely;*
- *That the figure contained by a set of visual rays is a cone the vertex of which is at the eye and the base of the seen object surface;*
- *That the seen things are those upon which visuals rays fall and the unseen things are those upon which visual rays do not fall;*
- *That, things seen from a larger angle appear larger, things seen from a smaller angle appear smaller, and things seen from equal angles appear equal etc.*

However, it should be noticed that Euclid did not apply the concept of ray to explain the nature of light. Integration of the light ray notion and the interpretation of light's nature appeared over a millennia later. [X]



Euclid discusses the laws of rays of vision geometrically. His study of vision is based on Plato's view that the rays of vision exit out of the eyes allowing the perception of images.
Heron of Alexandria (10 – 70) divides vision into optics, as the study of vision proper; dioptrics, as the study of lenses and sighting instruments and catoptrics as the study of mirrors. He formulates the law of reflection of the visual rays on the principle of the same angles.
Ptolemy (85 – 170) examines the degree of displacement of the visual field when objects are viewed through two different media, concluding that the relationship between the angles is a constant ($\alpha_1/\ \alpha_2$ = const). Nowadays, this law is known as the law of refraction, and Ptolemy's conclusion is approximately correct for large angles of observation.

Figure 2 – Ancient studies of geometrical optics

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Light rays came into use for the explanation of light's nature by Arabian physicist, from 9th to 13th century.

In the field of optics, one of the first major Arab writers was Al-Kindi (801 – 873), who developed the theory that everything in the world emits rays in all directions filling space. In optics, this attitude will play a significant role in the development of the concept that the light sources radiate light in the form of light rays. Ibn Sahl (940 – 1000) develops a concept of how curved mirrors and lenses focus the light rays.

The most prominent theorist of the Arab school of optics was Ibn al-Haytham al-Hasan, known in the West as Alhazen (965 –1040).[2] *Alhazen separated philosophy from astronomy, celestial kinematics from cosmology, and reduced physical entities to geometrical notions. Practically, in contrast to the unity of ancient philosophy and the study of natural phenomena, philosophy now becomes separated from the natural science, the division that exists to this day. Alhazen introduces the principles of hypothesis and experimental confirmations, in the same way it is being practiced to this day.*

In his optics, for the first time, the concept of Euclidean geometric ray of vision and the nature of light are incorporated, giving the key importance to the geometrical models of light.

He argued that vision occurs because the rays of light emanating from every point of an object, entering the eye. Vision occurs in the way that the light rays are projected on a retina, in the same way as in a camera obscura, the light is projected through the opening onto the screen. He proclaimed the vision rays superstitious belief and non-existent, according to which, the eye is reduced to a hollow sphere, with the function of the passive projection of

[2] According to the attitudes of official science, Alhazen, together with Newton, is considered as one of the most revolutionary writers in the field of optics in history altogether.

light. For the interpretation of the image perception, Alhazen used observations obtained through anatomical studies of the eye.

Alhazen abandons the ancient tradition of perception, in which the eye is an active organ radiating the visual rays, introducing the assertion that the process of visualization occurs in the way that the eye is a camera obscura the function of which is a passive projection of inverted image onto the retina.

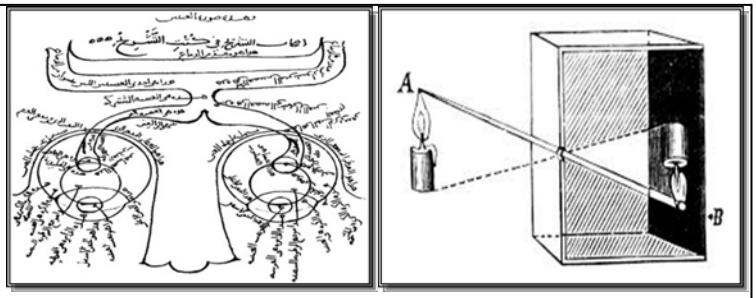

Figure 3 – Alhazen's study of the eye

Also, Alhazen repeated the assertion of the Atomists, namely that light travels in a straight line having a finite speed, in contrast to Aristotelian physics claiming that the speed of light does not exist. Avicenna (980 –1037) agrees with the attitude that the speed of light is finite, because the light sources radiate a kind of particles that must have a finite speed. Al-Biruni (973 – 1048) claimed that the speed of light is much greater than the speed of sound. Al-Shirazi (1236 –1311) and his student Al-Faris (1260 –1320), based on Alhazen's teaching, explained the rainbow appearance, in more or less the same way, as it is being lectured nowadays in the official books of optics.

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The Arab School of optics, and especially Alhazen, had a significant impact on the development of optics in Europe. It is interesting to notice that after Alhazen, the development of optics divides into two streams; experimental optics, which proves its claims by the inductive method based on the methodology: problem definition – hypothesis – experimental evidence – analysis of results; and philosophical optics, which attempts to come to knowledge by philosophical deduction.[3] *Experimental optics, slowly but surely, becomes the subject of academic study, while philosophical optics increasingly withdraws into enclosed speculative circles.*

The following text provides a brief description of the experimental optics development.

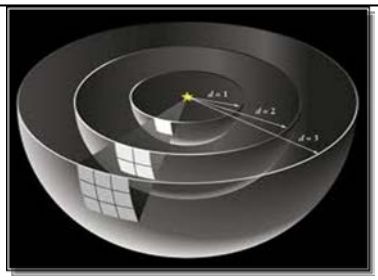
Englishman Roger Bacon (1214 – 1294) is strongly inspired by Alhazen's work and significantly contributes to the spreading of Alhazen's ideas to the West. He published a book on optics that is dealing with the physiology of vision, the anatomy of eye, the description of light in terms of space-time concepts, and the analysis of mirrors and lenses. He is considered a likely inventor of a monocular.

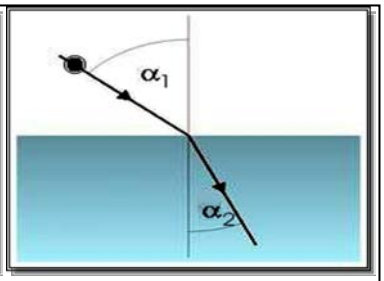
In 1604, Johannes Kepler (1571–1630), published a book on optics, in which he describes the law of decreasing intensity of light on the principle of inverse-square distance, analyzes the reflection of plane and curved mirrors, describes the mode of work of camera obscura, and deals with problems of vision and perception.

Willebrord Snellius (1571 – 1630) formulates the law of light refraction, and Rene Descartes (1596 – 1626) reformulates the law of light reflection. Also, Descartes supports the theory of corpuscular nature of light, giving the interpretation that color appears due to the different way of motion and speed of light corpuscles. [XI]

[3] Induction is the process of cognition proceeding from the particular and deducing a conclusion on the general; deduction is based on general principles applying conclusions to a particular.

Kepler concludes that light decreases according to the principle of inverse square law based on the assumption that light from the light source expands in all directions radially. Practically every sphere encompassing a light source contains the same "amount" of light. ($A_1 : A_2 = 4 \times \pi \times r_1^2 : 4 \times \pi \times r_2^2$ tj. $\Phi \sim 1/r^2$)





Based on the principle of least time of light propagation between two points, Pierre de Fermat (1601 – 1665) gets the degree of refraction as $\alpha_1 / \sin \alpha_2 = \text{const}$. Descartes examines the same problem coming to the conclusion that light is being refracted because the speed of light corpuscles increases in a denser medium, due to the law of conservation of momentum.

Figure 4 – Achievements of Cartesian optics

Francesco Maria Grimaldi (1618 – 1663) describes the phenomenon when the light behind small slits expands on a screen, a phenomenon that is nowadays called the diffraction of light. He notices that there are circumstances under which "the light can cancel out the light", which is the first observation of a phenomenon that is nowadays called the light interference. Grimaldi states the idea that there are certain kinds of colors in light. [XII, 4]

Grimaldi measures the size of the shadow casting a thin rod, noting that the shadow is bigger than it should be. This means that there are circumstances when light deviates from rectilinear path, out of which he concludes that light is not consisting of corpuscles, but is some kind of fluid that can bypass obstacles.
In addition, looking at light passing through two adjacent openings, he notes that the projection on the wall has bright and dark areas, a phenomenon that cannot be explained by corpuscles of light, because they cannot cancel each other out.

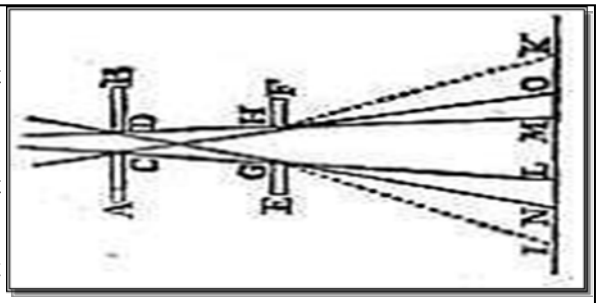


Figure 5 – Grimaldi's experiments

Christian Huygens (1629–1695) describes the double refraction of light in a crystal of Iceland's calcite and points out the phenomenon of light polarization. He puts forward the theory of the wave (undulation) nature of light.

Thinking about the way in which light propagates through space, Huygens makes an analogy between mechanical waves and light. According to him, light expands through space by the oscillations of the aether particles following the laws of oscillations.

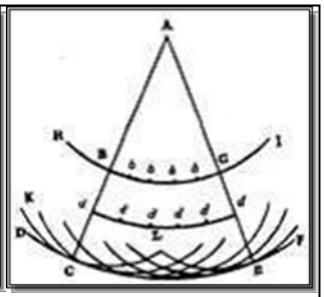


Figure 6 – Huygens's theory of light

Meanwhile, there are still publications treating optics in a manner of Aristotelian physics. In Newton's era, certain concepts still existed, for example, that colors appear by interpenetration of light and darkness.

However, Newton puts an end to the last remnants of Aristotelian physics, and in the explanations of light and colors, introduces interpretations that are considered relevant to the present day.

[4] Practically, Newton's theory of color appeared conceptually by integration of Descartes' idea (that colors appear because of the effect of light particles) and Grimaldi's idea (that colors somehow exist only in light).

4) Summary Overview of Newton's Color Theory

In 1704, Newton published the book "Optics" which deals with the problems of geometrical optics introducing radically new concepts in the interpretation of the luminous phenomenon, terminating the then accepted interpretations of the color appearance, which date back to the Aristotelian physics.

In his earlier works, he has already formulated the universal gravitation law, as the existence of force acting at a distance, through the mutual attraction of material objects (Latin "gravitas" is the weight). Dealing with optical phenomena, he came up with the idea of the corpuscular nature of light. He considered that light is composed of tiny particles (so-called "corpuscles") and that such presupposition could explain the appearance of colors in nature.

The book "Optics", Newton begins with eight definitions determining the notions he later used for a description of luminous phenomena. Practically, that was the generally accepted understanding of light's nature, according to the views of the then physics. Eight Newton's definitions could be briefly interpreted in the following:

- *The light ray represents the smallest part of light.* [XIII]
- *Refrangibility of light rays is their disposition to be refracted or turned out their way in passing out of the transparent medium. Based on an eclipse of Jupiter's moons (nowadays known as Römer's method of measuring the speed of light), it seems that light travels in time.* [5], [XIV]
- *Reflection of light rays is their disposition to be reflected or turned back into the same medium when light strikes the material surface.* [XV]
- *The angle of light rays incidence is the angle between the perpendicular axis of reflecting or refracting surface, and the line that describes the path of light rays.* [XVI]
- *The angle of reflection is equal to the incidence angle.* [XVII]
- *The sine of reflected or refracted light ray angle is equal to the sine of incident angle.* [XVIII]
- *Light with the rays of the same refractive properties is called simple, homogeneous and isotropic (i.e. the same in all directions). Light that has rays of different refractive properties is called complex, heterogeneous and anisotropic.* [XIX]
- *The colors of homogeneous light are simple and basic, while the colors of heterogeneous light are complex and compound.* [XX]

After these definitions, Newton engages the experimental confirmation of attitudes he advocated. Without going further into the content of "Optics" here, it can be said that Newton formulated his understanding of the essence of the color appearance, through three classical experiments with prisms. After editions of "Optics", these experiments were rewritten, practically, in all the books dealing with the color phenomena up to date. In the original document, the experiments are not formulated in a way as it is done here, so the

[5] Because of later presentation containing the description of the speed of light, it is important now to notice, that Newton's second definition, light explicitly relates to the notions of space (distance) and time.

below description should be understood as an interpretation, with the main purpose to briefly summarize the essence of Newton's comprehension of color. [XXI]

The three key experiments of Newton's color theory read as follows:

1) *The colors are contained in white light, and they can become visible through the experiment of light dispersion (decomposition).* [6, XXII]

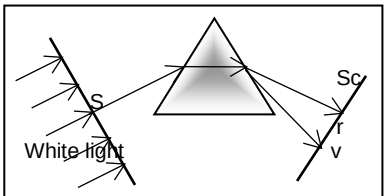


Figure 7 – Newton's proof of decomposition of light

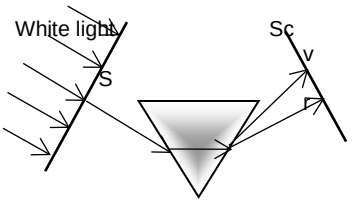


Figure 8 – Newton's proof of light decomposition no.2

The light falling on one side of equilateral prism passes through the narrow slit S. One can notice that the light in the prism passes through double refraction, and on the screen Sc, one can see multi-colored fringes i.e. the "solar spectrum". Solar spectrum (Latin "spectrum" – an apparition) consists of the seven colors, namely: red, orange, yellow, green, blue, indigo and violet. This leads to the conclusion that the colors are contained in white light and that the colors can be separated from white light by the dispersion of light. Furthermore, since on the screen, one can notice the spectral colors that are refracted at different angles, it is deduced that a color is nothing else but light of specific index of refraction. The lowest index of refraction has a light of red color, and the highest a light of violet color.

If the prism is turned upside down in a way that the thicker side is upwards, we again get the spectrum, but in an inverse color order. The relationship between the refractive index and the color remains the same, and this observation suggests that the thickness of the prism's glass plays a role in various indexes of refractivity of the colored light ray.

2) *Lights of monochromatic colors are basic components of light, and they can be re-synthesized into white light from which they were originally created.*

When the spectrum obtained by the decomposition of light is focused with the help of a lens, one can see a bright spot on the screen, suggesting that white light is heterogeneous (complex), because it consists of the light rays of homogeneous (monochromatic) colors.

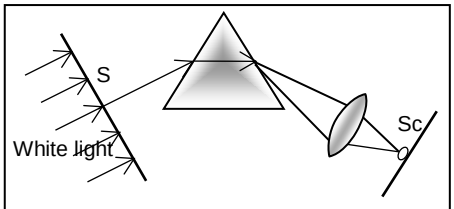


Figure 9 – Newton's proof of white light synthesizing

3) *Monochromatic light is homogeneous light and cannot be further decomposed.*

Light rays pass through the slit S, but now on the screen Sc, we make a small slit S_1, allowing the monochromatic light to pass through. When the monochromatic light passes through another prism again, it may be noticed that the monochromatic light is refracted in the prism, but it is not scattered in

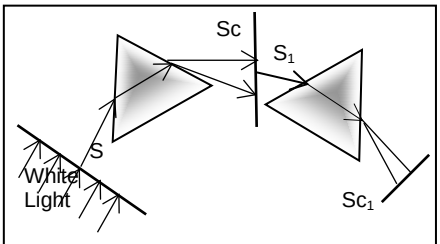


Figure 10 – Newton's proof of the homogeneity of monochromatic light

[6] Newton's original hypothesis reads: "Sunlight is composed of rays with different refractive index". The second hypothesis reads: "Sunlight is composed of primary colors mixed in an appropriate ratio". Out of these claims along with the hypothesis that the determinant of color is its index of refraction, the mentioned hypothesis is deduced.

multicolored rays of light. Thus, one deduces that the monochromatic light is homogeneous, and it cannot be further decomposed.

Aristotelian physics interpreted the appearance of colors by mixing light and shadow (darkness). Newton opposes this view by referring the objection that when the penetration of some spectral rays behind a prism prevents the opaque body, one can again see the rest of the unchanged spectrum on a screen, regardless if the rest of the spectrum is limited by the shadow. [XXIII] *From this, one concludes that the light rays are the reality producing colors, and that the shadow does not participate in the color appearance in any way.* [XXIV]

Or, if we put a rotating paper wheel behind a prism, the color on the wheel changes as the wheel rotates. One and the same ray of light in one incident angle appears on the paper as white, in the other angle as yellow, and in the third as red. Since the brightness is always the same, Newton concludes that the shadow does not participate in the appearance of colors. [XXV]

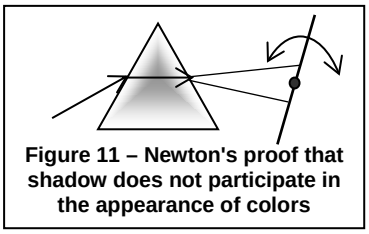


Figure 11 – Newton's proof that shadow does not participate in the appearance of colors

We have a similar case with soap bubble. It may be noticed that the colors on the bubble constantly change even if the bubble is illuminated with the light of equal intensity, which would mean that the shadow does not participate in the appearance of colors. [XXVI]

After conducting experiments, Newton was inspired to proclaim that "all the colors in the universe that are not created by human imagination, are made by light, whether it is a color of monochromatic light, or it is some kind of their mix". [XXVII] *The colors of an object are determined by certain reflective properties of the object's surface.* [XXVIII] *A red object appears red, because its surface reflects only the red rays out of white light, while the rays of other colors are absorbed; a green object reflects only the green rays of light, and the rest is absorbed, etc.* [XXIX] *Color mixing is the result of mixing of the colored rays of light.* [XXX]

In Newton's world-view, neither any color on the outer object, nor colors created by human imagination, can be counted as something what might be considered in an objective manner. Moreover, the light rays themselves are not colored, but they only have the capability to cause a sensation of color. [XXXI]

Howsoever, Newton interpreted the appearance of the solar spectrum, with the effect of gravity on light' particles.

Newton considered that light consists of tiny particles of different masses, and that the denser medium (the glass prism) into the light ray penetrates, acts on the light corpuscles in such a way that particles of smaller mass (the colors toward red), are less exposed to the increased gravity of denser environment; while particles of the bigger mass (the colors toward violet), are more exposed to gravity.

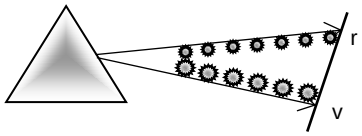


Figure 12 – Newton's interpretation of the phenomena of color appearance by the light corpuscles

This is the reason why the red light has a lower index of refraction than violet; particles of the red light on the thin portion of the prism are less exposed to gravity than particles of the violet light, which pass through the thickest portion of the prism. That is why, by turning the prism over, we get the colors in an inverse order. Practically, Newton tries to explain the essence of color with the different speed of the light particles.

After the light is being scattered into corpuscles (monochromatic colors), the light corpuscles cannot be further subdivided. [XXXII]

This is in accordance with Newton's atomistic apprehension of light, because an atom in its original meaning is indivisible (Greek"ἄτομος"– indivisible), i.e., it is possible to reach the smallest corpuscles of light that cannot be further subdivided, and in fact, that is a monochromatic ray of light.

Anyway, Newton's interpretation that gravity plays a role in luminous phenomena was later entirely discarded; but the idea – that colors exist only in light (and not on objects), and that colors are lights of specific refractive index – was subsequently developed and applied to the explanation of all color phenomena, and that stands as a valid interpretation of color phenomenon up to the present date (y.2010).

5) Summary Overview of the Optics Development after Newton

After Newton, an intense flourishing of new theories takes place in an attempt to embrace the phenomena of light and colors. Theoretical models are accompanied by a powerful development of optical devices.

In 1803, Thomas Young obtains interferential stripes by the double diffraction of light. Since the phenomenon could not be explained by Newton's corpuscular theory, a revival of Huygens' wave theory of light occurs. In 1817, Augustin-Jean Fresnel obtains interference experimentally, defining a mathematical model that describes interference. Thus, the Newtonian corpuscular theory is gradually abandoned, and the final stroke to this theory provides the light polarization experiment conducted in 1808 by E.L.Malus, and finalized in 1818 by Young and Fresnel.

When light pass through two adjacent openings, the interference stripes can be seen on the screen. This phenomenon is interpreted by the wave nature of light.
The experiments of polarization lead to the conclusion about the type of light oscillations.

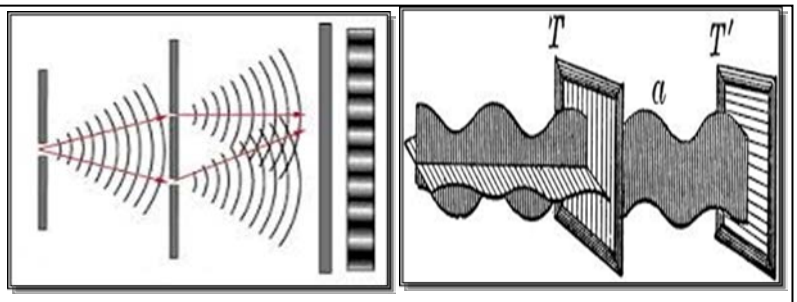


Figure 13 – Interference and polarization of light

In such a way, in the descriptions of luminous phenomena is introduced the concept of wavelength. Thus, a beam of light is converted into the oscillation of energy. Colors have become oscillations of light with strict wavelengths. It is increasingly accepted the conviction that light is a kind of energy that can perform work. The concept of the speed of light is being rapidly developed. Certain ideas about the speed of light occurred in the 17th and 18th centuries, through astronomical observations, and in 1849, the experiments were conducted that, seemingly, support the thesis on finite speed of light. Through works of physicists Hippolyte Fizeau (1819 – 1996) and Léon Foucault (1819 -1968), the light speed is estimated experimentally.

Meanwhile, the development of spectral analysis and spectroscopy takes place (1835-1865). It is noticed that the flames of burning material analyzed by the prism, produce different colored stripes on the screen. This propels a momentum for technical analysis of materials and the development of new theories about the structure of matter. Anders Jonas Angstrom, Charles Wheatstone, Gustav Kirchhoff, Robert Bunsen, are just some of many physicists who contributed to the development of spectral analysis. Spectral analysis was used for the development of one of the first theories about the structure of atom, through the work of Niels Bohr (1885-1962).

In 1864 James Clerk Maxwell (1831–1879), puts forward the theory of the electromagnetic nature of light. Thus, light, heat, UV radiation, radio-waves, become oscillations of electromagnetism, which differs only by the speed of vibration. The concept of the speed of light is expanded by Fizeau-Doppler effect of light, which – through spectral analysis – relates the different colored light rays of an object to the motion of the object itself. This idea will have a colossal role in the development of the concept of celestial bodies' motion.

A new chapter in theoretical models of light begins with early 20th century. In physics, it comes to revival of atomistic Democritus' belief who claimed that, in the universe, only atoms and empty space between atoms exist. In 1900 Max Planck (1858 - 1947) puts forward the quantum theory, assuming existence of a quant – as an elementary part of energy; followed by Albert Einstein (1879 – 1955), who in 1905 applies this theory to light, arguing that light consists of energy particles, of photons. Thus, modern optics finds a way to Alhazen's and Newton's claim that light is discontinuous and composed of something smaller.

Optics of the 20th century may be characterized by the development of theories going in two main directions. On the one hand, there is the quantum physics (later the term "quantum optics" is introduced), in which – the concepts of the matter structure, previously developed through the spectral analysis – one applies to light. The number and behavior of all smaller particles increase with a vertiginous speed. Through the laser technology, light with completely new properties was developed.

On the other hand, the concepts developed in quantum physics, are now conversely used for astrophysical speculations on structure and age of celestial bodies, their classification, and practically, the genesis of the universe.

Ideas that have been popularized through the mass media as "progressive", e.g. a belief in the black holes in space, the size of universe, the expansion of universe, the origin of the universe through the "big bang", the age of the Earth, etc., are just some of widely accepted theories, constructed in a combination of quantum physics and astrophysics. Through this powerful propaganda, new ideas are being integrated in school systems, involving ever younger students.

"Reactionary" ideas and perceptions, philosophers and poets, collected in more than two millennia of the philosophy development, continue to attract dust in the archives, or are only discussed in outsider circles, banished to the periphery of cultural life.

6) Summary Overview of Goethe's Teachings on Colors

In 1810, Goethe published the book "Teaching on Colors" in which he described his observations and ideas about the appearance of colors in nature, collected over two decades.

"Teaching on Colors" is divided into two parts. In the first, historical part, Goethe provides a detailed historical account of the color phenomenon interpretation, from antiquity to the beginning of the 19th century. In the second, didactic part, Goethe gives his interpretation of a color phenomenon.

Goethe does not describe the color phenomena in the form of mathematical formulae or theories on colors. Abstract mathematical models and theorizing in the form of natural law definitions is something that is strongly inconsistent with Goethe's understanding of proper studying of natural phenomena. He believed that mathematical theorems and models often separate a man from the real essence of phenomena in nature, and that through them, the view from the phenomenon (reality), is directed towards something which is a mere mental construction of phenomena, which is a mere picture of reality. He was of the view that a nature researcher should focus on the phenomenon perception as such, hence he reverted to the ancient comprehension of theory (originally, the theory comes from the Greek "θεωρία" – means observation, beholding).

Then, these perceptions should be purified by separating important from unimportant, and presented in a way that the description of a particular color phenomenon agrees with the overall picture of all chromatic phenomena. Therefore, he presented his Teaching on Colors as a collection of categorized perceptions of color phenomena, where the cognition of color occurs only in comprehensive considerations of all color phenomena.

According to Goethe, the color phenomena can be categorized into the following groups:

1) Physiological colors

To this category belong colors that do not exist in nature, but solely and only in the eye. To depict these colors, Goethe used the experiments that are, in modern terms, expressed as the experiment of afterimage colors (post-perceptive colors) and experiment of chromatic induction.

Let us describe only the most characteristic experiments.

a) The experiment of afterimage colors

Let us keep a fixed view on a colored surface about thirty seconds, for example, on a red colored square. Then, quickly direct a view on a white surface, or just close the eyes. Thus, we will get the impression of complementary color, because in front of our eyes, we see the green square.

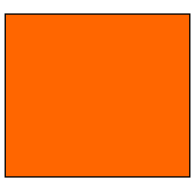


Figure 15 – The experiment of afterimage color

Figure 14 – Goethe's impression of the afterimage

In the external reality, the green square does not exist, and the modern culture considers this phenomenon a kind of optical illusion.

b) The colored shadow experiment

Let us take the two sources of light, one red and one white. Put an object that casts a shadow in front of the screen. After illuminating the object, we can see on the screen that the shadow cast by the white light appears red, but the shadow cast by the red light appears green. The shadow is black only where red and green shadows mix.

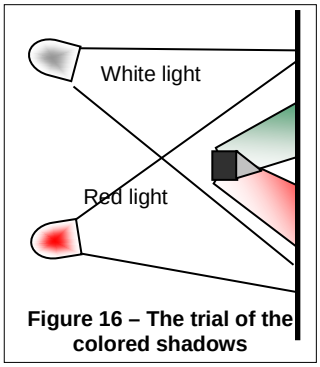


Figure 16 – The trial of the colored shadows

Nowadays, there is an interpretation that the green shadow is black too, but the black shadow appears to us as green only because of red surrounding i.e. the eye introduces a color that does not exist in reality. This phenomenon is presently called "the chromatic induction" (Latin "inductio" – introducing). [XXXIII]

Goethe was of the opinion that these phenomena point out the facts of crucial importance:

1) *Colors can appear apart from sensory perception, when any law of geometrical optics (rejection, refraction, light scattering, even light itself) no longer plays a role.*

2) *The eye itself tends to supplement sensory perception, because the eye is not a passive apparatus of light perception, but an active organ that seeks harmony of colors. Where the present culture sees only an optical illusion, Goethe saw a fact of the greatest possible importance.*

3) *A man is an integral part of nature and cannot be removed from the process of scientific observation.*

The first thesis inspired Goethe to ascertain that the color study needs to be separated from the study of geometrical optics. These two branches of science are related but are not identical. Hence, it should be established the chromatic – as the science of color, opposite to the geometrical optics – which studies the properties of light with the help of geometry. He explicitly stressed that the replacement of the appearance of secondary chromatic rules (which includes the laws of geometrical optics, e.g. reflection or dispersion of light), with the appearance of primary rules (chromatic phenomena), often led to the misinterpretation of color as a natural phenomenon. [7, XXXIV]

The second thesis inspired him to state that it is possible to speak about aesthetics on a scientific basis, and this attitude will play a key role in the development and interpretation of his circle of colors.

The third thesis emphasized a humanistic approach in studying nature, and this attitude will be elaborated separately, in one of the later chapters.

[7] According to Goethe, for example, in the experiment of light dispersion, different refraction of light rays in the prism is the phenomenon of geometrical optics, with respect to the appearance of color as a primary phenomenon of chromatics.

2) *Physical colors*

By physical colors, Goethe regarded the appearance of colored lights. Goethe is of the opinion that Newton's chromatic misinterpreted the primary color phenomenon – which includes the question of how a color appears, with the secondary phenomena of colors, and those are the laws of geometrical optics.

Goethe supports the views of Aristotle on the origin of colors, and these attitudes had been generally accepted before Newton. According to Goethe, physical colors appear by interpenetration of light and darkness. Goethe described the appearance of physical color through the multitude of experiments, and in the following paragraphs, only four most prominent ones will be mentioned.

a) *The penetration of light into darkness experiment*

Pour water into a transparent test tube, which is blurred with a semi-transparent liquid, for example, by injecting a few drops of milk or lather. When we watch the light penetration through the turbid liquid from a dark room (out of the darkness), we can notice the appearance of a reddish-yellowish color in the liquid, namely, if the light is stronger, the color tends more towards yellow; if the light is weaker, the color tends more towards red.

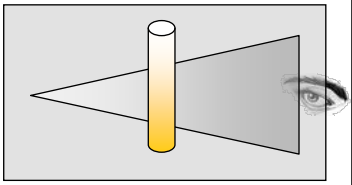


Figure 17 – The experiment of penetration of light into darkness

Alternatively, we can change the blurriness of the liquid. At low blurriness of the liquid, the color is yellowish, at high blurriness of the liquid, the color is reddish. Therefore, when the light penetrates into the darkness through a transparent medium, a red-yellow color appears.

The same phenomenon occurs in the appearance of morning or evening afterglow. Then, from the darkness of Earth, we look at the sunlight through the atmosphere (clouds). When the sun is higher in the sky, the light is stronger and the color of clouds tends more towards yellow. When the sun is nearer the horizon, the light is weaker, and the color of clouds tends more towards red.

Figure 19 – The color of clouds changes due to brightness

Figure 19 – Smoke becomes reddish observed on the light background

Or, when we look through the illuminated smoke from the dark space, the smoke gets a reddish color.

b) *The penetration of darkness into light experiment*

Let us repeat the same experiment, but with a dark background. Now, from illuminated space we look through the turbid liquid into the darkness, and we can notice

the appearance of bluish color. If the contrast between the light and the darkness is weaker, the color tends more to turquoise green, if the contrast between the light and the darkness is stronger, the color tends more to blue even to violet.

Alternatively, we can change the blurriness of liquid. At low blurriness of the liquid, the color is bluish; at high blurriness of the liquid, the color is deep bluish to violet. Therefore, when we look at the darkness out of the light through a transparent medium, the blue color appears. We can spot the same phenomenon in the blueness of the sky. From illuminated Earth, we look into the dark space through the atmosphere.

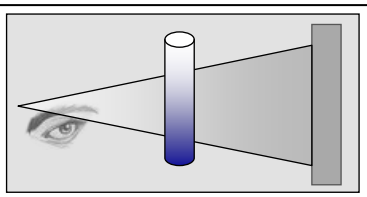


Figure 20 – Penetration of darkness into light experiment

It is similar to the blueness of the sea – out of the light, we look into the darkness of the sea depths. When the depth is smaller (the darkness is weaker), the color tends more to turquoise green. When the depth is bigger (the darkness is stronger); the color tends more to deep blue. Therefore, the illuminated snow looks bluish.

Figure 22 – The color of the sea changes in accordance with darkness

Figure 22 – The smoke becomes bluish observed on a dark background

When we watch the illuminated smoke on a dark background in a dark room, the smoke becomes bluish.

c) The appearance of spectrum in the prismatic experiment

Although Newton had many critics of his then- new color theory, through all the Royal Society correspondences, he defended it tenaciously as a fact, not a theory. [XXXV] *Anthony Lucas (1633-1693) describes the setting of a prismatic experiment virtually identical to Newton's with a number of serious objections to the "new theory". Lucas criticises "very different colours, yea quite opposit ones may at the same incidence appeare under the selfe same degree of refraction."* [XXXVI] *Or in 1740, Louis Bertrand Castel (1688 – 1757) published a critique of Newton's explanation of the spectral color appearance claiming that the appearance of spectral colors depends on the distance between the prism and the screen, trying to provide an explanation of the spectrum appearance with the concepts of light and darkness.*

Goethe will come to the same conclusion looking a white wall through the prism. When a wall is viewed through the prism, colors do not appear on the wall, but only on places where differences in contrast exist. According to Goethe's logic, if colors appear by light decomposition, then a spectrum should be visible on a white wall, which reflects the white light. [XXXVII] *Such reasoning led Goethe to the conclusion that colors cannot occur from light itself, but only by interpenetration of light and darkness. After conducting experiments with a prism, Goethe concluded that the appearance of the seven colors in the spectrum is only a special case of a more general law.*

When we repeat the experiment with a prism, but now instead of a narrow ray of light, we let a wider beam of light through a prism; we can notice that the spectrum of seven colors appears only at a precise distance between the screen and the prism. At smaller distances, the beam of light behind the prism is white with colored edges, and at greater distances, the spectrum of seven colors completely disappears, and dominance of green color begins.

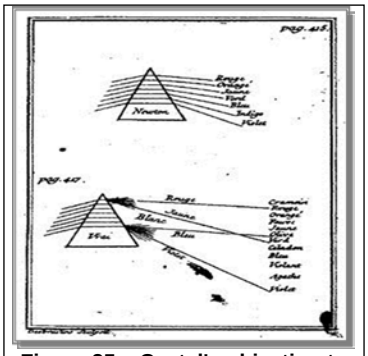


Figure 25 – Castel's objection to Newton's explanation of the experiment with the prism

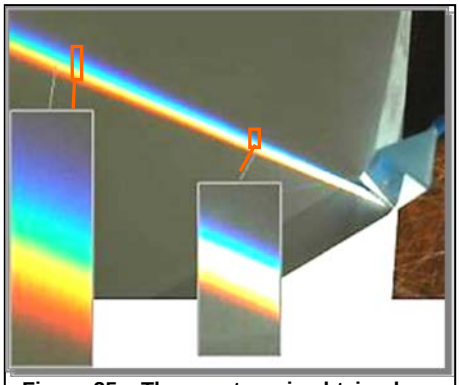


Figure 25 – The spectrum is obtained only at certain distance from the screen

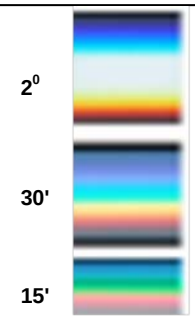


Figure 25 – Appearance of bright spectrum according to the distance from the screen

Goethe claimed that the colors appear in the boundary areas of the light and the darkness interpenetration; namely, on the upper side of the beam (relative to the position of the prism), the light penetrates into the darkness causing the appearance of red and yellow; while on the underside of the beam, the darkness penetrates into the light causing the appearance of blue and violet. According to Goethe, in the prismatic experiment, the primary phenomenon of the color origination is the appearance of the colored pairs in the light and the darkness interpenetration area; while the spectrum with green in the middle is a secondary phenomenon, because green appears only as a result of the yellow and the blue light mixing, as shown in the diagram. [8, XXXVIII]

In glass plates, the light refraction can occur without the appearance of color. Therefore, the light refraction is the phenomenon of geometrical optics, and not a phenomenon that should be strictly related to the colored light phenomenon. Means, the color neither define the index of light refraction, nor white light containing all the colors.

And, in order to prove that colors do not appear by the dispersion of light, but by the interpenetration of light and darkness, Goethe conducted the experiment of a so-called dark spectrum.

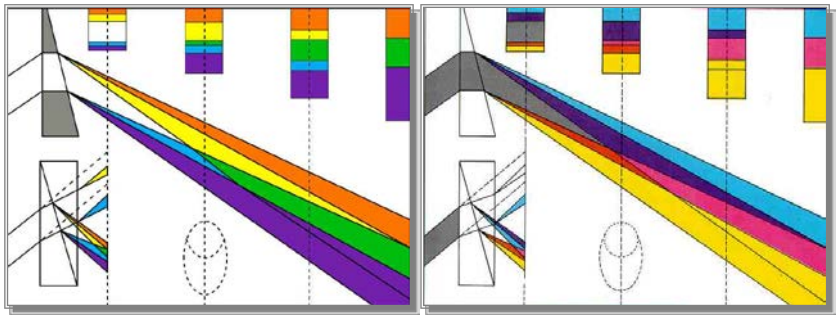


Figure 26 – Goethe's explanation of the appearance of bright and dark spectrum

[8] By the appearance of spectrum at only a certain distance from the prism, Goethe denies Newton's complaint that when a rotating wheel is placed behind the prism, it turns out that the same ray of light is white at first, afterwards yellow and then red.

Now, illuminate the entire prism with the white light, but block the penetration of light with an opaque body, in the central part of the prism. Again, on the screen, we notice the appearance of colors on the boundary of light beam. Now the colored pairs are violet-blue and red-yellow. When a screen is at a smaller distance from the prism, one can notice a black stripe framed with pairs of colors. At greater distances from the screen, red and blue dominate (or violet, depending on the purity of the white light used), which mixing produces a so-called dark spectrum with magenta in the middle. At very large distances magenta begins to dominate.

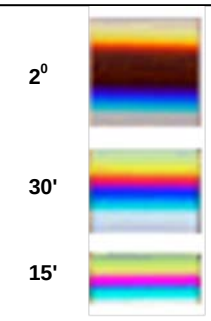


Figure 27 – Appearance of dark spectrum, according to the distance from the screen

Magenta (purple, red-violet) is a color that does not exist in Newton's experiment with a prism.

d) The chromatic aberration experiment

Goethe claimed that the same appearance of light and darkness pervasion, which can be studied in an experiment that is nowadays called the experiment of "dispersion of light", can also be achieved by the experiment of chromatic aberration. Chromatic aberration is the appearance of colored edges around figures viewed through transparent materials.

Let us put a white square on the black surface. When we look a white square through the prism or a piece of thick glass, we can notice that the pairs of color appear on peripheral areas of the square, namely, on the transition of black into white, there is an appearance of a red-yellow pair; on the transition of white into black, there is an appearance of a blue-violet pair.[9] *If the prism is more distanced from the pad (or the same, if the white square is diminished), yellow and blue starts to overlap creating green. This experiment would be analogous to Newton's experiment of obtaining a bright spectrum.*

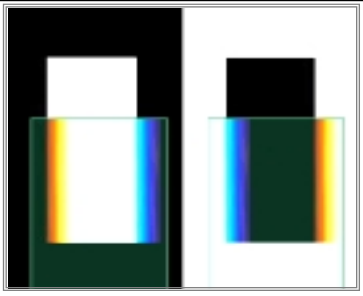


Figure 28 – The experiment of the chromatic aberration

Conversely, let us look a black square on a white background through the prism. Again, on the border of the square, there is an appearance of color pairs; on the transition of white into black, there is an appearance of a blue-violet pair; on the transition of black into white, there is an appearance of a red-yellow pair. If the prism is distanced further from the pad (or the same, if the black square is diminished), red and violet start to overlap creating magenta. This experiment would be analogous to Goethe's dark spectrum experiment.

3) Chemical colors

In his book, Goethe gradually enters into the description of color phenomenon. In the first step, "the colors in the eye" are described, i.e. the color produced by a human

[9] The transition goes towards the direction of refraction; in the given example refraction of light occurs from the left to the right.

psyche when responding to sensory impressions. In the second step, the colors in light are described, the colors that exist as long as there is a source of light. In the third step, Goethe engages in describing the color of objects, colors that are embodied in matter. Thus, through the degree of permanence, from the volatile colors in the eye, across the temporary colors of light, we come to a persistent color of the object.

According to Newton's color theory, colors can exist only in the light that shines on objects, while objects themselves have no ability of coloration. An illuminated object appears to us in a certain color only because of its particular reflection of light rays. A blue object appears blue to us, because the object reflects only the blue light from the white light that contains all the colors; a red one seems red because an object reflects only the red light etc. In the Newtonian world view, colors do not exist in nature, but only and solely in light.

Thus, color is deprived the ability of telling us anything about the inner quality of things. This attitude is in strong opposition to the experience of colors, which existed in the beforenewtonian era. The ancient and the medieval science were of the conviction that colors exist on objects themselves, and that their existence reflects a deeper reality. E.g. the combination of black and yellow worn by wasp was considered a reflection of wasp's aggression; frog is not yellowish-green without reason, and the likes.

Goethe was of the opinion that colors belong to the external nature and that in a relation between the object and its color, a deeper truth about nature is being revealed. And as a proof of the assertion that the color of materials indicates the objective properties of a material, Goethe refers to the argument that acidic compounds, generally manifest in the yellow-red colored combinations of minerals; while alkaline compounds, generally manifest in the blue-violet colored combinations of minerals. Acids intensify the yellow-red color of the material, alkalines intensify the blue-violet color of the material. Litmus paper becomes red in an acidic environment and blue in an alkaline environment. Through the color description of minerals, Goethe rises to the color description of plants and animals. In Goethe's world-view, colors of plants and animals, point to the objective laws of flora and fauna.

Colors of the external objects, Goethe names the chemical colors (in modern vocabulary pigments), and the chemical colors belong to a separate category of color phenomena.

4) The aesthetic-ethical influence of colors

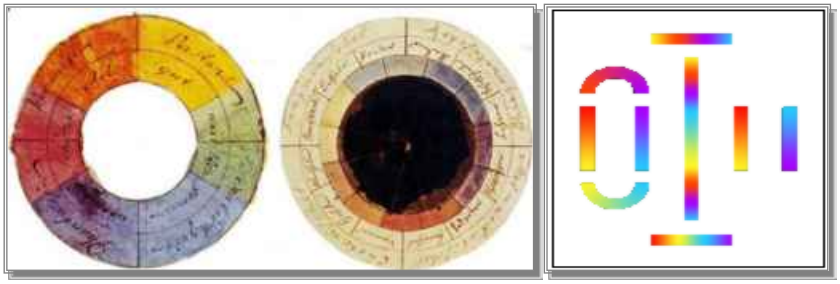
Goethe was dissatisfied with Newton's interpretation of color phenomena, also because he believed that such an interpretation does not provide any possibility of connecting physics with practical problems of the color application, which is crucial for e.g. artists and designers. He was of the opinion that attributing colors only to light, introduces an artificial gap in the field of color phenomena; on the one hand, such a description of color, repels color into the area of geometry and abstract theoretical models of light; and on the other hand, such an abstract description of color is not able to find any way to people who are engaged in the color application from the practical side. Newton's interpretation of color as a form of light with some refractive index, which in our interior causes the sensation of color, makes the exact scientific approach in studies of color from the aesthetic, psychological, or medical perspective impossible.[10]

[10] This gap is very much alive to date. Modern science is not able to find the path from e.g. the external redness of a rose, to the inner experience of the rose redness. The redness of the rose, from the external sensory stimuli,

Based on the conducted experiments, Goethe came to the conclusion that yellow and blue (indigo) are the two primary colors, which are the first incorporation of light and darkness, and that other colors are either their weakening (when they tend towards darkness), or reinforcement (when they tend towards light). That means that red would be the weakening of yellow, while violet is the strengthening of blue. However, for aesthetic consideration, colors should be arranged in a circle of six. Color circle is consisting of a yellow-red couple, appearing on the boundary of light-dark; and a blue-violet couple, appearing on the boundary of dark-light. Green and magenta are transitory colors.[11]

In the final chapter of his book, Goethe is thoroughly engaged in relations of the aesthetic colored combinations and for Goethe these considerations are not of secondary importance, because colors affect people psychologically, aesthetically, ethically and medically.

This is consistent with his view that a man is an integral part of nature and that nothing exists in the eye (i.e., the human psyche), which is not already in nature.



Color circles The "magnetic" relations of colors

Figure 29 – Goethe's aesthetic color considerations

- - -

Goethe's "Teaching on Colors" was completely rejected by the official science, although it was acknowledged the esprit and the breadth of perceptions. The main objection referred to Goethe, was the lack of experimental evidence for quoted claims. Goethe was seeking the cause of the color appearance in darkness, and therefore, as it was thought, he has returned to the outdated concepts of Aristotelian physics. Leading physicists of the time considered that darkness is only a lack of light – and this remained so to this day.

On the other hand, Goethe's Teaching on Colors had a good reception among philosophers, artists, and to some extent, among psychologists. The famous German philosopher Arthur Schopenhauer spoke praiseworthy about Goethe's teaching, and in 1816, he published his book "On vision and the Colors" inspired by Goethe's teaching. [12, XXXIX]

through the transfer of information via neurons, in a mystical way, becomes our experience of redness in our brain.

[11] For the sake of expression precision from this point on, blue will refer to the color of the sky, while indigo will refer to blue mixed with violet. Indigo is the color of a deep sea.

[12] In parts of his book, Schopenhauer completely deviated from Goethe's original attitudes. As an advocate of the thesis that the world of the senses is only our presentation of external reality, he concluded that the colors are only our presentation of something that causes a sensory perception. Allegedly, he opposed Goethe with the words: "There would be no light if I did not see it", to which Goethe replied: "No – it would be you that would not be, if you did not see the light".

Wassiliy Kandinsky considered Goethe's teaching the most significant book, and he further elaborated Goethe's teaching in his own book "Concerning the Spiritual in Art".

G.W.F. Hegel indicated to the ingenuity of the composition in which "Teaching on Colors" was presented. There, one begins with a man (physiological colors), across colored light phenomena (physical colors), all the way to the coloration of objects (chemical colors), and returns to a man by the consideration of aesthetic-ethical influence of colors. Hegel utilized such a composition for the construction of his philosophical system. [XL]

One of the rare officially recognized physicists, who spoke affirmatively about Goethe's teaching, was Werner Heisenberg, the Nobel Prize winner for work in theoretical physics in 1932. Apparently, Heisenberg's uncertainty principle, in which subject and object make an inseparable unity, which prevents simultaneous cognition of both speed and mass of a particle, was inspired precisely by Goethe's teaching that color is inseparable from the eye, i.e., perceived (color) is inseparable from the one who perceives (man). [XLI]

II NEWTONIAN THEORY OF COLORS

"Colors are the deeds of light, the deeds and sufferings."

Goethe "Farbenlehre"

We will now begin to deal with the Newtonian color theory in more details. Focus of observation will be directed towards the physical colors, i.e. the appearance of colored lights, because that is exactly the field of most radical conflict between the Newtonian and the Goethean schools of colors. All claims of the Newtonian theory of colors quoted here are not formulated by Newton himself, but they stem from Newton's mentality of thinking.

The thesis that we will be dealing with are illustrated with photographs of conducted experiments. None of the attached photos is post-processed, but are given according to the possibilities of printing techniques. Description of used equipment is listed at the end of the book.

Theses of the Newtonian theory of colors might be presented in the following way.

1) White Light Contains All Colors

If we represent light with the help of the geometrical model of light – as a beam of parallel light rays, then at the very beginning we are already on the best way to accept that light is composed of something smaller and that it can be decomposed. Moreover, if we add the experiment with a prism, the things became obvious at first glance. White light can be decomposed, and it contains all the colors!

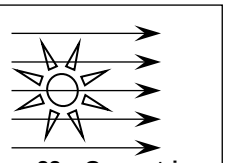


Figure 32 – Geometric representation of a light beam consisting of the parallel light rays

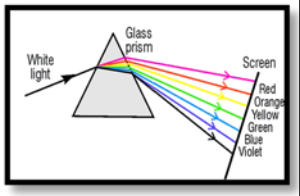


Figure 32 – Newton's proof of decomposition of light

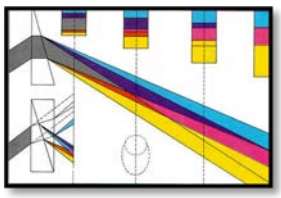


Figure 32 – Goethe's dark spectrum

But this is simply not the truth. Spectrum does not contain magenta. Goethe clearly noticed this fact and addressed the logical question: "If white light does contain all the colors, then how does magenta appear?". Goethe's interest in the issues of color origination – from which he subsequently formed his Teaching on Colors – was born precisely out of such questions. One of the key things Goethe begun to study is the dark spectrum where magenta appears.

Nowadays, it is recognized that spectrum does not contain magenta, but the Newtonian color theory gives the interpretation that "purples" are always created by mixing red and violet. These colors are also called "the outspectral" colors, and it is considered that they do not exist independently, i.e. they do not have the appropriate wavelength in the electromagnetic

spectrum. In the chromaticity diagram – which is a representation of a bright spectrum in a form of a closed curve – they are shown on a straight line without marks for wavelengths.[13]

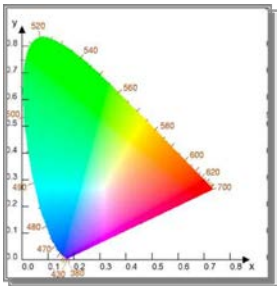
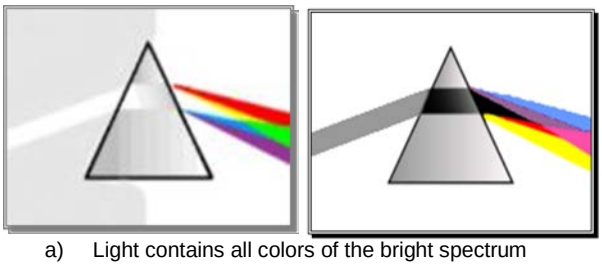


Figure 34 – Chromaticity diagram



a) Light contains all colors of the bright spectrum
b) Darkness contains all colors of the dark spectrum

Figure 34 – Bright and dark spectrum

But, let us hold our view for a while, on the spectrum appearance in the prismatic experiment. If Newton's experiment is used as a proof that white light contains all the colors, then Goethe's dark spectrum, could also serve as a proof that darkness contains all the colors. This is not a matter of commitment to Newton or Goethe; this is a matter of pure logic.

However, for modern naturalist, an idea that darkness contains all the colors is out of the question, because it is considered that darkness is only a lack of light. Darkness is a speculative noun; it does not exist in reality. This attitude is related to the way of interpreting the black surface existence. It is believed that the black surface is black, exactly because of a lack of light reflection. In the Newtonian color school, black is the negation of white, and not something that exists as objective reality. [14, XLII]

Therefore, let us consider the second thesis of the Newtonian school of colors with more details, namely that darkness is nothingness.

2) Darkness is Nothingness

In the presentation of the experiment with a prism, Newton forgot to emphasize one thing. Experiment with a prism was conducted in a dark room, where an opening in the window served as a source of light. Newton did not stress that the dark room was really essential for the spectrum appearance, though as undisputed fact worth that if a room is not darkened, spectrum cannot be seen. He has never stressed this fact, because he considered it irrelevant and intelligible per se. It is continued in such a manner until the present day; in a description of the color phenomenon, one never reckons with darkness as necessary for light perception. Of course, by emphasizing that darkness is a reference point for light perception, it is not proven that darkness is more than just the absence of light.

Figure 35 – Darkness is necessary for the perception of spectrum

[13] This attitude leads to the conclusion that is impossible to speak about a circle of colors objectively. What objectively exists is a spectrum, which contains all the colors, and when we attempt to bend this straight line, the curve acquired is not a closed circle but a parable. Circle of colors can be used in aesthetic considerations, but no color circle has an objective base in a sensory phenomenon. That is why, the modern physics recognizes only the chromaticity diagram in a horseshoe shape. A straight line on the diagram represents purples.

[14] Historically, it is difficult to trace the origin of conviction that the black surface does not reflect light. As it can be deduced from Newton's way of the experiment explanation, in Newton's time such a belief was just a matter of course. According to the physics of Aristotle, the emptiness did not exist, "nature abhors a void".

Therefore, let us consider in detail Newton's experiment that is being presented as a proof that white light consists of monochromatic lights.

If the light ray falls on a prism in a dark room, the light will be decomposed into its components by dispersion, and, in fact, these are the spectral colors. A convex lens makes a synthesis of the spectrum into the original heterogeneous white light. So, we have a cycle: Light – prism (analysis) – color – lens (synthesis) – light. But, let us conduct the same experiment with Goethe's dark spectrum. On the screen, we get a black dot. Now, we apply the same logic to the darkness. Darkness – prism (analysis) – color – lens (synthesis) – darkness.

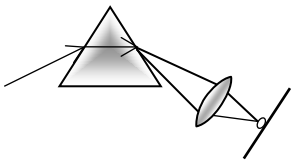
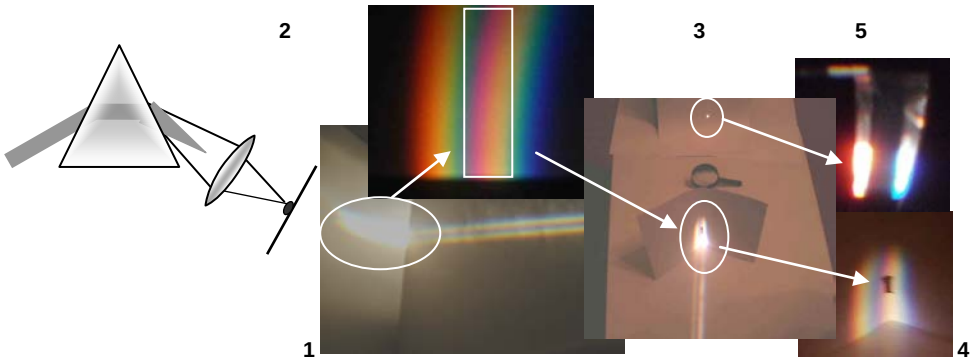


Figure 36 – Newton's proof of the white light synthesizing

So, we could also say that darkness contains all the colors!

A dark spectrum with magenta in the middle is let through a slit in the area of magenta. After focusing magenta with the lens, the dark stripe appears on the screen.



Trial 1 – By focusing the dark spectrum with lens, a dark stripe appears on the screen

But for modern naturalists, darkness does not exist, darkness is a void, and the dark spectrum with purple in the middle is obtained by the sum of boundary lights, by mixing the red and the violet rays of light. Yes, but can the sum of light rays produce nothingness?

According to the laws of optics, light sources follow the law of the additive sum of the intensity of light sources. The total intensity of three light sources is equal to the sum of intensity of a single light source. [XLIII]

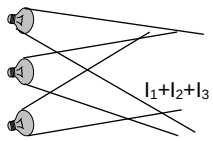


Figure 38 – Additive mixing of light sources intensities

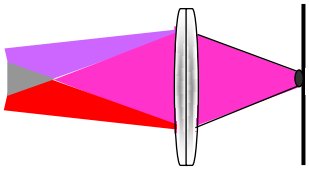


Figure 38 – Sum of lights produces nothingness?

According to the laws of official optics, magenta in the middle of the dark spectrum is obtained by mixing the red and the violet light, but it is still the light, and not a void. How come that the sum of lights can produce "nothingness"?

Goethe was on the trace of medieval and ancient physics that both light and darkness considered as the two polarities, and colors as the phenomena appearing in their interactions. According to the notions of Aristotelian physics; on the one hand, black was not merely the nonexistence of white, but the real color as any other; and on the other hand, darkness was not just a reference point for light perception, darkness is a real natural

phenomenon, the power polar opposite to light. According to these interpretations, colors can be born only out of the interplay of light and darkness. Colors neither appear in the dispersion of light, nor from light itself.

So let us consider in more detail Newton's theory that colors appear by light decomposition.

3) Colors Appear Perpendicular to the Beam of Light

If light is what is being decomposed in the experiment with a prism, then colors can appear only perpendicular to the light beam. However, in the experiment with a prism, the spectrum is obtained only at a certain distance between the screen and the prism. Goethe claimed that precisely this is an indication that colors do not appear by light dispersion, because if colors appear by the dispersion of light, then why do we not get a spectrum in entire width of the light beam right behind the prism? If we look a white wall through the prism – which according to modern physics reflects the white light – why do we not see the spectrum, but colors only on boundary areas of the object, where light and darkness encounter?

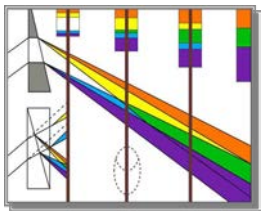
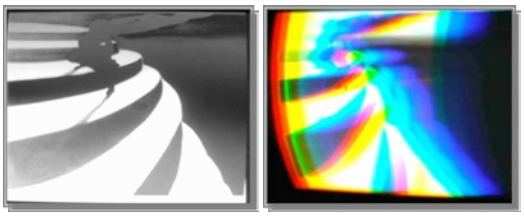
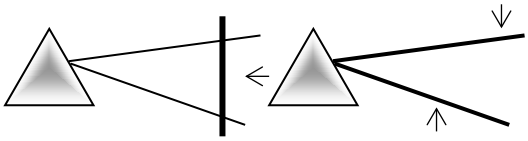


Figure 39 – Bright and dark spectrum appear at a certain distance from the prism



Trial 2 – Left image seen through the prism produces the image on the right

According to Newton, colors appear perpendicular to the beam of light, by the decomposition of light. According to Goethe, Newton wrongly rotated the plane in which the colors appear. Colors appear in a plane parallel to the beam of light, namely in a place where light and darkness pervade, i.e. at the boundary of rectilinear propagation of light.



a) Newton's verticals b) Goethe's parallels

Figure 40 – Newton's and Goethe's view of the plane where the colors appear

As a proof of his claims, Goethe made the point that the spectrum does not exist immediately behind the prism, there is a white or a black stripe bordered with the colored pairs, red-yellow and blue-violet. According to Goethe, the green color in the bright spectrum is obtained by overlapping yellow and blue, which begins to occur only at a certain distance between the screen and prism. According to Newton, green is obtained simultaneously with all other spectral colors, by light decomposition.

Again, magenta in the dark spectrum is obtained by overlapping red and violet on a certain distance between the screen and prism. Newton did not examine this case at all, and an explanation for the magenta appearance was included later. According to the Newtonian school, this color is out of the spectrum, out of a specific wavelength. According to the way in which magenta appears, the Newtonian school has accepted the same thing that was advocated by Goethe. It is just about that the Newtonian school has one interpretation for the appearance of magenta, and the other for the appearance of green, while according to

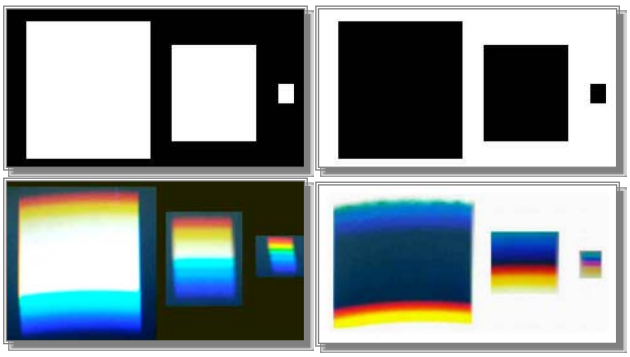
Goethe, both spectral green and spectral magenta appear according to the same principle. And to substantiate his claims, Goethe used the chromatic aberration experiment, for which he believed that it shows exactly the same thing, which is obtained by letting the light beam through a prism.

Let us look at the white square on a black background through the prism. A greater distance between the prism and the square would be analogous to the distancing of the screen, in the light dispersion experiment. Alternatively, the same is obtained by diminishing the white square. Or, we can look through the prism, the black square on a white background.

Figure 41 – Diminishing of the figure is equivalent to the distancing the screen

In both cases, only on borders horizontal to the beam of light one can notice the appearance of colors, while colors do not appear perpendicular to the beam of light.[15]

According to Goethe, colors appear by a rule: where light penetrates into darkness (means, visual field is brighter than the point from which we watch), a pair of yellow-red colors appears. Inversely, where darkness penetrates into light (means, visual field is darker than the point from which we watch), a pair of blue-violet colors appears. When the prism is very far from the pad, the bright and the dark spectrums appear.

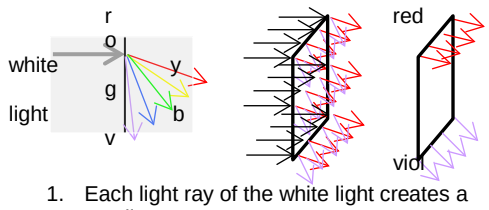


Trial 3 – Chromatic aberration

When we watch the white square on a black background, with a larger distance between the prism and pad, yellow and blue start to overlap producing green. Inversely, when we watch the black square on a white background, with a larger distance between the prism and the pad, violet and red start to overlap producing magenta.[16]

On the contrary, the Newtonian school argues that the chromatic aberration occurs for two reasons, the dispersion of light perpendicular to the rays of light, and the additive re-mixing of the colored light rays. The whole process takes place behind the prism, which decomposes the incoming light, on the entire breadth and length of the figure created by the light reflection.

E.g. the light rays illuminating a white surface form a figure of the white surface by reflection. Prism disperses the image of white surface on all spectral colors, all along the beam width, but the



1. Each light ray of the white light creates a small spectrum.
2. Spectra are again mixed into the white light all over the width of beam
3. Only marginal rays remained uncompensated, and we see the boundary colors

Figure 42 – Interpretation of the white area existence after the dispersion of light, according to the Newtonian school

[15] According to the Newtonian school, light reflects from the surface entering into our eyes; therefore it should be imagined as when coming out from a white background. Means, the area horizontally to the beam of light represents the upper and the lower border of a square, while the area vertically to the beam of light represents the left and the right border of a square.

[16] In given experiment, the images are produced watching the squares on a computer screen, so violet is not noticeable. When the images are illuminated with the sunlight, on the border of the dark blue area, magenta can be noticed.

resulting colors, mix again producing white color. Only at the borders, there was no additive color mixing, so we see the red and the violet colored border. [XLIV]

That is what modern science claims. Nevertheless, let us consider what hard facts of life claim.

1) *Actual appearance of colors in chromatic aberration*

Pay attention to how colors really look like in the chromatic aberration experiment. On the border of figures, there is no appearance of red and violet, but of color pairs, namely, red-yellow and indigo-violet. This fact puts into question the theory of additive re-mixing of colors into white. However, the proponents of the Newtonian school consider that this is not a very important fact, and that re-mixing of colors, does not appear on the light rays at the very border of the spectrum (red and violet), but part of the yellow and the blue light rays are also not re-mixed. It is not very clear why.

According to Goethe's teaching, this problem does not exist, because the essence of the color origin is exactly the appearance of color pairs, yellow-red and blue-violet.

2) *The width of the area where there is no appearance of color*

According to the Newtonian school, the dispersion of white light appears only in the area of white surface. This is because black is only a lack of light; black makes a void in the light beam, so black is never involved in the process of dispersion.

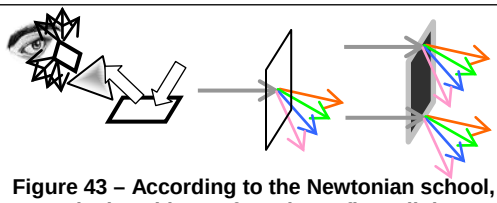
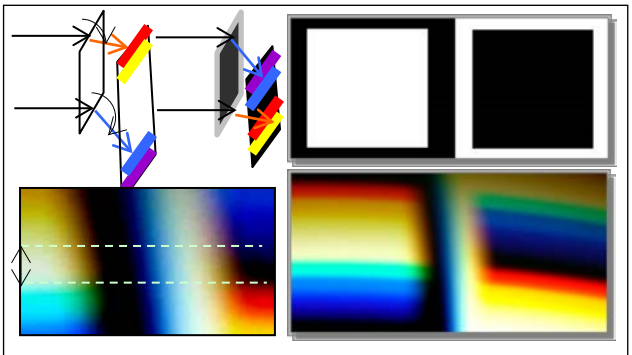


Figure 43 – According to the Newtonian school, only the white surface that reflects light, participates in the appearance of the white color

Practically, according to the Newtonian color theory, in the light dispersion of the white square on a black background, only the whiteness of the square participates, while, in the light dispersion of the black square on a white background, only the whiteness of the background participates.

On the other hand, we should not forget the fact that, in the light dispersion experiment, we have different refractive indices, the smallest with the red light rays, and the highest with the violet light rays.

If the claims of the Newtonian interpretation about the area where colors appear were true, then the black and white square of the same size – simultaneously viewed through the prism, from the same distance – would have to create a different width of the area where colors exist, due to different indices of the reflected light. Since we simultaneously watch the squares, the dispersion of reflected light appears simultaneously, both from a white rectangle, as well as



Trial 4 – The size of central area where colors do not appear is the same, both in black and white square

from the white surface around the black square. However, in reality, we see very clearly, that both the width and the position of the white and the black stripe without colors are the same.[17]

According to Goethe's teaching, this problem does not exist, because colors appear parallel to the light beam causing that both the light as well as the black background, participate in their appearance.

These considerations put into question the theory claiming that colors appear perpendicular to the beam of light. And if this is incorrect, then light, in fact, cannot be decomposed and does not consist of monochromatic light rays.

Now, we have come to the point where we can ask: Is light something that can be decomposed, is light discontinuous at all?

According to the Newtonian color theory, the monochromatic light ray is an essential component of light; it is the smallest part of white light. Therefore, let us consider in detail the thesis of the Newtonian color theory, namely, that light is being composed of monochromatic light rays, and that light is discontinuous.

4) Light is Discontinuous

As a proof that monochromatic light is homogeneous, Newton used the experiment with two prisms.

The white light ray is let through a prism. Spectrum appears on the screen. If, from the spectrum, we select a narrow ray of monochromatic light that is let through the second prism; then we can notice that the monochromatic light is refracted, but it cannot be decomposed, it remains of the same color. From this reasoning, one draws a conclusion that white light is heterogeneous (complex), and is being composed of the colored rays of light, which are homogeneous (simple).

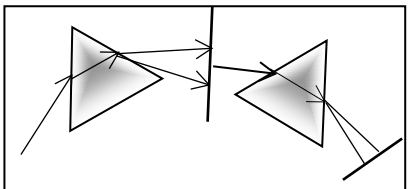


Figure 44 – Newton's proof of the homogeneity of monochromatic light

Even so, it must be emphasized that – no matter how the above experiment seems logical at first glance – it hides an assumption that is not considered at all, that is taken as the truth per se, namely, that light can actually be decomposed, that light is discontinuous. Though, before the proof that monochromatic light is homogeneous, and that white light is consisting of heterogeneous lights, there should be the proof that light can be decomposed at all, that light is of discontinuous nature. Therefore, let us analyze in more detail the theory that light is discontinuous, and composed of something smaller.

The very idea of discontinuity of light has arisen from the effect of a slit on the light beam. It is being reasoned as follows: When the beam of light is let through the slit, out of the light, we have selected a part of light. If the slit is reduced, a part of light let through is decreased. When the slit becomes very narrow, the elemental part of the light beam is separated, and that is, in fact, a light ray. The light ray is merely the smallest part of light we can perceive, it is an elemental constructing block of light. However, let us consider what really happens when the slit – through which the light is let in – is reduced.

[17] Due to the limitation of printing technique, the yellow area on the photograph is slightly narrower than its real size. Therefore, the photo does not clearly show that the width of the white and the black stripe is the same.

When the light beam passes through the slit, on the vicinity screen, one can see the beam of light of aperture size. If the slit is reduced, the beam on the screen is reduced, as well. But if the slit is reduced to the size smaller than half a millimeter, the beam on the screen begins to extend. In modern physics, the appearance of light beam extension at small openings is called the light diffraction. [XLV]

The physical meaning of the above facts is that the light ray does not exist in terms of geometrical optics – because behind the slit, the beam of light decreases as the slit decreases – but only up to certain limits of the slit size. When the slit becomes very narrow, the light beam behind the slit begins to expand. Light behaves in a way that it can be narrowed only to a certain limit, and beyond these limits, no matter how paradoxical it may sound; further narrowing of the light beam causes the increasing of the light beam on the screen. [XLVI]

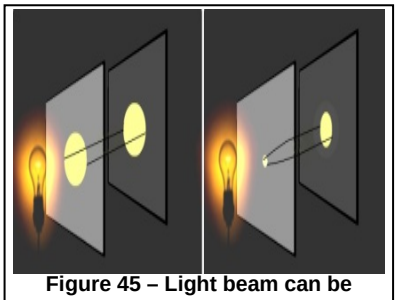


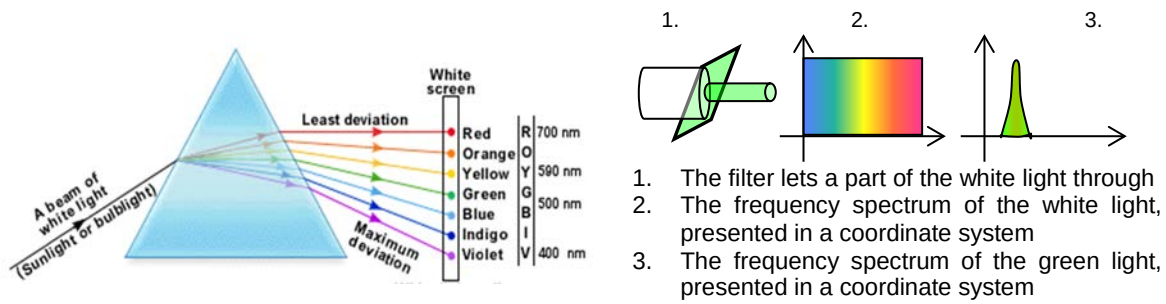
Figure 45 – Light beam can be narrowed only to some extent

This leads us to rethink the question whether light can be described in discontinuous terms, terms implying that light is composed of something smaller, of the light ray. And if light cannot be described by the notion of light rays, then even the monochromatic light ray cannot be a merely elementary building block of light. Because, if there is no ray of light, it is irrelevant whether we create the notion of the white light ray or the colored light ray. This leads us to the question: What is monochromatic light?

Thus, we have come to the point where we can say something about the origin of monochromatic light, about the origin of colored light.

5) Colored Light is a Result of Selective Absorption

Let us consider the way in which the Newtonian school explains the origin of colored light that is obtained when light passes through a transparent material of a specific color, through a colored light filter. Since white light is considered something that contains all the colors, the coloration of light is being explained by the selective absorption of a white light spectrum. Practically, the color of light is a consequence of the transmissions of only part of the white light through the filter, the filter acts as a sort of a light's percolator, transmitting something, and something not.



1. The filter lets a part of the white light through
2. The frequency spectrum of the white light, presented in a coordinate system
3. The frequency spectrum of the green light, presented in a coordinate system

Figure 46 – The notions of the Newtonian school on the colored lights.

Green light has become green because out of the white light that is let through a green filter – just the green part of the white light has passed. A red filter lets only the red part of the white light through, etc. Hence, the colored light is a result of the partial white light transmission, the rest of the white light is absorbed by the filter. [XLVII]

However, it was very soon realized that such a strict definition of colored light cannot be applied to the explanation of color mixing, because it remained unclear what let a yellow and a blue filter through simultaneously. Yellow and blue filters produce a green color. If the yellow filter lets only the yellow part of the spectrum through, and the blue filter only the blue part – what remains is a void. In other words, we should not be able to see objects looking through the yellow and blue filter simultaneously. Therefore, there is an addition, that filters do not just let one strict spectral color through, but parts of the spectra of adjacent colors. E.g., the yellow filter, besides yellow green light, lets part of both green and blue through. The blue filter lets part of green and violet through. It is not very clear what lets the red filter through, it should let part of yellow and part of magenta through, but magenta does not exist in the spectrum. [XLVIII]

No matter how, since the facts of life point that mixing of colored lights differ from mixing of colored pigments, the Newtonian school has introduced two interpretations of color mixing. According to this theory, mixing of colors is either the result of addition of the original spectrum of light (additive color mixing), or subtraction of the original spectrum of light (subtractive color mixing).

1) Additive color mixing

When one mixes yellow and blue light, it is actually the mixing of yellow and blue parts of the whole spectrum. The obtained spectrum of green light consists of a spectrum of yellow and blue, and such obtained green light has no dominant wavelength in the green part of the spectrum. Such a color mixing is called the additive, because it is considered that the obtained spectrum is a result of adding the input light spectra. The intensity of color obtained is increased, because the obtained spectrum has a wider range than the input spectra. Therefore, in our example, the color obtained is bright green.

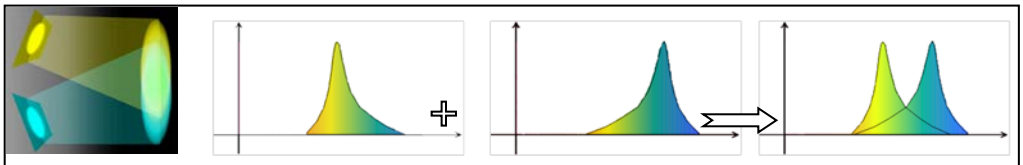


Figure 47 – Additive color mixing

2) Subtractive color mixing

Green light can be obtained by letting the white light through the yellow and the blue filter. The spectrum of obtained green light consists only of the residuum of green spectra that is able to pass through both the yellow and the blue filter. Such a color mixing is called the subtractive, because it is considered that the light obtained is a result of the subtracting the input light spectra. Dullness of color obtained is increased, because obtained spectrum is narrowed, so the light is weaker. Therefore, in our example, the color obtained is a dark green.

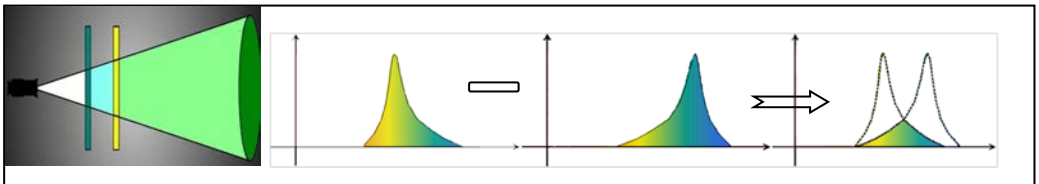


Figure 48 – Subtractive color mixing

One thing must be emphasized. Newton has never considered the problem of additive and subtractive color mixing, but the theories of additive and subtractive color mixing were developed later, based on Newton's understanding of color mixing. However, let us emphasize the illogicality of the Newtonian school of color mixing, by distancing even farther from the nearby spectral colors.

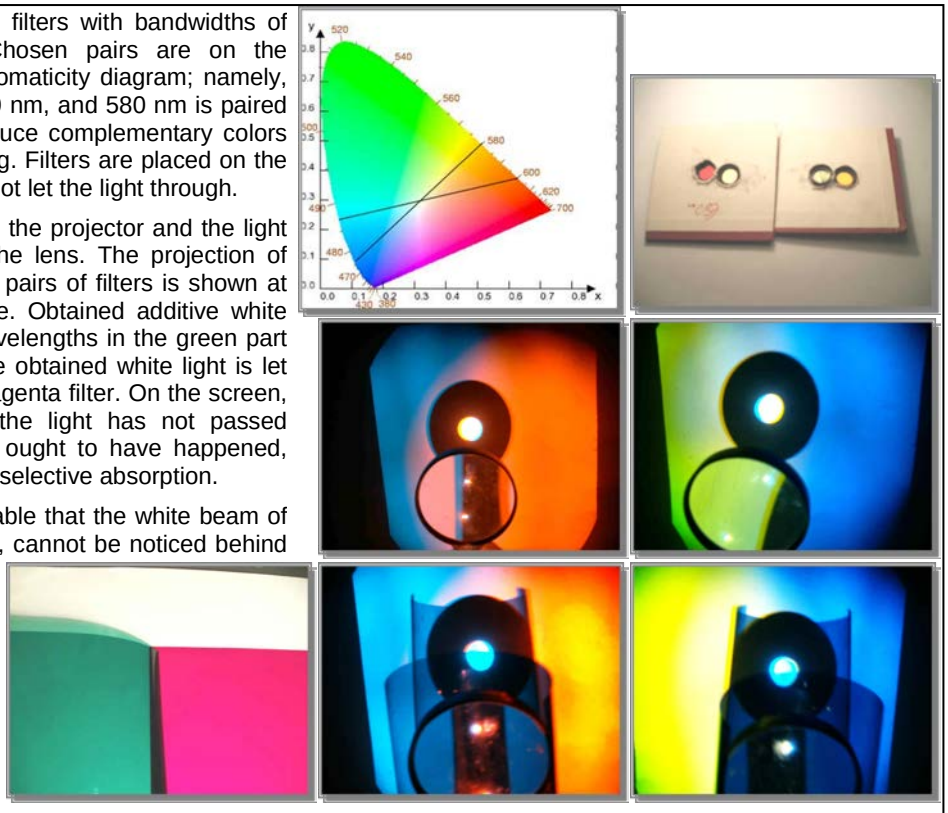
It is known that white light can be obtained by mixing lights of complementary colors. E.g. yellow and indigo produce the white light. The same case is with a pair of red and turquoise, or green and purple, etc.

Let us conduct the following experiment. Let us take the white light obtained by additive mixing of yellow and indigo. Such light has nothing in the green part of the spectrum. According to the Newtonian color theory, this light should not be able to pass through the green filter, because filters let only the part of light through, the green filter lets only the green part of light through. Yet, this contradicts the life facts, because we know that there is not such a beam of white light that cannot pass through the green (or whatever colored) filter.

Two pairs of interference filters with bandwidths of 10 nm are selected. Chosen pairs are on the opposite sides of the chromaticity diagram; namely, 600 nm is paired with 480 nm, and 580 nm is paired with 480 nm. Filters produce complementary colors that create white by mixing. Filters are placed on the cardboard plates that do not let the light through.

Plates were placed inside the projector and the light obtained is focused by the lens. The projection of light on a screen through pairs of filters is shown at the pictures in the middle. Obtained additive white light has no dominant wavelengths in the green part of the spectrum. Then the obtained white light is let through the green and magenta filter. On the screen, one cannot notice that the light has not passed through the filter – what ought to have happened, according to the theory of selective absorption.

In general, it is inconceivable that the white beam of light, obtained in any way, cannot be noticed behind the filter of any color.



Trial 5 – Letting the additive white light through the filter

6) Color of the Object is a Result of Selective Reflection

We are led to even greater contradictions, when we apply Newton's interpretation of the color origin to the phenomenon of the object coloration. The theory explaining why external objects can be seen in a particular color was put forward by Newton, and the way of visual perception of the object coloration, was subsequently developed through the works of T. Young, H. Helmholtz, J.C.Maxwell. [XLIX]

According to the theory of selective reflection, color is not the primary feature of the object, the object only reflects a part of the white light falling on it. Colors are in light and not on the external objects. Green surface appears green, because tiny particles of paint on the surface of the body, so-called pigments, reflect only the green part of the spectrum of the incident white light, while they absorb all other parts of the spectrum. [L]

But then, let us illuminate the green surface with the additive white light without dominant wavelengths in the green part of the spectrum.

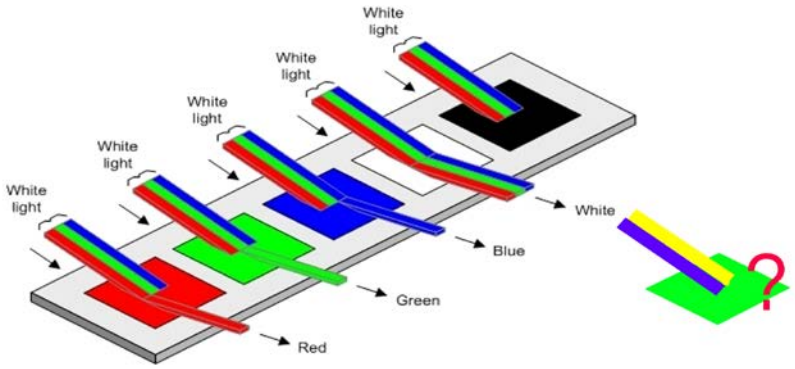


Figure 49 – According to the Newtonian school of colors, the coloration of the object is a result of a selective reflection

According to the Newtonian color theory, the black surface is black, merely because it does not reflect any kind of light, while the green surface reflects just the green part of the incident spectrum of the white light. However, the green part of spectrum does not exist in the white light obtained by the additive mixing of yellow and indigo light. Therefore, by illuminating the green surface with such light, there is nothing to reflect.

But this contradicts the facts of life, because we know that there is no such a beam of white light that is invisible on the green (or whatever colored) surface.

The same experiment as above except the additive obtained white was projected on the green and purple surface. We can notice that the focused light is visible on the colored surfaces.

Trial 6 – Reflection of additive white light on colored surface

7) Colors are Lights with Specific Index of Refraction (Wavelength)

The Newtonian school of the physical color considers that the monochromatic light – with its fundamental feature of the strictly determined refractive index – is the basic component of the white light. Therefore, it is said that the red color, is light of the smallest index of refraction; while the violet color, is light of the largest index of refraction. Other colors are between these two extremes. And since a color exists only in light, one came to the

conclusion that the mere essence of color lies in the fact that color is a light ray with specific index of refractivity. [18, LI]

Even without intention to deny that different colored lights might have different refractive indices, it must be stressed that here occurred a replacement of what is primary with what is secondary. Because, it is not the essence of e.g. the green color, to be a light ray of some medium refractive index. Spectral green and a green obtained by mixing yellow and blue, have different refractive indices. But we see them as the same color. [19, LII] *Here, we have a replacement of the thesis. Based on the fact that specific color might manifest through the light of specific refractive index, the reverse conclusion – that color is the light of specific refractive index – is proclaimed artificially.*

Anyway, the indices of refraction were subsequently related to the wavelengths of light, by the development of notions on the wave nature of light. So it is said that the light with minimum refractive index (red), is the light with the longest wavelength, while the light with maximum refractive index (violet), is the light with the shortest wavelength.

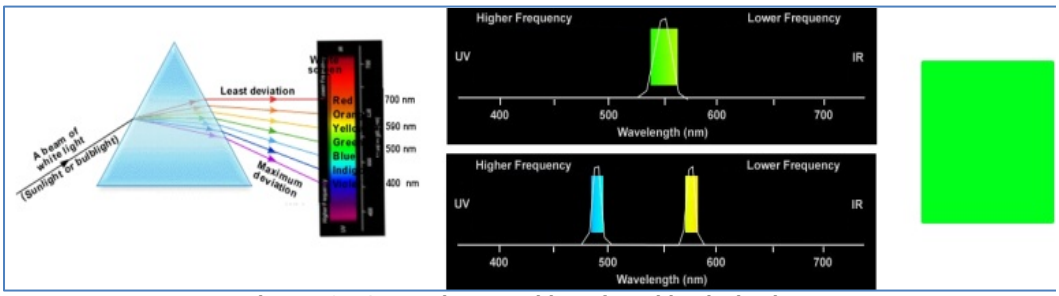
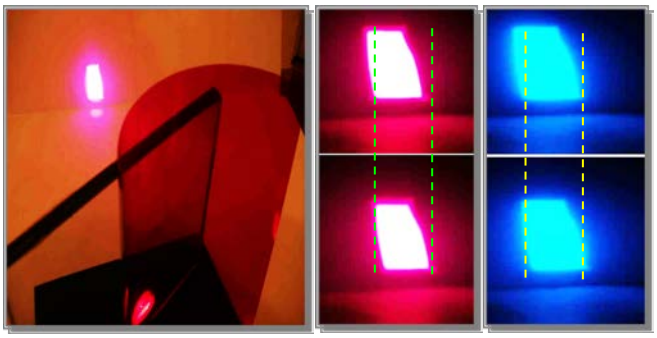


Figure 50 – Spectral composition of two identical colors

However, precisely the existence of identical colors of the different spectral composition indicates the fact, that it is not true that a color is the light of a specific wavelength. Conversely it should be the case. A certain color will manifest through the light of a certain wavelength. But the wavelength is not a determinant of the color itself.

The colored light beam of the projector is let passed, firstly, directly to the screen, and then through the thick glass plate, as shown in the first picture. The glass plate shifts the light beam at the screen due to the refraction of light, which is seen on the photographs taken from the same position.
However, both the magenta and the blue beam of light are shifted on the screen. According to the Newtonian color theory, magenta is an outspectral color and it should not have a specific refractive index i.e. a specific wavelength. But the experiment shows that the beam of magenta light is refracted by the glass plate, i.e. it has a certain refractive index.



Trial 7 – Refraction of magenta light beam

This conclusion leads us to the fact that the Newtonian school of colors has no explanation for the question what color is.

[18] This conviction is a reverse conclusion of Newton's theory that "Lights which differ in color, also differ in degrees of refrangibility".

[19] Newton's problem reads: "To define the refrangibility of the several sorts of homogeneal light corresponding to the several colors". In modern vocabulary it means: "Determine the wavelength of light that corresponds unambiguously to a particular color".

Yes, indeed. What is a color? [20, LIII]

- - -

Let us recapitulate the conclusions of the possible critical analysis of the Newtonian color theory:

1. *White light does not contain all the colors.*
2. *Darkness is not nothingness.*
3. *Colors do not appear perpendicular to the beam of light, i.e. the white light ray does not separate into its components.*
4. *Light is not discontinuous, i.e. the light rays are not components of light.*
5. *The colored light is not a result of selective absorption.*
6. *A color of the object is not a result of selective reflection.*
7. *Colors are not lights with specific indices of refraction (wavelengths).*

The Newtonian color theory leaves more questions unresolved than answered. All this suggests that we need to take a completely different direction.

And here on the scene appears the timeless genius – J.W.Goethe.

[20] Upper experiment shows the impropriety of the first part of Newton's theorem that "Each homogeneous light has a corresponding color, in accordance with the refractive index ...". It turns out that the light of magenta color, as the "outspectral", should also be heterogeneous, i.e. it should not have a specific refractive index like some of the "spectral" color.

III GOETHEAN TEACHINGS ON COLORS

"All factual is already the theory"

J.W.Goethe

One of the most basic optical experiments, to which the modern culture pays less attention, is the darkened chamber experiment.

Let us take a closed cardboard box with a punctured hole on the front pane. The wall on the opposite side of the opening is replaced with a semi-transparent glass or paper. When we put a light source f.e. a candle, in front of a darkened chamber, on the side opposite the opening, we can see an inverted image of a candle. Darkened chamber was known in antiquity, and in medieval times it was called by the Latin name "camera obscura"

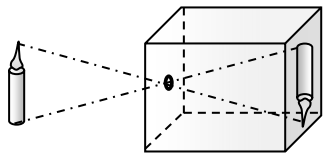
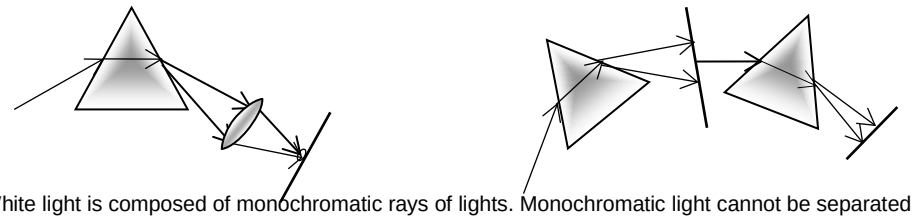


Figure 51 – Camera obscura

On the other hand, let us clearly visualize two Newton's experiments, the first – in which he argued that the white light consists of monochromatic lights, and the second – in which he argued that the monochromatic light is homogeneous.



White light is composed of monochromatic rays of lights. Monochromatic light cannot be separated

Figure 52 – Newton's proofs

Let us connect these two experiments with the camera obscura.

The narrow beam of white light is let through a prism. Behind the camera obscura, the monochromatic yellowish-green light that is separated from the spectrum is diminished by the lens. On the screen, we get a white blur. What does this experiment teach us? That we can get white from yellowish-green?

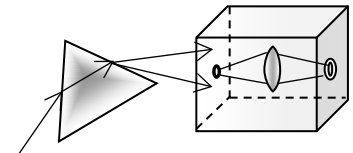


Figure 54 – White can be obtained from yellowish-green?

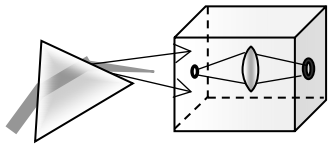


Figure 54 – Black can be obtained from magenta?

Conduct the same experiment with Goethe's dark spectrum. Now, it is chosen the narrow beam of magenta light that is diminished by the lens. On the screen, we get a black blur. What does this experiment teach us? That we can get black from magenta?

Exactly the camera obscura will show what an obscure picture of the world one gets if one starts believing in something that is only a sketch of reality, instead reality itself.

1) Light is a transparent Image

Before any interpretation of optical phenomena, one must first explain what light is. In order to avoid being misled, at the very beginning, we shall not be involved in things that are beyond perception. Let us not be troubled at the outset with the question of whether light is of wave or corpuscular nature. We shall stick to pure phenomena, as it was taught by Goethe himself.

Light is the carrier of the image! There is not any ray of light whatsoever; rays of light are geometric notions of light. In reality, light does not consist of the light rays. Rays of light are something we have adjoined to a phenomenon of light. If a light ray existed, then by looking through a magnifying glass, we should see the ray. However, we do not see any ray, we see an image. And it does not matter whether the image we watch is seen directly, or we look at its projection on the screen. The image is in light; light is an image without contours, so we observe the brightest object of the image as a beam of light. To be able to see the original image, it is necessary to focus light by a lens. This is how the overhead projector operates – the blurred image of light is enhanced by the lens, making the image details visible again.

When light is focused on the screen, we see the image illuminated by light.
Figure 1 – the actual image,
Figure 2 – focused image by lens
Figure 3 – focus, zoom

1 **2** **3**

Trial 8 – Light is a transparent image

On the other hand, the camera obscura shows that the image illuminated by light does not depend on the size of the beam. If the beam is expanded, the image carried by a light beam is magnified; if the beam is contracted, the image carried by a light beam is reduced. Light never loses the image, not even when passing through small openings. Light carries the image, and the eye sees that image! [LIV]

That and nothing else is needed to understand, to be able to approach serious interpretation of luminous phenomena.

2) Light is Monolithic

Let us connect the chromatic aberration experiment with the light dispersion experiment. If we want to come to an understanding of color, we must turn the prism over and start considering things from a quite different perspective.

When we look at the picture of the white square on a black background through the prism, we look directly at the picture. And when we conduct the light dispersion experiment, then we look at the picture from the side. The chromatic aberration experiment and the light dispersion experiment are exactly the same two experiments.

It is just that in the first case – we look at the original image through a prism; and in the second case – we look at the image projection on the screen. In the first case, our eye is the screen; in the second case, we watch the image reflection on the screen. And it is completely irrelevant whether we have made an image by illuminating the real picture, or we have made an image by looking at the light source through the square opening. Or, through a square opening, we watch the beam of sunlight that always carries an image of the sun.

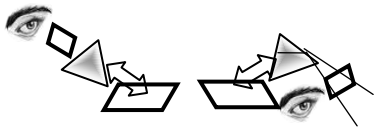


Figure 55 – The chromatic aberration is a front view, and the dispersion of light is a side view, of the image carried by light

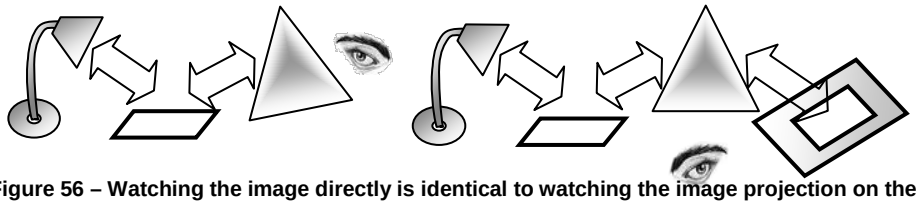


Figure 56 – Watching the image directly is identical to watching the image projection on the screen

In fact, what we see as a bright spot in the focus of lens, it is nothing else but a reduced image of the sun. It is just that the sun is so bright that its radiance flashes the rest of the image. What is wrongly imagined as an abstract source of artificial light, it is always the light carrying the image of glowing filaments. It is just that the image of glowing filaments is so increased in a way that it is conjoined with the rest of the image. [21, LV]

When the light of artificial light source is focused by the lens, we see the glowing filaments as the brightest object of the image. But it turns out that the whole image is here, just that the bright object overshines the rest of the image.

When we blur the brightest object of the image of the sky, after focusing the sunlight, we see the sun as a bright circle.

Trial 9 – Light is a transparent image 2

[21] It is very interesting to notice that, in his book, even Newton himself used the expression "image of the Sun created by a light beam", and the like. However, as optics evolved in the direction of increasing abstraction, the awareness – that one has to deal with the image – has been completely lost. Later, it remained just a ray of light. A ray of light has to do with reality only if the eye is included in the consideration. When we consider the light ray without eye, we enter the realm of abstractions.

And no light rays enter the prism; we look at the image carrying by light through a prism. The image illuminated by light is what "enters" the prism. The prism causes the image shifting which – when viewed as a projection – is seen as a shifting of the light beam on the screen, in the direction of the thicker end of the prism. If we look directly at the picture, we see the picture shifted towards the thin end of the prism.

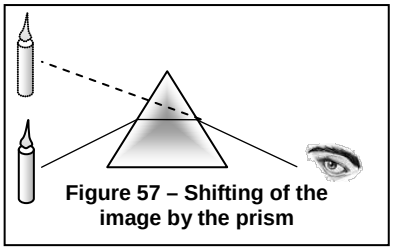


Figure 57 – Shifting of the image by the prism

Apart from the image shifting, the prism also magnifies the image. And since the prism is not of an ideal shape, simultaneously, a reduction of the image sharpness occurs, so-called the image aberration. Aberration is a phenomenon where figures lose sharpness; the edges become fuzzy due to irregularities of optical appliances. In geometrical optics, this is sketched as a multiple focus of the lens, which means nothing else than the image has become fuzzy at its contours. [LVI]

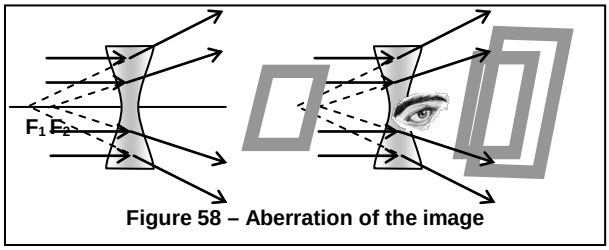
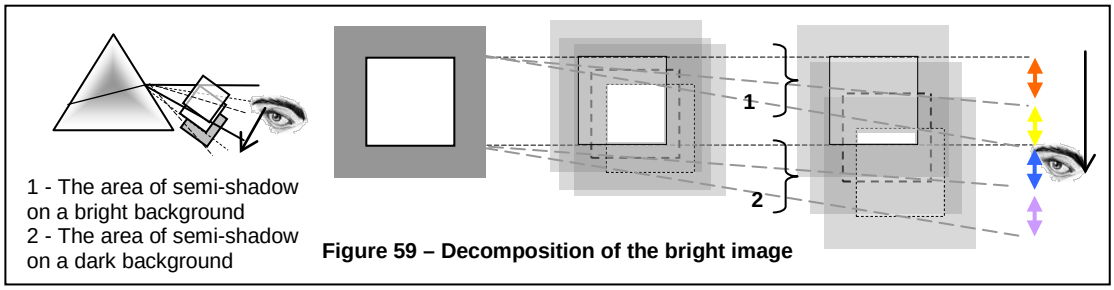


Figure 58 – Aberration of the image

Light is not being decomposed, but the image illuminated by light has become fuzzy. The picture of the white square on a black background has lost the sharp contour and has weakened. In such a way, an area of semi-shadow (a so-called "terminator") is created, i.e. the area of light and darkness interpenetration. On the boundary of light and darkness interpenetration, colors are now born. Colors are weakened light, light weakened by darkness i.e. shadow.



1 - The area of semi-shadow on a bright background
2 - The area of semi-shadow on a dark background

Figure 59 – Decomposition of the bright image

Where a weakened picture of the white square is shifted on a white background, there is a place where light penetrates into shadow causing the appearance of red and yellow.

This is the same as when we look at a picture of the sun through a turbid liquid, we watch light out of darkness. The fluid shifts the image, and a transparent medium distorts the contours of the image allowing the light penetration in the area of darkness, i.e. shadow. Red appears. That is why morning or evening afterglow occurs, only here, the atmosphere shifts the image of the sun dispersing the image sharpness.

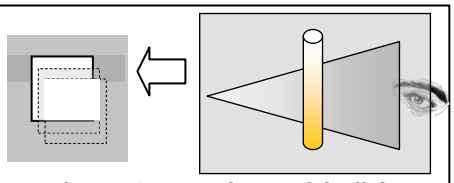


Figure 60 – Experiment of the light penetration into the darkness

Conversely, where a weakened picture of the white square is shifted on a dark background, there is a place where shadow penetrates into light causing the appearance of blue and violet. We look at darkness out of light. Blue appears. That is why, the sea is blue, only here, the water shifts the image of the sun dispersing the image sharpness.

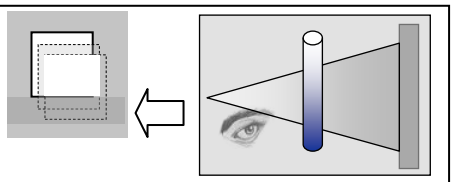
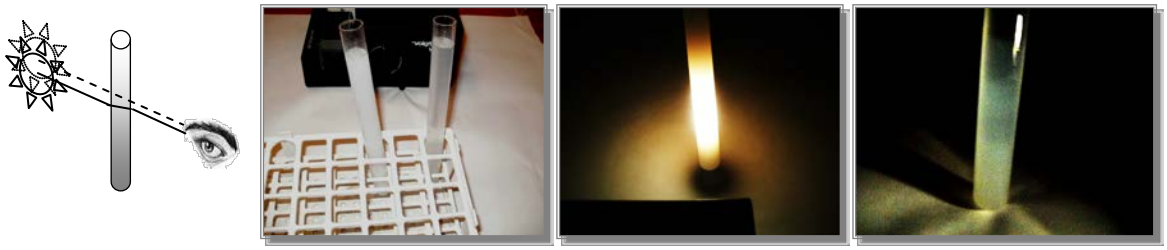


Figure 61 – Experiment of the darkness penetration into the light



1. When we look a picture carried by light on a bright background through the water blurred with milk, the water becomes yellowish.
2. When we look a picture carried by light on a dark background through the water blurred with a few drops of milk, the water becomes bluish.

Trial 10 – Penetration of light into darkness and darkness into light

Where the image of the white square is shifted towards a white background, it indicates that light is weakened by shadow; hence there a red and yellow color appears. Where the image of the white square is shifted towards a black background, it indicates that shadow is illuminated by light, shadow is reinforced; hence there a blue and purple color appears.

If the prism is distanced from the surface, or the same; if a screen in the experiment of light dispersion is distanced from the prism, the image will be even more distorted, so yellow and blue will start to mix producing green. Spectrum will appear. [22, LVII]

And light has not been decomposed. Light has been, and has remained, monolithic!

3) Darkness is Monolithic

Let us repeat the same experiment, but this time with a black square on a white background.

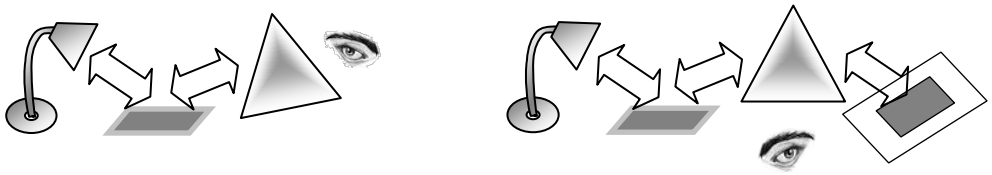
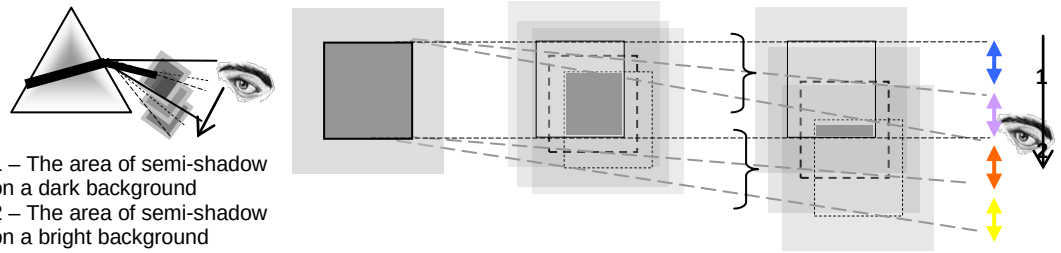


Figure 62 – Obtaining Goethe's dark spectrum

Now the image that is being viewed through a prism is different. Where the image distortion is overlapped with a black background, it indicates that shadow is shifted towards light, hence blue and violet appears; where the image distortion is overlapped with white background, it indicates that light is shifted towards shadow, hence yellow and red appear. If we distance the prism farther from the pad, violet and red start to overlap producing magenta.

We see Goethe's dark spectrum.

[22] In his book, Goethe described a multitude of experiments where colors are obtained by weakening or strengthening light. E.g., an interesting experiment is the one with the white parchment paper on the window glass. When we look at a parchment paper on the window glass illuminated by sunlight, the parchment becomes yellowish. By placing more parchments over this parchment, the color changes from yellowish to reddish. Conversely, when a parchment is illuminated with light reflected from snow, depending on the thickness of parchments added, parchments change color from bluish to violet-bluish.
Practically, these experiments are based on Aristotle's observations. See endnote.

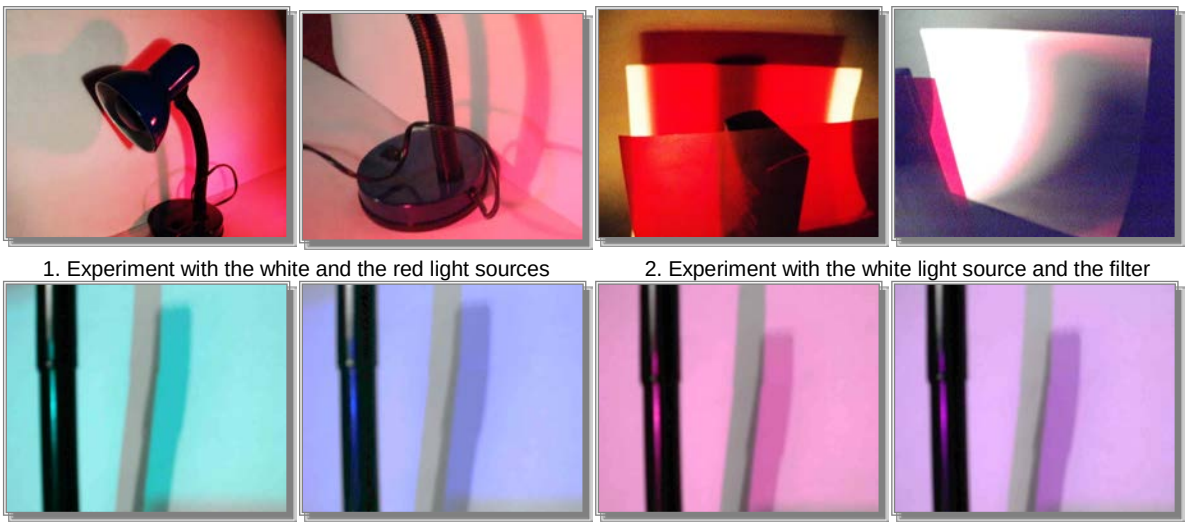


1 – The area of semi-shadow on a dark background
2 – The area of semi-shadow on a bright background

Figure 63 – Decomposition of the dark image

Let us consider the colored shadow experiment, described in Goethe's "Teaching on Colors". [23] *Two sources of light, the white and the red, illuminate an object. The shadow cast by the white light is red. But, the shadow cast by the red light is green.*

The same experiment can be made when we look at the image on a screen that is colored by a red filter, in the shadow area of an object. When we illuminate the red filter with the white light, we see the red color on the screen. As long as we look at the shadow of the object in the range of the filter, the shadow of the object is dark. But, if the shadow of the object is shifted towards the area of semi-shadow – by positioning the filter aslant to the light source – we can see the greenish color. This is because we have enabled the encounter of darkness and light. Wherever light and darkness meet, a color appears. The same is done in Goethe's colored shadow experiment. The shadow is illuminated by the white light. Due to the diminishing of light by darkness, illuminated shadow of red environment becomes shadow of complementary color – of green.



1. Experiment with the white and the red light sources
2. Experiment with the white light source and the filter

Turquoise light creates reddish shadow | *Blue light creates yellow shadow* | *Purple light creates green shadow* | *Violet light creates yellow-green shadow*

The white light in combination with differently colored light sources

Trial 11 – Experiments of the colored shadows

Goethe's terminology "the penetration of light into darkness" or "the penetration of darkness into light" is quite incomprehensible to modern people. Let us change the expressions.

Consider the chromatic aberration experiment. When we look at the image through a prism, due to the distortion produced by glass, the image is disassembled into faded images. Semi-shadows occur in the contour area of the figures. Those semi-shadows are now illuminated by the white light; we always watch illuminated images. Colors are being born out of the illuminated semi-shadows, depending on the brightness and position of the observer.

[23] Schema of the experiment is given on the sketch no. Figure 16 pg. 16.

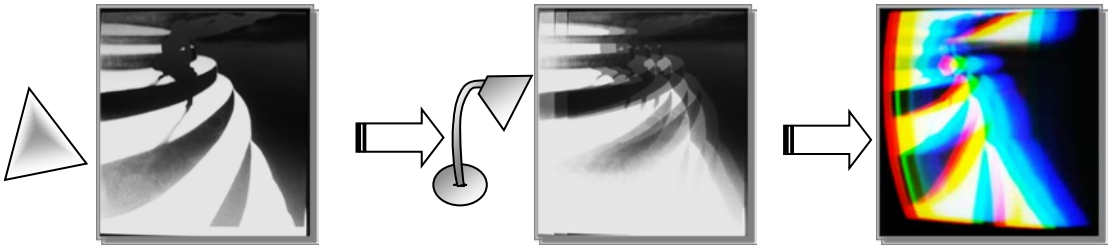


Figure 64 – Appearance of colors in the chromatic aberration

Light creates white color; darkness creates black color. White color is the first shade of light. Black color is the first illumination of darkness. Darkness is not just the absence of light, such as black color is not just a lack of light reflection. Light is the power that illuminates the images and cannot be decomposed. Darkness is the force opposite to light and manifests itself as the shadow of an object. Darkness cannot be decomposed either.

Darkness is monolithic!

4) Colors are not contained in Light

First, let us consider the effect of the lens on the image.

a) Convex lenses

When we look at the picture on the screen, means, when we look at the image reflection, a convex lens reduces the image (within the focal length). When we look directly at the picture, a convex lens magnifies the image.

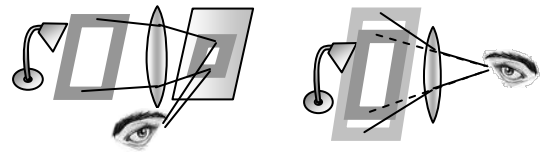


Figure 65 – Convex lenses

b) Concave lenses

When we look at the picture on the screen, means, when we look at the image reflection, a concave lens magnifies the image (within the focal length). When we look directly at the picture, a concave lens reduces the image.

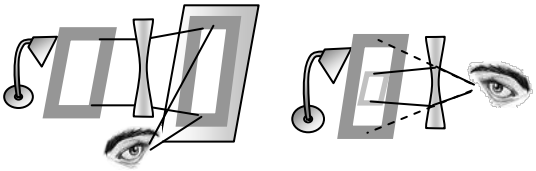


Figure 66 – Concave lenses

Now let us analyze Newton's experiment with which he tried to prove that white light contains all the colors. What has happened?

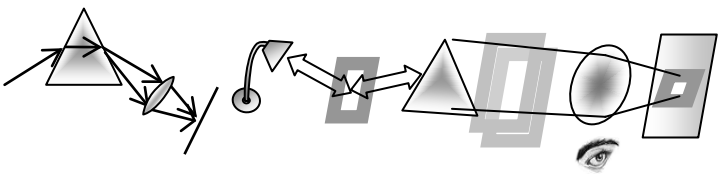


Figure 68 – Newton's experiment of the white light synthesis

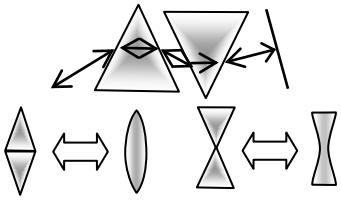


Figure 68 – Lenses are a combination of two prisms

Firstly, the prism has magnified the image producing the dissipation of image contours. On the contours, semi-shadows are created causing the appearance of colors. Then, the lens has reduced the image producing the diminishing of the image contour dissipation. Since the dissipation of contours is minor, the area of the light and darkness interpenetration is small, so we cannot see colors on the edges.

The same thing would happen if an increasing of aberration by a prism was compensated by a decreasing of aberration with the second prism.

Perhaps it would be less confusing to present lenses as a combination of two prisms. Convex lens is the same as the joint of two prisms at their base. Concave lens is the same as the joint of two prisms at their top.

Optical devices do not add up colors. An optical device magnifies or reduces the image. In Newton's experiment, no addition of colors has occurred. Light does not contain the colors.

Light is colorless!

5) Colors are not contained in Darkness

Let us consider the experiment I have used as a skit, at the beginning of the book, with respect to the thesis that darkness contains all the colors. Now we do the same as in the previous experiment, only now, we watch the black square on a white background. Of course that darkness does not contain all the colors.

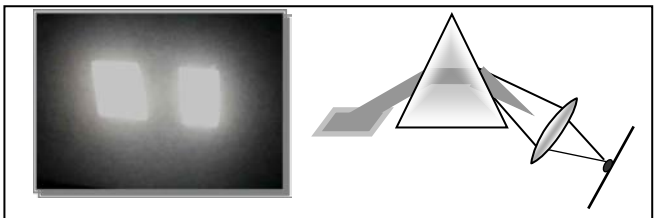


Figure 69 – Dark spectrum is reduced into the original image by convex lens

All we have is a distortion of the black square on a white background that is being reduced again to a black spot by the lens.[24]

6) Colors exist on Objects

Of course, the image illuminated by light does not have to be black and white. The image in light appears in a way as it was created by a light source, alone or in combination with color of an object. If the surface of an object illuminated by light is colored, the image carried by light is colored, too. When we look at the blue square on a white background, we perceive an image of the blue square on a white background through light.

Now, if the blue square is illuminated by yellow light, what happened?

[24] In a particular case, in the experiment from the beginning of book, a dark spectrum was created with a beam of light that is obscured in the middle, shown at the picture attached. This image is again obtained by focusing with the lens (see trial no 1 pg. 26).

Yellow image carried by light, is mixed with the image of the blue square on a white background, and now we see the blue square on a white background with a green circle. This is because the eye merges the impressions into the entire image.

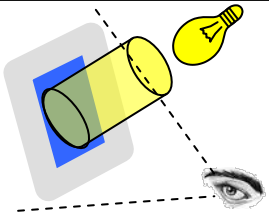


Figure 70 – Mixing the color of objects and the colored image of light produces a new image

Reflection of light on the surface exists, but it is the least significant fact of the color appearance on the surface. It is not a reflection of light off the surface something what has caused the surface color. The color of the surface is a very complex phenomenon that involves at least three things, namely:

1) *Color of the surface*

A color exists on the surface of a body. In books of physics, it is common to say that the reflective properties of the surface determine the color of the surface. As an argument is usually stated that, for example, a green surface illuminated with the red light does not appear green, but dark. This is used as evidence that the greenness of the surface is determined only by the reflection of input light. Since the green color does not reflect the red light rays, the surface is dark. [LVIII]

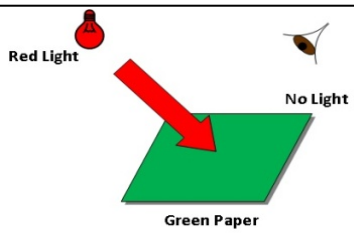


Figure 71 – Notions of the Newtonian school on the coloration of objects

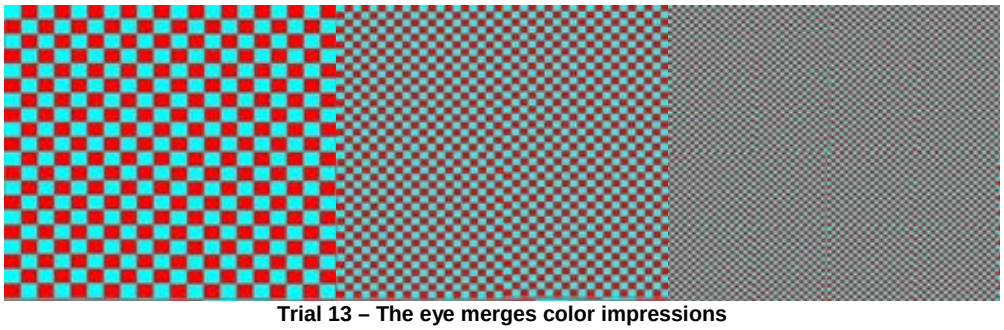
Yes. But it is being forgotten that the green object is visible when it is illuminated with the red light. If the whole outside world was green, we would still see it even under the red light. If the green surface had not reflected the light of any color, then that object would have become invisible under the colored light. However, the object can be seen, just that its color is not visible. Colors exist on the surface of the body. The primary phenomenon of light is illumination, and the primary phenomenon of perception of the body color is its color.

Trial 12 – Leaves under the red filter

2) *Quality of light*

A part of the truth is hidden in the theory that the color of light determines the color of objects. Only, the problem is that modern physics tries to declare this part of the truth as the full truth.

The fact is that the quality of light affects the color of objects. When we illuminate the surface of the object with the additive obtained white light, it may be noticed that the quality of light illuminating the colored surface affects what we see. The green surface looks different when it is illuminated with the white light obtained by mixing red and blue, than when it is illuminated with the white light obtained by mixing yellow and purple. This is because these two kinds of white lights have different qualities, or as nowadays commonly said – a different spectral composition. This fact is very well known to painters and photographers. It is not the same, whether the object is illuminated by sunlight or by the light obtained from fluorescent bulbs. The colors are different.



Trial 13 – The eye merges color impressions

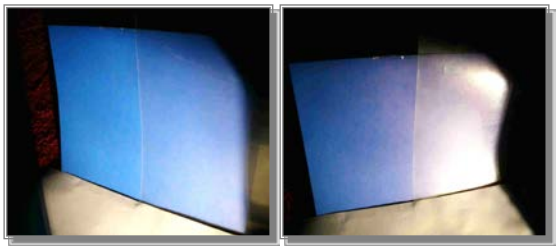
This is because one of the basic properties of our eyes is merging the small details that cannot be discerned, into one impression. When we place the red and the turquoise squares alternately, if the squares are small enough, the eye is not able to discern details of the image, hence we see the red and the turquoise squares as the impression of gray. When e.g. a green surface is illuminated by the light from a red source, our eye merges the image of green surface with the image of the red light source into one impression, into gray color – and this is what we see as the newly created color of the image. [25]

Our eye is what mixes colors!

3) *Reflective properties of the surface*

Thirdly, there is a reflective property of the surface. The reflective properties of the surface do not determine the color of objects, but the glare of the color. For example, we can have two blue surfaces of the same color hue, but with different reflective properties.

Smear one part of a collage paper with varnish or just cover it with colorless cellophane. The left surface reflects less light than the right one, as seen in different reflection by rotating the surface. Color hue remains the same, but now a reflective property of the surface is changed. This is what we see as the surface glare, the glare on the colored surface. Reflectance determines the gloss of the surface color, and it is a tertiary phenomenon of the coloration perception.



Collage paper is covered with cellophane. The source of light is on the right side.

Trial 14 – Reflective properties of the surface

7) Colors are not contained in other Colors

Let us consider the experiment with which the Newtonian school tries to prove that colors are defined by a certain spectral composition. E.g. when we let the green light obtained by mixing the yellow and the blue light through the prism; after the crossing the prism, such green light is being decomposed on the yellow and the blue light we see on the screen. This process is called the spectral analysis. Spectral analysis leads to a conclusion that such green light is composed of a spectrum of blue and yellow light.

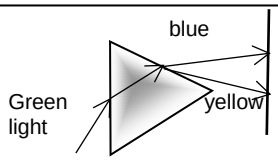


Figure 72 – Spectral composition of light

[25] In the same way, the inability of sensory reception of illumination leads to blindness, and the inability of color distinguishing leads to the daltonism (color blindness).

Yet, in the interpretation of this phenomenon we deal with the same errors. Let us draw the entire sketch to the end.

First, we have merged the yellow and the blue image of the colored light sources by a convex lens. Thus, an image of yellow and blue light is reduced, the images are mixed, and now we see an image of the yellow and the blue light sources as the green light. Then, with the help of the prism, the image is magnified again. On the screen, we see the original image.

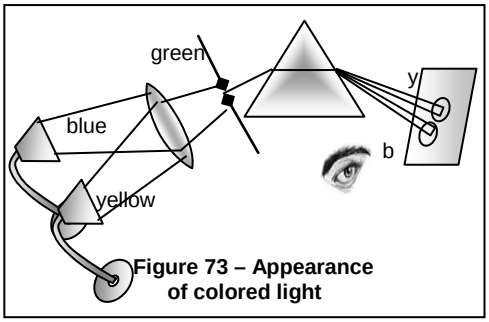


Figure 73 – Appearance of colored light

Colored lights do not hide other colors. Colored lights contain colored images. It is just about that a convex lens merges images, while a concave lens expands images. A prism is a half of a lens; the prism magnifies the projection of an image on the screen. We can magnify or reduce the image, and thus create the apparent occurrence of colors.

Red and green light sources illuminate the prism and loupe. The light obtained is bright yellow. The left image shows how both the prism and the loupe enlarge the image, which is seen near the prism as a double light beam on each side of the prism. And since we have two light sources, there is a double shadow cast by the object. Shadows are in an inverse arrangement of light beams.
Expanding the original image can be achieved by watching the bright yellow light through the opening. Practically, each optical device behaves like a camera obscura, with respect to the image magnification.

Trial 15 – Optical apparatus enlarge the image

Furthermore, as it is not true that green hides yellow and blue, in the same way the color filters do not absorb other colors. If we put a blue filter behind the prism, the image carried by light is now colored blue. When yellow is mixed with the blue color of the filter, we get green. Due to the mixing of colors in a dark field of view, green is of enhanced dullness, we get the dark green. The more opaque the filter, the darker is green.

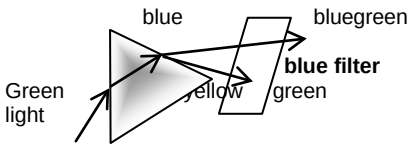


Figure 75 – According to the Newtonian school, light filters absorb light having a different color than the color of filter

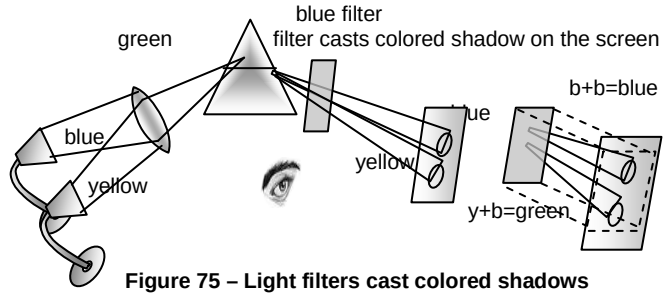


Figure 75 – Light filters cast colored shadows

Now, a meticulous reader would ask – "If we have already obtained the dark green, why is it not visible on the white screen?".

Exactly because the blue filter casts the shadow on the white screen, the screen behind the filter is no longer white but dark blue. The obtained green could not be brighter than the blue shadow cast by the blue filter. Green is always in the shadow of blue filter, only the dullness of green is stronger than the dullness of blue. Color filters do not hide parts of light, they just color images.

A conviction that something can be subtracted from the spectrum with the help of light filters was born out of conviction that filters let a part of light through. When we watch the spectrum on the screen through a green filter, the spectrum becomes green due to the green shadow cast by the filter. Only the green part of the spectrum is visible on the screen. Other parts of the spectrum are poorly visible, because they are merged with the shadow of filter.

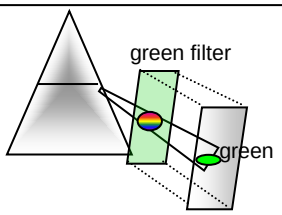


Figure 76 – Coloring of the spectrum with the light filter

Partial passing of light through the light filters is something that cannot be seen in the phenomenon itself. Casting of shadows is something that can be seen in the phenomenon. The phenomena should not be supplemented with our beliefs. The phenomena should be described as they are. Light filters are objects casting colored shadows, not the objects that let light through selectively. Color is not being hidden in any other color enabling to get one color out of another.

It is not only untrue that white color contains all other colors. White color does not contain any other color at all.

8) Color Intensity depends on Contrast of Light and Darkness

Let us consider Newton's experiment, with which he attempted to prove that a monochromatic light cannot be decomposed. Spectrum appears behind the prism, and then the part of the spectrum is let through a small opening. Behind the opening, the monochromatic light is let through another prism.

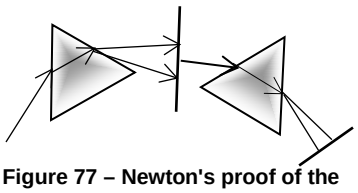
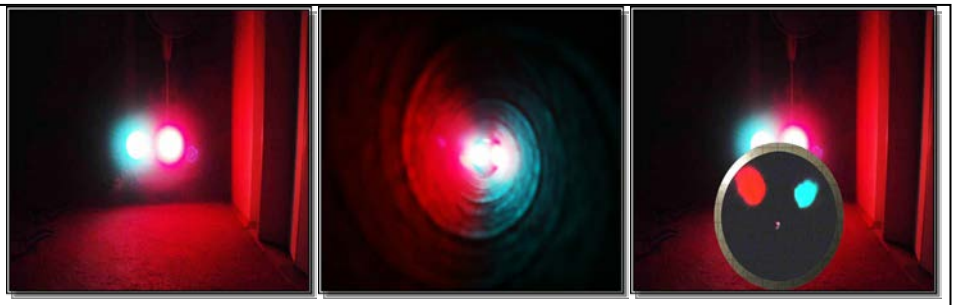


Figure 77 – Newton's proof of the homogeneity of monochrome light

But to really understand what has happened, let us first consider how the camera obscura operates.

When we look at the picture through an opening, our field of view is sheltered by the opening, so we see the part of the picture. If we are closer to the opening, we see a bigger part of the picture; if we are farther from the opening, we see a smaller part of the picture. E.g. when we watch an image of a room through the keyhole; if we are closer to the keyhole, we see a bigger part of a room. If we do not look directly at the picture, but at a projection on the screen, then it is necessary to move away from the screen to be able to see the bigger part of the picture. If the screen is brought closer to the opening, we see a smaller part of the picture.

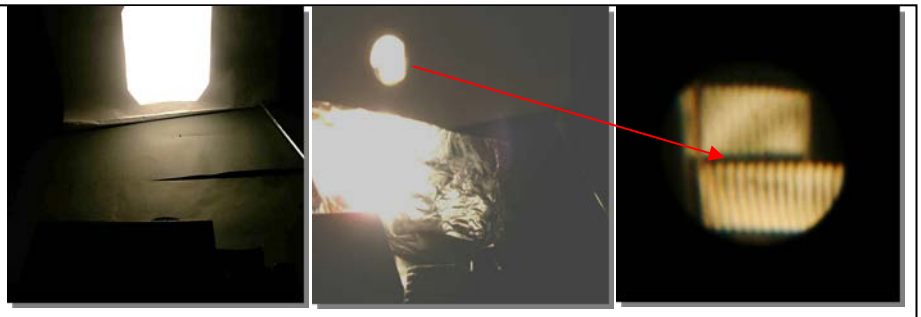
The actual image and the image projection in the camera obscura. Actual picture is the picture of blue and red light sources. The image in the camera obscura is central-symmetrical, which is seen as the changed position of blue and red light sources.



Trial 16 – Camera obscura

When we watch the image on the screen, we see the image inverted central-symmetrically, where the opening is the center of symmetry. This means nothing else than that the image projection expands rectilinearly. In our experiment, this means that the projection of image of the blue light source extends from left to right, while the projection of image of the red light source extends from right to left. In other words, behind the opening, the blue light source illuminates the right part of the inner wall of the camera obscura, while the red light source illuminates the left side of the inner wall of the camera obscura, what we see as the inverted image projection.

The light of the projector is visible on the screen. As the alufoil with a small hole is being moved in front of the projector, the original image is more or less conspicuous on the screen, and this is the image of glowing filaments of the halogen lamp, with a reflector behind the lamp.



Trial 17 – Focusing of the image by the camera obscura

We should keep in mind that the lens can be presented as a camera obscura, which sharpens images, depending on a focal length of the lens. The larger the aperture of a lens, the larger distance has to be between the screen and the lens, to obtain the image focus. In general, the lens behaves not very differently from a camera obscura with a small opening. It is just that the lens glass additionally magnifies or reduces the image.[26]

1. A larger distance from the screen increases the image
2. Convex lens increases the distance needed for the appearance of the whole picture. The dotted line presents a magnified picture of the candle produced by the convex lens.
3. Concave lens decreases the necessary distance for the appearance of the whole picture. The dotted line presents a reduced picture of the candle produced by the convex lens.

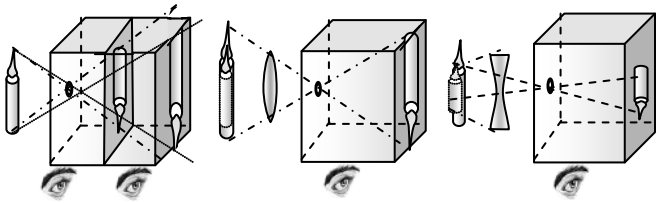


Figure 78 – Projection of the image in camera obscura

Practically, this means that when any lens is placed in front of the camera obscura, this is basically the same thing as when the image is viewed through two cameras obscura. This is exactly what Newton did. Go back to Newton's proof. Draw the actual picture. What happened?

Firstly, the image of the white square on a black background is viewed through the prism. Thus, the image distortion occurs, the image loses its sharp contour, and colors appear on the boundary areas of light and darkness. If the distortion is significant, we see the entire spectrum with green.

Then the image is viewed through a small hole in an obscura camera. Nothing particular has happened there, except that we have limited the field of view, and now we see a part of the image. Camera obscura does not change the image in any way, except that it inverses the figures for 180^0, if we look at the projection of the image.

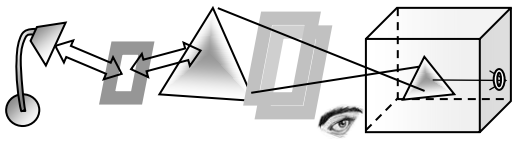


Figure 79 – The actual presentation of Newton's experiment of homogeneity of monochrome light

[26] See the second picture of trial 15, pg. 47.

Camera obscura limits our field of view. The distance from the opening to the screen determines whether we can see a part of the image or the whole image. And if we place the lens in front of camera obscura, it just changes the needed distance between the opening and the screen, which determines when the whole picture begin to appear. If we place the prism in front of camera obscura, it is the same as if we place a lens; a prism is half of a lens.

Behind the camera obscura, distorted image is re-magnified with the second prism. Nothing has happened because the field of view is limited by the screen. The screen limits a field of view on the distorted part of the image. That part of the distorted image creates an illusion of a so-called monochromatic light. Monochromatic light is not reality; reality is the green image. Magnifying the green part of the image produces again the green part of the image.

Consider the experiment stated in Goethe's "Teaching on Colors" – Volume 2, Table XIII, Figure 1.

If in the light dispersion experiment, we limit the white stripe behind the prism by an opening, we have produced nothing else than the limitation of the visibility of the image of the white square on a black background. If the screen is closer to the opening, we see the white stripe on the screen. But if we distance the screen farther from the opening, the spectrum begins to appear on the screen behind the opening.

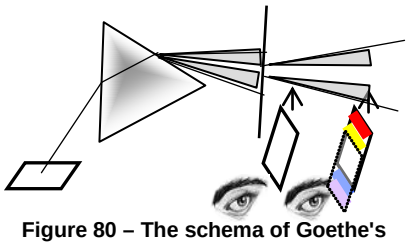


Figure 80 – The schema of Goethe's experiment of obtaining the spectrum behind the screen

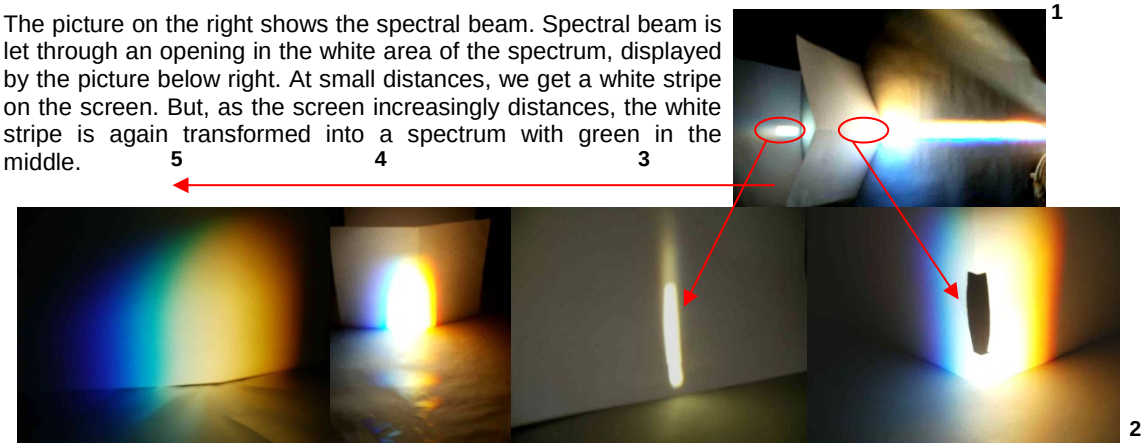
This is because the image increases with the larger distance between the screen and the prism. Since the prism has distorted the image, now the image distortion increases together with the distance between the screen and the opening. Every ray of light carries the entire image, and in every ray of light is an image that is distorted as a result of aberration. The only question is at which distance from the screen that becomes visible. In other words, it is just about how far the "light ray" containing the whole picture should be distanced, to make the spectrum visible again.

This experiment clearly demonstrates that it is out of the question that, behind the prism, all white light has decomposed into spectra, and then, again rejoined into the white light by the additive color mixing, as the Newtonian color theory claims. If this were the truth, at larger distance behind the opening, we would not get the spectrum again. We would always get a white stripe, at any distance from the screen. In fact, the white stripe behind the prism just shows an undistorted area of the image. Such a white stripe always exists; it just becomes narrower and narrower by distancing the screen from the prism.

*It is an illusion that we can take a "green part of the spectrum", spectrum is an illusion – it originally meant "**apparition**". Part of the picture can be seen. However, light never loses the original image howsoever passes through small openings. Small openings only limit a field of view; small openings do not restrict the light. The illusion that the beam of green light is separated from the light beam itself occurs because the field of view is focused on the distorted part of the picture.*

But, place yourself exactly in the middle of the opening!

The picture on the right shows the spectral beam. Spectral beam is let through an opening in the white area of the spectrum, displayed by the picture below right. At small distances, we get a white stripe on the screen. But, as the screen increasingly distances, the white stripe is again transformed into a spectrum with green in the middle.



The same experiment as above, just the spectral beam is focused before the opening. The picture on the right shows the wide white stripe obtained by focusing of light. Behind opening, we again see the spectrum on the screen.

Trial 18 – Goethe's experiment of obtaining the spectrum behind the screen

If we want to see the original colorless image again, we must position ourselves in exactly the center of the image, in exactly the part of the spectrum, which still carries the original, undistorted image. In other words, in the camera obscura, which has not changed the original image in any way, we must position our field of view in such a way that we look exactly into the center of the spectrum, in the very middle of the spectrum there is always the "ray" of light that is not distorted and that still carries the original image. This center of the spectrum is located in a yellowish-green part of the spectrum, when we look at the white square on a black background. When we look at the black square on a white background, the central light ray is located in the area of magenta.

When one looks into the center of the spectrum, the original image appears. Newton's experiment is exactly the same as you have been peeping through the keyhole from a slant angle, wondering why you could not see the whole room. But if you want to see a picture of the entire room, just peep through the center of the keyhole.

Now, it is clearer my frisky trick with the camera obscura.

1. *The picture of the white square on a black surface.*
2. *The picture is distorted by a prism, and the spectrum appears.*
3. *In the spectrum, we limit the field of view with the camera obscura exactly to the undistorted part of the image, which is placed in the area of yellowish-green. When a beam of light is viewed from the front of the screen, it looks as if we have taken a part of the spectrum. When the beam of light is viewed from the back of the screen, it can be noticed that the beam is whitish in the middle, i.e. this is exactly the central point of the spectrum.*
4. *The initial image is focused on the screen by a lens.*
5. *On the screen, we see the original image as a weak bright blur.*

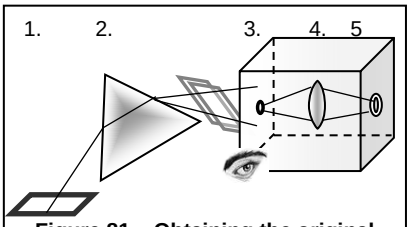


Figure 81 – Obtaining the original image in camera obscura

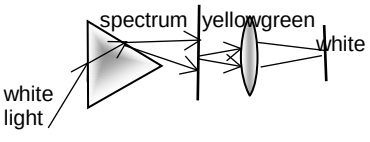
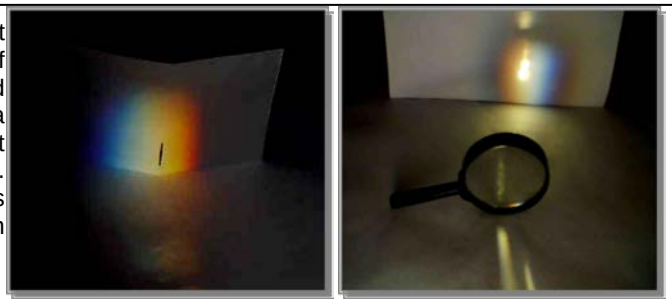


Figure 82 – Newtonian representation of the above trial

If things were drawn in Newtonian way, one would say – yellowish-green contains all the colors! Of course that yellowish-green does not contain all the colors.

This is an identical experiment to Goethe's experiment of obtaining the spectrum behind the screen, it is taken a narrow beam of the white light in the yellow spectral region. Just in the end, the beam is focused by the lens to obtain the original image.



Trial 19 – Obtaining the original image behind the screen

Let us consider Newton's experiment by chromatic aberration.

In the first step, we watch the white square on a black background. In the second, the image of the square has lost its sharp contour, so colors appear. In the third, the field of view is sheltered, so only the green distortion is visible. In the fourth, the green image distortion is again viewed through the prism. Practically, now the green part of the picture is magnified.

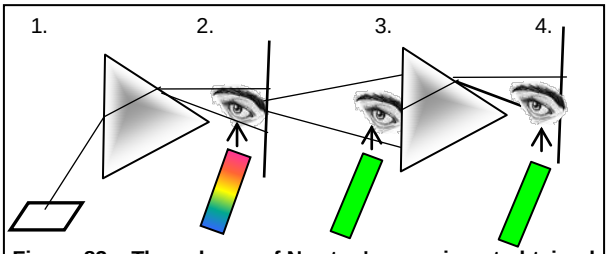


Figure 83 – The schema of Newton's experiment obtained by chromatic aberration

Nothing happened. This is the same as when we watch through the prism into the pure green surface. Since there is no meeting of light and darkness, green remains green.

Newton's experiment describes the attempt to cause some effect by watching into a monochromatic picture through the prism. In fact, Newton's experiment is not evidence that monochromatic light cannot be decomposed; it is precisely evidence of a central thesis of Goethe's Teaching on Colors, stating that colors appear only by light and darkness interpenetration.[27]

9) Additive Color Mixing is Merging of Impressions of Bright Colored Images

According to the interpretation of color mixing of the Newtonian school, when colored lights are mixed, we are dealing with the addition of the white part of the spectrum. E.g. when yellow and blue lights are mixed, mixing of the yellow and the blue part of the spectrum appears. Parts of the spectrum are being added, therefore this kind of color mixing is called the additive color mixing.

However, when the differently colored light sources are watched, there is no addition of the spectrum. Light carries the image; the image is what the eye sees. One of the basic properties of the eye is merging of simultaneous impressions of image details. When we watch two colored points, the eye is not able to distinguish image details, but it merges these impressions into one image. When we watch colored lights simultaneously, the impressions of

[27] Here, Goethe's teaching should be supplemented emphasizing that the statement "colors appear by light and darkness interpenetration", refers to the white light.

the image illuminated by light are merged. Therefore, we see the green light as a newly merged impression of the yellow and the blue light source.

What is important is whether the mixing of the colored images is obtained in a bright field of view or in a dark field of view. If the field of view is bright, then it is a matter of mixing the images of the colored light sources. Then we look at light out of darkness. When we watch the merging of light-images on the screen, we watch a bright field of view out of the darkness; colored lights are always brighter than the point of observation. A field of view is bright, because it is created by light – not by the screen, but by the light that illuminates the screen. We see the images of colored light sources, not a screen.

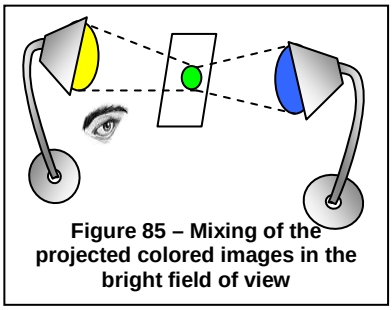


Figure 85 – Mixing of the projected colored images in the bright field of view

Therefore, the green obtained is green of enhanced brightness. The illumination of the green image is larger than the illumination of yellow and blue image. That is completely understandable, because the illumination of the merged image is higher than the illumination of images of the constitutive light sources.

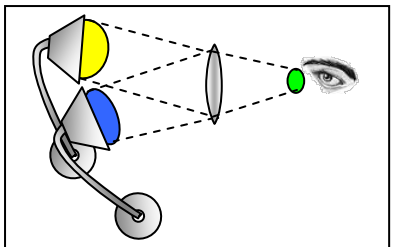


Figure 84 – Direct mixing of colored images in the bright field of view

The impression of mixing of colored lights can be obtained in another way. Instead of watching the projection of images on the screen, let us look directly at the two images, which are merged by convex lens. Out of the darkness, we look at the merged image of yellow and blue light source.

We see the bright green image.

10) Subtractive Color Mixing is Merging of Impressions of Dark Colored Images

According to the interpretation of the Newtonian school, during the subtractive mixing of colors, a narrowing of the original white spectrum occurs. E.g. when the light that passes through yellow and blue filter is being mixed, the original spectrum is confined to an area of yellow and blue light. However, here too, we do not subtract any kind of light from spectrum. Just, the eye merges the impressions of colored shadows.

Look at the white light through the yellow and blue filter. Filters cast a shadow over our eyes, and our field of view is shaded. Obtained color is a color of increased dullness. Modern physics recognizes only the additive law of intensity of light sources. E.g. it is said that the total intensity of light from two light sources, is equal to the sum of intensity of the single sources of light. But, the same law is valid for shadow. The total strength of the shadow produced by two objects casting shadows, is equal to the sum of strength of individual shadows. Two filters cast a twice stronger shadow, so the color obtained is shaded.

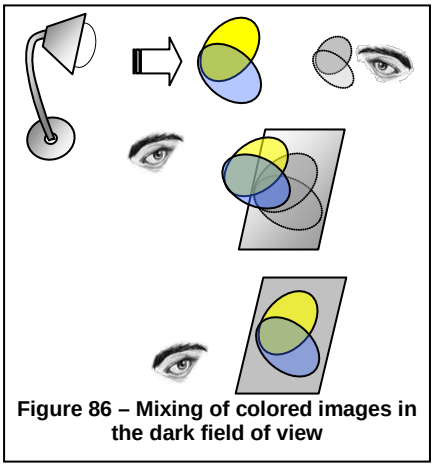


Figure 86 – Mixing of colored images in the dark field of view

The same experiment can be done in another way. Rather than looking directly at the mix of colored shadows, let us look at the projection of shadows on the screen. Watch the dark background through the yellow and blue filter. Again, the field of view is shaded, because the filter casts colored shadows. In other words, we look at darkness out of light. Therefore, the obtained color is of enhanced dullness, we get the dark green.

Or, instead of looking at a dark background, put the filters on a dark background. Paint pigments mix in such a way. When we speak on color mixing, just hold on to the eye phenomenon.

Yellow and blue produce an impression of green.

- - -

A nice experiment of mixing the impressions of colored lights and colored shadows can be obtained with the help of three light sources. Take three lamps with red, blue and green light.

If we watch the mixing of impressions of colored lights, we get:

red + green = yellow of enhanced intensity
red + blue = magenta of increased intensity
blue + green = turquoise of enhanced intensity

yellow + magenta + turquoise, of increased intensity = white

Trial 20 – Mixing of the color impressions on a bright and dark field of view

Again, if we watch the images of colored shadows cast by an object, three light sources cast a triple shadow. Therefore, we have:

The shadow of the blue light source is obtained by mixing the impressions of shadows of red and green light, so the shadow is yellow.
The shadow of the green light source is obtained by mixing the impressions of shadows of red and blue light, so the shadow is magenta.
The shadow of the red light source is obtained by mixing the impressions of shadows of green and blue light, so the shadow is turquoise.

We get:
turquoise shadow + magenta shadow = blue darker shadow
turquoise shadow + yellow shadow = green darker shadow
magenta shadow + yellow shadow = red darker shadow

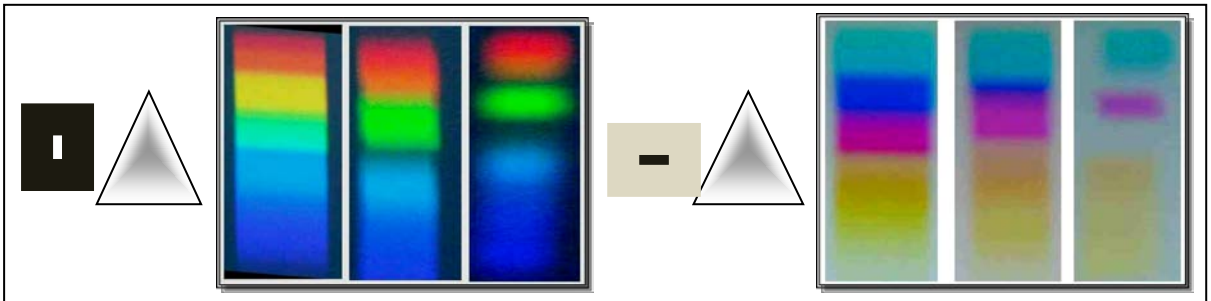
blue darker shadow + green darker shadow + red darker shadow = black

There is no subtractive or additive color mixing. It is all about whether the colored image impressions are being merged in a bright field of view – when the color brightness is enhanced; or they are mixed in a dark field of view – when the color dullness is enhanced.

11) Goethe's Color Circle is Objective Phenomenon

Look at the picture of the white square on a black background through the prism. If we distance the prism farther from the pad, the image is distorted and colors begin to appear on the edge. On the one hand, red and yellow, and on the other hand, blue and violet. If we increase a distance, yellow and blue start to overlap producing green.[28]

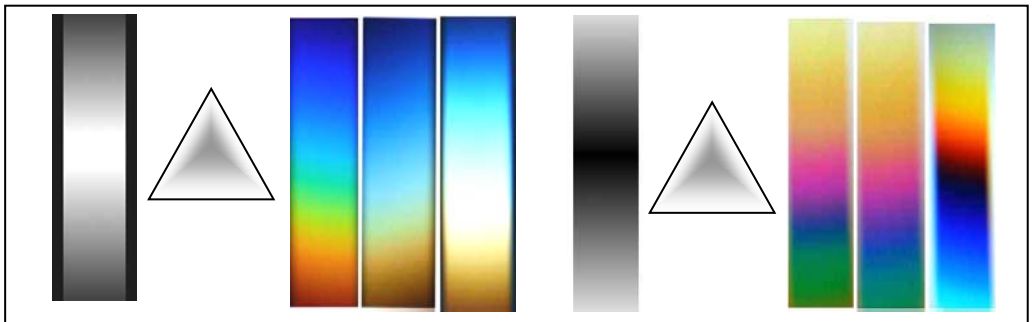
Place the prism very far. The image is now so much distorted that we get the separated colored squares. The same effect would be obtained, if – in an experiment with a prism – the screen is distanced very far from the prism. Conversely, look at the black square on a white background. Distance the prism very far. Again, we get the separated colored squares. This is an image of disassembled Goethe's dark spectrum. [29]



a) Bright spectrum b) Dark spectrum

Trial 21 – Chromatic aberration of a remote picture

Yet, in the light dispersion experiment, separated colored squares are difficult to spot, because the input image is blurred. Watch through the prism an image with black tints, which is practically nothing else but the picture of glowing firmaments of the artificial light source, or the image of the sun seen through a narrow opening. When we distance the prism farther from such an image (or the same, when we reduce the image), we get the spectrum without sharp tints, like the spectrum obtained as the projection of the input light. To obtain the separate images on the projection, input image must have sharp edges. However, it cannot be obtained by the projection because color overlaps. In his experiment, Newton could not get the spectrum with the sharp color transition because he has used a picture of a small glittering-white circle on a black background (practically a small hole in a window, in a dark room).



Trial 22 – Chromatic aberration of a picture without sharp edges

There are three dominant colors of the bright spectrum namely, red, green and indigo blue. There are three dominant colors of the dark spectrum namely, yellow, purple and turquoise.

[28] Compare to trial no. 3, pg. 28.

[29] These experiments are obtained on a computer screen, so the violet nuances are not visible. Depending on the quality of the input white light, more colored squares can appear. In a given experiment there were three, but it can be more.

Now arrange the six colors of light and dark spectrum, in a circle. Thus we get Goethe's color circle, which serves for the aesthetic analysis of color impressions.

There are two primary colors. The primary color of light is yellow, which is the first color of light weakened by darkness. Yellow is the first shade of light. If yellow is weakened, a red appears. The primary color of darkness is indigo blue, which is the first color of darkness weakened by light. Deep blue is the first illumination of darkness. If blue is strengthened by illumination, a violet appears. Green and purple are transitory colors.[30]

Figure 87 – Goethe's circle of colors

Goethe's circle of colors is not fiction. It is based on a completely real and objective phenomenon.

12) Physical Color is weakened Light

Official physics considers that color is the light of certain spectral composition. To clarify the essence of what official physics calls the spectral composition of light, let us first consider the relationship between an object and its shadow.

When a three-dimensional object is illuminated from one side, it casts a shadow on the screen. The shadow of a three-dimensional object is two-dimensional; it is a projection of a three-dimensional object on a plane. If the object changes, shadow takes over other forms. In such a way, we can make a myriad of different forms of shadows. Now, let us consider what physics calls the spectral composition of light.

Figure 88 – Three-dimensional object casts a two-dimensional shadow

E.g., we have the two green lights, the first, obtained by mixing yellow and blue, and the second is pure green. The light is let through a spectrum analyzer, through a prism. At the screen, we get a projection of the spectral analysis. However, we already know what it is all about. Since light carries the image, the prism has just magnified the image carried by light displaying the original image. The image carried by light is two-dimensional, it is on the plane.

The question arises: is it possible to make a projection of these images? Of course, images can be projected; the projection of images can be done as follows:

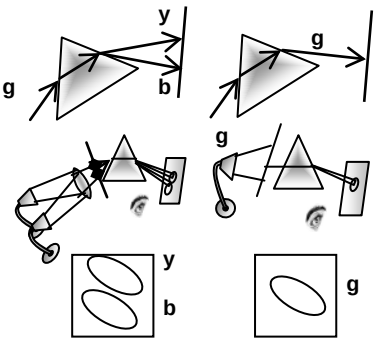


Figure 89 – Light is a two-dimensional image

Observe a black piece of cardboard in a position perpendicular to our view. On the one side, the surface of a black cardboard is illuminated by the light carrying images. And just turn the

[30] Precisely speaking, white and black are primary colors of light and darkness. White color is fixed light, black color is fixed darkness. However, because of the rules of color mixing, a special place belongs to these two colors, so they can be considered colors outside the circle of other colors. White and black can be obtained by combining any two colors from the color circle, but for other colors that is not the case.

board. What have we got? Nothing else, but the spectral composition of light. The spectral composition of light is exactly the projection of the original image carried by light, the shadow of the original image.

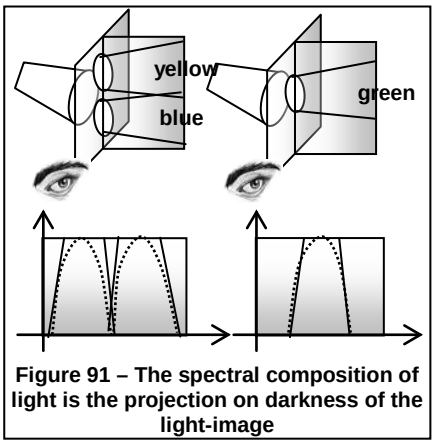


Figure 91 – The spectral composition of light is the projection on darkness of the light-image

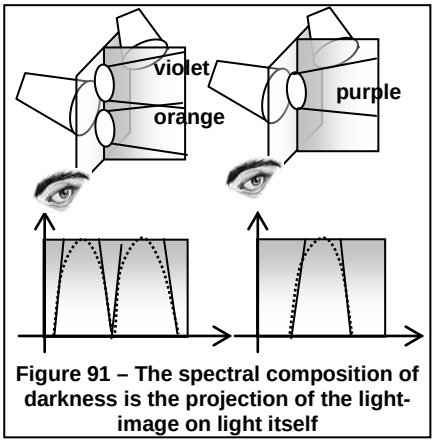


Figure 91 – The spectral composition of darkness is the projection of the light-image on light itself

The shadow of image can be obtained in another way. Instead of a black cardboard, take the semitransparent cellophane and illuminate it with the white light. Now the image is projected onto the light. The colors are complementary. Again, just turn the cellophane. What have we got? Nothing else, but the spectral composition of darkness. This is exactly the projection of image carried by light on the light itself. Because, if we give ourselves the right to talk about the spectral composition of light, then we could talk about the spectral composition of darkness, as well. Shadows can be obtained in myriad ways.

However, considering the hands creating a play of shadows on the wall, we cannot find out much, if we take shadow as reality, instead the hand itself; so about the being of colors, we cannot find out much if, instead of colored images illuminated by light, we consider the shadow of an image as reality, its spectral composition.

Nevertheless, it is not just about the deception in terms of understanding the being of colors; the issue has had colossal importance in terms of understanding the world. Later, colors have been connected with speed and conversely, conclusions about the universe origin have been deduced from this conviction.

The very idea that colors can be associated with speed, began to emerge from the belief that a path of light beam changes, when light travels from rarer into denser medium. [LIX]

Then Newton spread the conviction that white light contains all the colors and that the color determinant is its index of refraction. It is believed that red color is determined with a lower refractive index than violet. It is being forgotten that red and violet colors can be obtained in many different ways. Then, as a consequence of the wave theory of light, the refractive index was related to the wavelength of oscillations, and one started believing that the wavelength of light decreases as the refractive index increases. [LX]

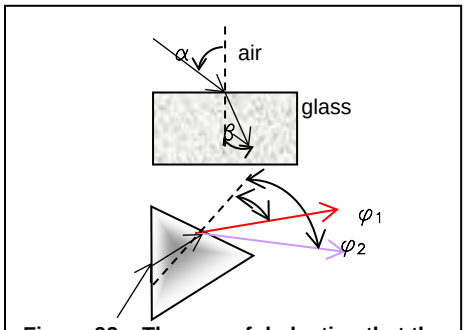


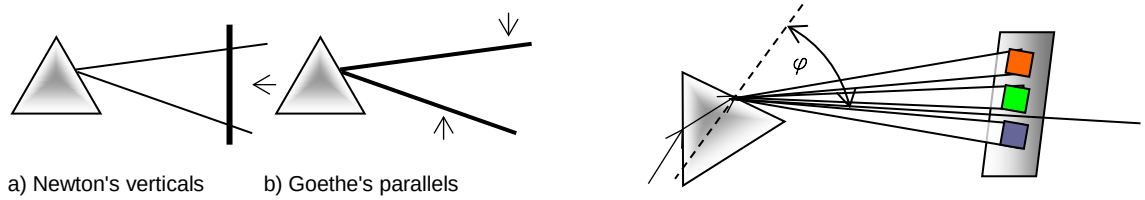
Figure 92 – The way of deduction that the light speed depends on wavelength

And since oscillations with different wavelengths have different speed of expansion through space, now color has been associated with the speed and through the calculation is concluded that colors have different speeds in different mediums, or as it is being said – the speed of light depends on the wavelength. [LXI] *In the end, the concept of different speeds of light was*

used reversely for the estimation of the speed of objects. [31] *Afterwards, the stars which have different colors were observed and one came to the conclusion that the stars travel. Then it is said – the universe is expanding, because once upon a time, it exploded. What kind of fantasy has been developed based on the belief that the universe is expanding. And the whole thing is based on an illusion!*

Color does not appear perpendicular to the beam of light, but in a plane parallel with a beam of light. Imagine where humankind would have been today if Goethe had not been considered a childish poet who was writing something on colors.

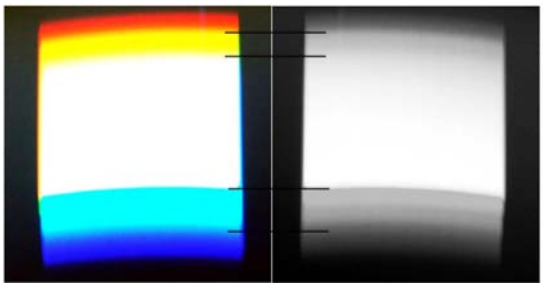
Have a look on the spectrum itself. Choose any line in the direction of the light beam, with a certain angle, with some refractive index. At the beginning, the beam of light is white; then, with increasing the image distortion, colors appear; and in the end, it is transformed into colored images with gaps between.



a) Newton's verticals b) Goethe's parallels

Figure 93 – Refractive index is not a color determinant

Spectrum with green in the middle appears only at a particular distance from the prism. The spectrum is a function of distance from the prism. The relationship between color and so-called "wavelengths of light" can be unambiguously established only at a certain distance between the screen and the prism. Color is not the light of some wavelength, color is weakened light. Color is not determined with spectral composition. All that science is based upon the mental shadows of reality, upon the theoretical notions of illuminated images that are the only reality of optics. And now we have come to something I would explicitly like to emphasize.



When the chromatic aberration experiment is photographed with a black-and-white technique, it is clearly evident that the colors are darker than white and brighter than black.

Trial 23 – The colors are weakened light

This chapter of the book is written in a somewhat satirical tone. Nevertheless, who might think that in this book one wants to depreciate Newton or his followers – it is absolute nonsense. Isaac Newton was a very sharp-witted thinker, probably one of the most perspicacious men of his time. But, that is exactly the essence itself! Newton deduced completely logical conclusions from completely false premises.

And, all this indicates that if the modern culture does not want to continue believing in shadows of reality, instead of living in reality itself, things must be considered from quite a different perspective.

[31] I am referring to the Doppler-Fiseau's effect in optics, to which we shall return later.

IV ON THE GOETHEAN APPROACH IN THE STUDY OF NATURE

" Our senses don't deceive us; our judgment does"

J.W.Goethe

1) Concerning Goethe's Method of Cognition

The following words of famous English naturalist Lord Kelvin, probably best reflect the attitude of official science in terms of essentiality and methods of scientific cognition:

> *"I often say that when you can measure what are you speaking about, and expressed it in numbers, you know something about it; but when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of Science, whatever the matter may be".* [LXII]

Without disputing the undisputed right of the official science, to set the cognition of only quantitative in nature as a sole sought-after ideal; people who do not want to be limited by the cognition of only quantitative, also indisputably, are entitled to ask: "May really only the cognition of quantitative in nature, lead to a comprehensive understanding of man and world?".

However, a proper answer to this question cannot be provided within sciences that had set only the quantitative study of nature as their ideal. And now we draw closer to a despised science, which is in today's culture banished into the periphery of cultural life – we draw closer to philosophy.

In the ancient Greece, philosophy was considered the highest knowledge, something out of which all the other practical sciences originated. Modern philosophy is denied a right that anything at all, should and can be said, about the scientific investigation of nature. In fact, it must be stressed that this attitude is partly justified. Because, if philosophy – as it is the case nowadays – is able to provide only later comments on scientific discoveries, then the philosophy of such range is certainly not needed to anyone. That can be accepted, but at the same time emphasized that – the contempt for the philosophical way of cognition, cherished in the modern culture, must not be an excuse for those who want – from their own boundedness – to limit the knowledge to the entire rest of the world.

The fact that all sciences had originated from philosophy, or at least, from the way of thinking cherished in certain philosophical schools, is true even nowadays; only modern natural researchers are often unaware of this fact, and do not have a courage or willingness to engage in reflection on the last consequence of attitudes, which they advocate.

Thereby, we got to the point where we can briefly describe the philosophy of Immanuel Kant, the philosopher who most consistently expressed extreme consequences of attitudes claiming that scientific is only what can be described by mathematics, and whose mentality of thinking dominates the overall scientific thought for already 250 years.

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As people, we are placed in the world we perceive through our senses. If we examine the colorful world around us, we can rightfully ask: "What can the content we receive through our senses our eyes, ears, nose, etc. – say about the essence of things? And how is the sensuous content in connection with our inner experience? ".

Through my senses, I receive the content of the external object which in my interior, I experience as the red color of the outer object. However, is my sensory experience in any real connection with the properties of external objects?

At the beginning of his philosophizing, Kant promptly divided the whole experience into the external and the internal. The external is determined by the concepts of space and time, the internal by sensuous perception. Reason goes only as far as the source of its content allows – the sensory perception. Without sensory content, mind is empty and without any possibility of cognition. Thus, knowledge is limited to only what our senses provide. Therefore, science is possible only within the limitation of sensory perception. But even a whole sensuous content may not be the subject of science in a strict sense.

We perceive the sensuous content that produces a kind of inner effect, but it is only our individualized interpretation of objective reality. What I perceive as the redness of an object, is only an internal effect of something an external red object has in itself. Means, external things have certain properties "in itself", and we acquire an inner experience of the external thing by sensuous perception. The redness of the object is an external property about which essentially I do know nothing, except that I know it exists in a certain place and at certain time; and that inside me, the sensory perception of that red object arouses the experience of redness.

Again, since the sensory perception makes the content of our thinking, we – to have content of thinking, i.e. to be able to think at all – must accept the sensory perception and thus the internal interpretation of "things in themselves". This brings us to the conclusion that science cannot be born out of pure thinking, because the content of our thoughts is just a reflection of "things in themselves"; but science can be born only where we are capable of disassembling an external object into parts and reassembling it with an internal logical structure of concepts. Therefore, the subject of science can be only the sensuous content we are able to construct. Science can be born only in the combination of mathematics – as an internal logical structure of the concepts – and experiment, as external empirical construction of objects. Thus, we have avoided relying on the sensuous content, but through the inner understanding of the mathematical model of objects – that we have by an external construction made afterwards – have proven that our inner content is truthful.

Therefore, the attitude of the Kantian philosophy, in terms of what is scientific, can be summarized in a sentence: "Scientific is only what can be mathematically described and then confirmed by an experiment".

To this day this motto presents the Holy Grail of all those who believe that only mathematical models provide the exclusive right to speak truthfully about the phenomena of nature. [LXIII]

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Let us consider the consequences of such defined principles of science:

1) *Science is only possible as the science of external nature, because what is inside a man cannot be confirmed by an experiment. What is being called "humanistic sciences" may be just a collection of various descriptions, and not sciences in a strict sense (e.g., sociology, pedagogy, linguistics, etc., are not true sciences).*

2) *Again, from the content of the outer nature, only quantitative in nature can be considered a subject of science, because qualitative in nature cannot be expressed by the mathematical model (e.g. aesthetics is not a true science).*

3) *In addition, regarding quantitative in nature, only discontinuous objects provide a firm foothold for science, because discontinuous objects can be constructed. Strictly speaking, since alive cannot be assembled and disassembled, a true science is only possible about inanimate (e.g., biology is a true science only as long as it describes the processes in living in the same way as the processes in inanimate).*

Such a strict definition of science pervades science by inhuman, nonqualitative and cadaverous characteristics.

However, let us carefully analyze what the Kantian philosophy wants to convince us:

1) *In order to find something out about the past experiences of other people (historical events), we have to construct these past events. Since this is impossible, past experiences of people cannot be the subject of science in a strict sense. In other words, learning from experience cannot be the subject of science in a strict sense?*

2) *In order to find something out about the aesthetic meaning of Michelangelo's David, firstly, we have to shatter this statue into dust with a hammer, and then merge it back into a statue with glue?*

3) *In order to find something out about an animal, we first have to kill that animal and later to dissect it?*

Aware of it or not, the attitudes of modern naturalists considering the imperative of mathematical models and experimental verification in researching of the world, lead to the final consequences described above.

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In his "Philosophy of Freedom", Rudolf Steiner referred most consistently to the abstract and restricted content of the Kantian philosophy postulates. Without any intention to provide the content of "Philosophy of Freedom" here, the following will be briefly stated:

1) *If the entire inner experience was a result of the subjective experience of external, then science would be the result of subjectivity; so the manner of scientific mediation between the subject (man), and the object (nature), would be redundant, because anything produced by the subject, would be immediately known to the subject. Therefore, science could be perceived purely by a sensuous perception.*

2) *If thinking, and even thinking in mathematical models, did not provide a sensuous perception with some higher, more ideal content that does not exist in sensuous perception alone, then thinking (mathematical models), would be entirely redundant in the process of cognition.*

3) *If entire nature was outside a man, then the objective truth would be outside a man too – and therefore completely unfathomable – hence, any engagement in science would be completely unnecessary, because science would be only an internal illusion of the external reality.*

The absurdity of the first paragraph is self-explanatory.

Regarding the second paragraph, just consider that the simplest law of geometry, which claims that the sum of angles in a triangle is always 180^0, cannot be validated on the sensuous triangle alone. From the sensory triangle, we can conclude that the sum of the angles of that particular triangle is 180^0. This geometric law can be generalized only on a thoughtful, an ideal triangle the sides of which constantly move. Therefore, the conceptual content (the ideal triangle) has supplemented the sensory perception (the sensory triangle) with something that does not exist in sensory perception alone.

The third paragraph on the illusion of science is meaningless, because the principles comprehended in our interior we can very successfully apply to the external objects. The ideal triangle does not exist in sensuous reality, but the general principle observed within it, can be very well applied to the outer triangles. If science was an illusion, then the whole outside world would be an illusion, because an illusion can be applied only to illusory, and not to a real.

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Goethe himself did not provide a rounded philosophical system within his approach to the study of nature, but he bestowed upon us his "Teaching on Colors", in which he practically demonstrated how to approach the study of natural phenomena.

"Teaching on Colors" is not given in a form of mathematical formulae or theorems. This is because Goethe did not want to fall into the trap of mathematising, but he tried to hold on to the phenomenon essence. If in geometrical optics, we use a mathematical model of light, as an image of parallel lines, to get a better understanding of optical phenomena using this image, e.g. phenomenon of reflection; it is the application of mathematical images which can assist cognition. But if we now, out of something which is just a picture of reality, try to get reality itself – as Newton did, claiming that light is being decomposed, because the lines in a mathematical model can be decomposed – we mathematize and seclude from the essence of phenomenon. By mathematizing, we add something to a phenomenon which is not contained within.

Accused of being inappreciative of mathematics, Goethe said that exactly the opposite is true –"no one appreciates mathematics more than I do". [LXIV] Because, whoever is not able to realize the abuse of mathematics, is incapable of appreciating it in full clarity.

Goethe begins his "Teaching on Colors" with studying the eye as the sense of sight, not engaging in the question of how the eye sees, noticing that the eye actively changes the sensory content. He did not consider this fact as a reason to exclude a man from the process of scientific cognition, but on the contrary; out of this fact, he concluded that our psyche

actively responds to color. As he was not deluded with the idea that qualitative in nature may not be the subject of science, he engaged himself in a detailed study of the colored esthetic relations. Such thinking led him to what is ideal in a man, the ethical influence of colors, and this attitude can be meaningful only by accepting that in a man exists a deeper conceptual and ideal content, that is related to a deeper conceptual and ideal content of the world.

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Reading the previous chapters of this book, in which one has dealt with the phenomena of colored light, a devoted reader could certainly ask: "How is it possible that for already 300-years, the humanity believes in wrong notions on light and colors?" "What is the reason for that?"

Well – the reason is very simple. Certainly not because the previous chapters of the book introduced something brilliant. The reason is painfully obvious – first, the prism had been designed and only after that did Newton introduce his theory.

Therefore, the notorious thinking error of modern physics is not always so easy to spot, because when the facts of life force us to admit that there is a thinking error, every erroneous theory can always be replaced by another erroneous theory. When we run out of trumps for the maintenance of an erroneous theory claiming that light can be decomposed – because the facts of life have forced us to admit it – we can always interpret a newly observed phenomenon in a way that tiny, invisible and incomprehensible particles behave one way or another.

Thus, the deception of erroneous theory will not do great damage to a technically-technological development, which follows its own course (not closely related to theorizing), because one post-phenomenological deception is just replaced with another post-phenomenological deception. But the deception of erroneous theories will have a devastating effect in understanding of a man, understanding of its role in the world and understanding of the cosmos. The deception spread by the modern physics – that colors do not exist on objects – has not damaged the development of optical devices, but it has had a disastrous consequence in understanding of the effect of color on a man, his place in the cosmos, as well as in understanding of the role of a man in the whole cosmic development.

The deception of erroneous theories will not delude the phenomenon, because this phenomenon will stay the way it is – no matter how we interpret it, but the deception of erroneous theories will entirely delude us in understanding ourselves.

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With this brief excursion into the realm of philosophy, the author wanted to show, that the essence of this book is not an attempt to correct some experiment with a prism, but to suggest that official science, based on Kantian postulates, must change the way of the nature observation from the ground. It is not about cosmetic surgery, but about developing an entirely new approach of nature studying.

Such a new approach in the study of nature would not be based on Kant's philosophy, but on completely different foundations. We shall call this approach in the study of nature "the Goethean physics". Principles of the Goethean approach in the study of nature are given in Goethe's "Teaching on Colors" through a four-form description of physiological, physical, chemical colors, and the aesthetic-ethical influence of colors.

These principles can be expressed as follows:

1) *A man is a reflection of nature and a man must not be eliminated from the process of nature studying.*

2) *Perception is the foundation in studying nature, and one cannot go beyond perception. Mathematics can serve as assistance of perception, but mathematics must not replace the perception itself.*

3) *Qualities exist in a man and in nature, and quality can be scientifically studied. One must not artificially limit the knowledge.*

4) *The essence of nature cognition is based on the permeation of sensory perception with a conceptual and ideal content.*

Only now we have the elements to review observations that should be corrected in the original Goethe's book "Teaching on Colors".

2) Concerning Correction of Goethe's Teaching

The Goethean approach does not want to consider things in a dogmatic way. Nor the author of this book claims that the descriptions of the color phenomenon described here, should not and cannot be supplemented or corrected with newly observed facts. Goethe's ambiguities in the book "Teaching on Colors" will not prevent anyone from pointing to these ambiguities.

Consequently, Goethe's genius will not be weakened, but on the contrary, it will be highlighted and rounded. With such a positive attitude, we can approach the corrections and updates of the original Goethe's teaching.

1) Obtaining white light

Since the physical color is light weakened by darkness, Goethe was of the opinion that the color mixing cannot produce white again. Goethe had this attitude, because he believed that white light does not contain all the colors, and that the mixing of colors cannot produce white again, as Newton had claimed in his theory.

This should be corrected; the white color in light can be created by mixing physical colors in a bright field of vision. But certainly not because the white light contains all the colors.

In what is nowadays called the additive color mixing, lies a deeper truth. The essence of optics is the image; light is the image carrier. When colored lights are being imbued, it is about merging the impressions of colored images. E.g. when we focus the light of two different colored light sources by the lens, for example, the yellow and the blue light sources, the picture of the two light sources is reduced creating an impression of green light. When this green light is increased by the prism, we again see the original image.

Exactly the same case we have when colored pigments are being mixed. When we have two grains of matter colored in yellow and blue, the eye is not able to see different colored pigments, and thus the impression of green is created. To see the colored grains, it is necessary to enlarge the picture.

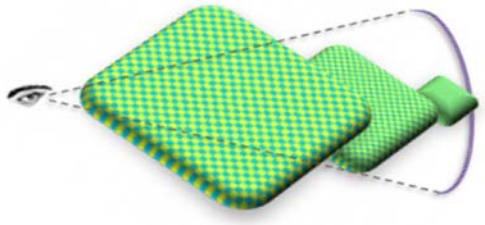


Figure 94 –The impression of the colored pigments

Practically, in the additive color mixing or in the spectral analysis, the primary thing that occurs is a reduction or an increase of the original image illuminated by light, the images are increased or reduced. [32] *When the image is reduced, a mixing of color impressions occurs; the eye mixes different colored images into an image of new color.*

So the whole story about obtaining the additive white light is more a matter of supplementing Goethe's claims rather than their correction. [33]

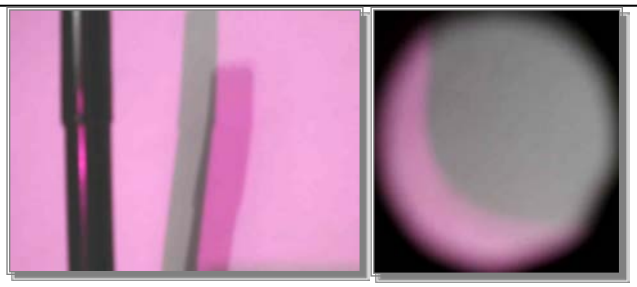
[32] Compare to the trial 15 and the chapter "Colors are not Contained in other color" pg. 47.

[33] Now it is easier to understand what is said in the chapter "Colors exist on Objects" on pg. 44, when it was mentioned that the quality of light affects what we see. When the green surface is illuminated with the red and the

2) *The colored shadow experiment*

This experiment was used in studying of colored shadows. Goethe believed that the appearance of colored shadows occurs as a result of "colors in the eye", i.e. that the shadow of color complementary to the color of light does not exist in reality, but the shadow just appears colored, because of colored environment. It is interesting that today's official physics agrees with Goethe precisely in this point – it is considered that this phenomenon is the appearance of chromatic induction and the explanation is that the eye introduces a color that does not exist in reality. This view was accepted by modern physics, because, if one accepts an attitude that shadow is not reality, but the only reality is light – then the experiment cannot be explained in any way except as a kind of optical illusion.

I would not be able to confirm Goethe's attitude through my observation.



Trial 24 – Observation of colored shadow through the focused field of view

First, the colors produced by chromatic induction can be photographed like all the other colors in nature. Means, they are visible even when the eye is not in colored environment. If we consider that this is about an optical illusion, then we could say with the same right that all the colors in nature are just kind of optical illusion. In fact, this is exactly the starting premise of Newton's interpretation of the color appearance in nature whose understanding was based precisely on Democritus' conviction that "Color is not a natural necessity, but something that is supposed and determined by the law, convention and habit".

Second, when we look at a colored shadow through the camera obscura, in such a way that the field of vision is entirely focused on the shadow, and not on the environment; the color of shadow remains, only it is a fact that the contrast of color observed through the tube is weaker than when a whole picture is being viewed.[34]

I am of the opinion that colors are real, but the reaction of the eye plays a role in the whole phenomenon, as well. In any case, these are things that can be discussed further.

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blue light source, the green surface looks gray. This is because the eye merges the greenness of surface with the red and blue color in one impression, by blending these three colors, the eye transforms them into an impression of gray. All three colors are there; they can be seen again when the image is enlarged by "spectral analysis". An essential feature of the eye is merging of chromatic impressions into one. The white light obtained by the additive mixing of red and blue light, has no different "spectral composition" than any other light, but it is about the eye that cannot recognize the image details. Mixing of colors is the property of eye, not a property of light that illuminates objects.

[34] To be able to see colors clearly, a strong light source is needed; in the experiment it was used a halogen lamp of 250W. With ordinary light bulbs of 40W, the color of shadows seen through the camera obscura fades. In the photo, green is affected with purple surroundings, but only to get a more expressive photo. Green is visible when the purple area is not affected, too.

3) Concerning the Essence of Darkness

In Goethe's original teaching, darkness was considered a polarity of light, the polarity that is essential – in the interpenetration with light – to give birth to colors. Darkness is a necessary force in emergence of colors. But Goethe was not considering the essence of darkness, and in his original teaching, he did not make a clear difference between the concept of darkness, and the concept of lack of light.

The dark is the absence of light. And darkness is something else.

And at this point, we have again approached a sharp thinker, who has been criticized in this book – again we get closer to I. Newton and his theory on the color origin.

Newton himself had a fairly dim feeling that something besides light is needed to make colors appear. But his analytical mind carried him in the direction of atomistic world-view, from which the theory that light is being decomposed emerged. The tragedy of Newton's color theory is that his true premonition was later entirely rejected, and the untrue one widely accepted. Newton rightly presupposed that gravity does participate in the appearance of colors, but he tried to explain this fact with the corpuscular theory of light.

The very same power that Goethe used to call darkness, a force creating shadow, is related to something, which is in modern terms called gravity. Colors appear in the interpenetration of light and material forces. The fundamental property of matter is that it has mass; it is subjected to gravity, because matter carries the heaviness within itself. Opacity or darkness is the essence of matter. Matter is opacity reinforced to tangibility. Conversely, a fundamental property of light is that it has no mass and is not subjected to heaviness. Light does not contain darkness; light is a polar opposite to heaviness. [35, LXV]

When light is pervaded with materiality, only then it comes to the encounter of light and darkness, to the encounter of light and gravity. When light comes into contact with opaque forces subjected to gravity, it becomes weakened. If we are poetic-minded just like Goethe, we will say "The colors are the deeds of light, the deeds and the sufferings". If we are pedantic philistines, we will say "Color is weakened light". Color is light which is being permitted by a part of darkness.[36]

Newton, the first physicist who mathematically defined gravity, was right about his feelings regarding the birth of colors. Gravity, as a force of materiality, is necessary for the appearance of colors. Darkness is not the absence of light; both darkness and gravity have the same cause – materiality. In fact, it turns out that the intellectual dispute between Newton and Goethe did not arise over the question what makes colors appear. Both, Newton and Goethe, consider that colors appear from light and darkness, i.e. gravity. It is just that

[35] The idea of polarity of light and gravity has its source in Aristotle's physics, which was teaching about a polarity between the ponderable i.e. terrestrial forces, and the imponderable i.e. celestial forces. Light – which was thought to be the nature of aether – belongs to the imponderable forces. Subsequently, this dualistic understanding of nature will reappear in XIX and XX century in the works of F.W.J.Schelling and R.Steiner. See endnote.

[36] Here, it may be mentioned an observation from Goethe's book. Water itself is transparent but when it is condensed, i.e. when it is transformed into ice, the ice is of white color. Thus we can imagine that transparency (light) is transformed into a white color by condensation, i.e. that color is the "condensed" light. However, in this book, instead of the description of color as "condensed light," the description of color as "weakened light" is used. This notion is more understandable to modern comprehension that light is weakened i.e. "loses speed" in an optically denser medium.

Newton is of the opinion that colors appear in such a way that gravity discomposes corpuscles of light, while Goethe is of the opinion that colors appear in such a way that gravity (darkness), weakens light. And now, it will probably become clearer why, in the previous chapters of the book, it has specifically been said that neither light nor darkness (gravity) can be disassembled. Both, light and darkness are monolithic entities, because neither transparency nor opacity can be disassembled.

It is considered that light intensity decreases with the square of distance from the light source. [LXVI] *We could say like this: The power of darkness increases with the square of distance from the light source. The reverse is also true. If light intensity increases with the square of distance from the dark object, then the power of darkness decreases with the square of distance from the dark object.*

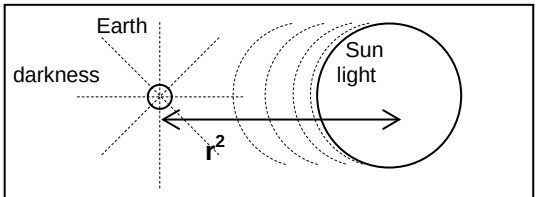


Figure 95 – Gravity is one pole of forces that participate in the rotation of celestial bodies

Newton's law of gravitation (where gravity decreases with the square of distance from the center of mass [LXVII] *), is the description of one pole of the forces involved in the rotation of celestial bodies around the light source.* [LXVIII]

Newton was thinking about the reasons for the movement of celestial bodies. Physicists from the Renaissance onwards cherish the doctrine of natural laws. The doctrine of natural law is based on thinking: "Something is so, because it must be so".

Why does the Moon revolve around the Earth?

Because it is a natural law – it must be so. Once upon a time, the planets begun to move, and now they are no longer able to stop. Then this law of imperative compulsion is expressed as a law of mechanical motion. The first Newton's law, the law of inertia reads: "The body is in a state of motion until is acted upon by a force". [LXIX] *However, one should say –"Body cannot be brought into a state of motion, unless a force brings it into motion".* [37]

If one had been thinking in such a way, it would have been realized that something is missing in the gravitational interpretation of the celestial bodies' movements. [38, LXX]

Goethean approach will not be based upon abstract definitions of natural laws. Goethean approach will always try to hold on to reality and will be based on the insight: "Nothing is so, unless something makes it so".

[37] In the physics of Aristotle, it had been considered that force is required to maintain motion, so Newton's formulation is an inversion of Aristotle's formulation that "an object will not move unless it is pushed".

[38] One of the first physicists, who had noticed that applying only the force of gravity as an explanation of the celestial bodies' motion is insufficient, was Gottfried Leibniz, with the statement "God Almighty wants to wind up his watch from time to time: otherwise it would cease to move." Nevertheless, the very idea that light somehow participates in the rotation of planets originates from Aristotelian Physics. Compare endnote.

4) Concerning the Essence of Light

If we study the historical development of ideas on the cause of the color appearance, we notice that the ancient physics confirmed the role of both light and darkness in the appearance of colors. Then Newton made a gap, from the one side; he introduced the concept of gravity in the interpretation of heavenly bodies' movements, but on the other side; this same power originated from materiality, he did not recognize as darkness, he considered darkness only as the absence of light. According to the notions he cultivated, gravity acts on the corpuscles of light, hence he developed a theory on the corpuscular nature of light. According to this theory, light is composed of tiny material particles.

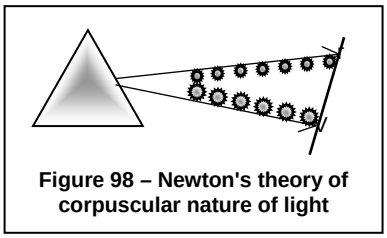


Figure 98 – Newton's theory of corpuscular nature of light

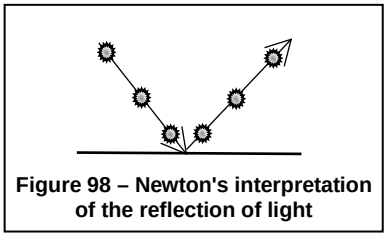


Figure 98 – Newton's interpretation of the reflection of light

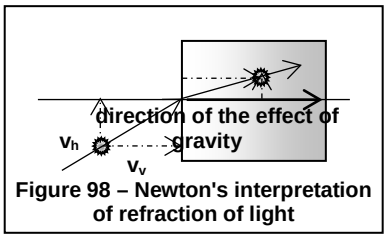


Figure 98 – Newton's interpretation of refraction of light

According to the theory of the corpuscular nature of light, a reflection of light could be explained by the light corpuscles bouncing off of the material surface, following the laws of mechanics, in the same way as the collision of the elastic sphere against the elastic wall. On the other hand, the refraction of light could be explained by changing the speed of light corpuscles in the transition from rarer into denser medium.[39, LXXI]

Meanwhile, in 1677, in his book "Treatise on Light", the Dutch physicist Christian Huygens, stated an assertion that light is of the wave nature and is transmitted through space via oscillations of aether particles. The concept of aether had been cherished in ancient physics, which considered that above what is nowadays called the three states of matter (solid, liquid, gas), and what the ancient physics used to call the state of matter similar to earth, air and water; there are even higher aggregate states – heat (i.e. fire alike), and ethers, i.e. the fifth aggregate state or state of existence of a so-called quintessence. [40]

The difference in understanding the light's nature of the two schools (corpuscular and wave) had been the cause of bitter debate for almost 150 years, until it was accepted that the corpuscular theory of light does not hold the water after the conclusion derived from a calculation that light is slower in the optically denser medium.

However, neither first nor second school recognized the difference between the dark as a lack of light, and darkness as the opposing power to light. Thus, it is not clearly recognized the darkness of matter, which weakens – i.e., as considered nowadays, slows the light down – nor is it recognized that a color is weakened light. And now we have come to an interesting case – the case of the electromagnetic nature of light.

19th century physicists had a strong tendency attempting to explain all phenomena in nature, with one unique force. It is not exactly clear the cause of the trend that wants to explain all

[39] The vertical component of the velocity of light corpuscles gains in speed due to the effect of increased gravity in a denser medium, i.e. $V_v<V_h$. Therefore, the red and blue rays that have different refractive indices, also have different speeds in a glass. According to Newton, the overall speed of light in a denser medium is increased.

[40] Subsequently, the concept of aether shall become the concept of "field", as part of space with special properties. There is a small article about quintessence on Wikipedia
http://en.wikipedia.org/wiki/Aether_(classical_element)

phenomena in nature in the same way. But, this aspiration has not been abandoned until the present day.

In 1864, with such a frame of mind, James Clerk Maxwell concluded that the light waves have the same speed as electromagnetic waves. Furthermore, he considered that both are transverse waves. Then he took a mathematical formula that links the speed of light in different mediums with indices of refraction (c_0 / c = n) and equalized it with dielectric constant ε, which determines the electric and magnetic polarization of the medium through which – as it is presumed – an electromagnetic wave propagates.

Since he believed that the light speed is equal to the speed of electromagnetic waves, Maxwell concluded:

$$\frac{c_0}{c} = n = \sqrt{\varepsilon}$$

Light is an electromagnetic wave! [LXXII, 41, LXXIII]

Then, a rush to prove the hypothesis took place, so it was noticed that e.g. a dielectric material that is optically inactive becomes optically active by illuminating (Kerr's effect). Or, a strong magnetic field rotates a plane of polarized light (Faraday's effect). [LXXIV] *Since electromagnetism has an effect on light, it was concluded that the equalizing in the formula is truthful – light is of electromagnetic nature (although no one has ever explained why it has not been said that the electromagnetism is of the light's nature).*

It turns out that when something is able to affect light, that thing is the same as light. This is a typical example of a replacement of theses. In such a way one could prove that prism is of the light's nature. Because when you watch a light beam through a prism – the colors appear.

Therefore – the prism is of the light's nature!

Based on the fact that one thing affects another, one cannot reversely conclude that these things are of the same nature. What did Maxwell use to proclaim the theory that light is an electromagnetic wave? Reality?

No, but a mathematical model!

In ancient physics, the perception was the basis for the study of nature, etymologically speaking, theory meant precisely – the observation. In the modern culture, the meaning of the word has completely changed; theory became a thought-notion of perception. Precisely this modification of understanding of what is theory supposed to be, reflects the modification of understanding of what is the essence of scientific observation. Precisely this change of understanding the essence of nature observation leads to colossal deceptions in studying of natural phenomena.

Because, upon which perception was Maxwell's electromagnetic theory of the nature of light based?

If we stick to the perception, it vividly shows that light cannot be grounded; light avoids ground, while the electromagnetism tends to the ground. Just the simplest perception as the

[41] Later, it turned out that even the equalization in the formula is not correct, and that there are many materials in which the refractive index is not equal to the square root of the dielectric constant. More details in the entry at the end of the book.

naked truth shows that light and electricity act contrary in terms of a tendency towards the ground. There is no doubt in the accuracy of Maxwell's formula; doubtful is the perception upon which the formula is based. [42] *The formula is correct, but whether the correct formula points to the truth?*

By dealing only with the perplexed mathematical models, physicists' attention was fully dragged away from the phenomenon essence. If light was of electromagnetic nature, a radio-antenna would attract light. If light was of electromagnetic nature, then transparent objects would become opaque by grounding.

And everyone should ask himself: How is it possible that such a lack of all connection to reality, has occurred in studying of natural phenomena?

What is the reason behind this?

[42] If light and electromagnetism are studied qualitatively, one could notice other differences between light and electromagnetism. In the field of electromagnetism, there is a phenomenon of electromagnetic induction, but not in the field of light. In electromagnetism, we can spot a so-called skin effect (the concentration of electricity on the surface of a conductor), but not in luminous phenomena. Most of the conductors are not transparent, which ought not to happen, according to the theory of the electromagnetic nature of light, because the conductors should "conduct" light. We see with the help of light, and not with the help of radio waves.

5) Man as the carrier of Light, Colors, and Darkness

Initial lessons of textbooks that explain Einstein's theory of relativity; usually start with an image such as this one:

> *"Let us consider a car moving slowly with the constant stopping and starting, which is often in the case of urban traffic jams. If we are sitting in a car, when a column starts to slowly move forward; in the beginning of the motion, we are not quite sure whether the car in which we sit is being moved, or the car in front of us is moving forwards. So, the motion is a matter of reference points, if we stand, and the car in front of us moves, it is the same as we move, and the car in front of us stands. Motion and rest are relative terms."* [LXXV]

Since the motion is relative, relative is what determines the motion and that is distance and duration, i.e. space and time. Relativistic Einstein's logic that space and time depend on speed was derived out of this way of thinking. Things are relative... It does not matter whether we sit in a moving car, or we just watch a car that is being moved…

Yeah. But show me a man who has arrived in Sarajevo, just by watching the car that has been traveling to Sarajevo! [LXXVI]

Relativism arose as an inversion of reality. The speed, in the mathematical model of speed, is determined by distance and time (i.e., space and time, $v = \Delta s / \Delta t$), and it is said – if it is possible to change one side of the equation, then it is possible to change another side, too. It is possible in mathematics. In reality, it is not possible. The essence of mathematics is exactly that symbolically describes the quantitative and not the qualitative relations. Quantitatively, it is correct to tumble the above equation to get $\Delta t = \Delta s / v$. But qualitatively – it no longer has anything to do with reality, because the distance in speed is not any physical quantity.

And of course, it is not irrelevant whether I am in a car that moves, or I just watch the car that is being moved. According to the theory of relativity, every motion is relative, every motion is determined only in relation to the reference point. Yes – but it is possible to believe in such an abstraction only if we forget a man. I can sit in a car that is moving, and I will still travel, even if the reference point – in relation to which the speed is measured – is moving. I will be in motion even then, when my speed is measured in relation to an object that is moving in the same direction and at the same speed. It is just that in such a case, it appears to me that I am not in motion. Relativistic logic is an attempt to identify reality with something that just ***looks like*** *reality.*

Because, once a man is removed from the process of scientific observation, any sort of fantasy is possible.[43]

Hereby, we touch the essence of the problem. The development of science from the Renaissance onwards, went in the direction of increased isolation of a man from the proceedings of scientific observation. Objective truth is outside a man, a man as a subject,

[43] Anyway, the whole dilemma – whether body motion is absolute or relative – is very old. E.g. Newton held that motion of a body in space is absolute, because he considered space a reality. Descartes held that motion is relative in space and determined only by the position of other bodies. More can be read on this subject at e.g. http://en.wikipedia.org/wiki/Bucket_argument
Here, I wanted to stress that the conclusion regarding the validity of one or the other attitude cannot be made based upon theoretical models, but only on the basis of the relationship between us in comparison to the external reality.

obstructs the cognition of objective truth. With such an attitude, science entered the realm of deception, ever more strongly one tries to remove a man from nature.

Why have people been able to believe that darkness is not required for the color appearance, that colors can appear only from light? Why have they been able to believe in the claim that the blackness is just a lack of whiteness?

Because a man is expelled from the process of cognition. Because of the widely spreading belief that something that does not exist in a man, exists in outer nature. But, the Goethean approach cultivates understanding that "nothing exists in the eye, what does not already exist in nature". All phenomena that we see in "objective" reality, all that already exists in "subjective" individual.

Consider a man. A man is a tripartite being; a man has the ability of thinking, the ability of feeling, the ability of volition. By thinking, we get mental images of the world and of ourselves. By feelings, we place ourselves in a personal relationship to the outside world, we perceive something as pleasant, something else as unpleasant, something makes us happy or sad, etc. Through our will, we act upon the outside world.

We are fully aware of our thoughts; thoughts belong to the aware, daily consciousness. Already with respect to feelings, this is not the case. Feelings exalt us or get us down; feelings belong to the suppressed awareness, a field of semiconsciousness. They can be compared with semiconsciousness of dreams. Impulses of will, we are fully unaware. We do not know how we raise our hand to perform some action, we are aware just of the effect – raised hand. The will lies in the field of unconscious, in the field of darkness of consciousness.

Light, colors, darkness, we carry within us. The same phenomenon, we see in the external nature as light, is exactly what we in our interior experience as thought. The same power that in the external nature we experience as weight, that is exactly what makes our interior impulse of will. [LXXVII] *And colors, that in the external nature we perceive as the play of light and darkness, this is what we experience in our interior as feelings arising in the interaction of thought and will.*

Thinking – feelings – will. Light – colors – darkness. Consciousness – semiconsciousness – unconsciousness. [LXXVIII]

When we look at the images illuminated by light, this is exactly the same process as when we in our interior think. Thinking is the ability to create notions, the ability to create mental images. In light we see a picture outside, in thinking we see an image inside. And now someone will ask: "If a man already carries light, why do not we see that people shine?".

Because light is invisible. If light were visible, the sky would be white, not blue. If light were visible, we would see the sunlight that envelops Earth. [LXXIX] *Light makes everything visible, but light itself cannot be seen. And as we do not see our own eyes, but we see with the help of eyes; so we do not see light itself, but only the images illuminated by light.*

Both light and darkness are invisible. The eye sees the colored images, not light itself. What is wrongly called light or the light beam, is actually an image of white color illuminated by light. Darkness cannot be seen either. The eye sees shadow as a manifestation of darkness. Shadow is opaque. White and black are the first sensuous manifestation of light and darkness.

Now one can ask the question: "Yes, but what is light in its very being, what does it consist of?"

Well, light is composed of the similar substantiality as our thoughts.

Huygens, who still relied on tradition, had a dim feeling about the above fact – claiming that luminiferous aether somehow participates in the phenomena of light. Modern culture perceives thinking as something unreal, a kind of illusion. It is even common to say –"it's just a thought"– in a sense, it does not exist. The reason for this attitude is that thoughts of modern people usually do not have the power to penetrate reality. And when you have something that does not penetrate reality, it is quite normal to argue that it does not exist. The loss of the ability to penetrate reality through pure thinking, can be confirmed through studying the history of philosophy. [LXXX]

Ancient philosophy had perceived thinking as something very real, as a force that penetrates into reality. Ancient philosophy had never been questioning the appropriateness of its existence. From the Renaissance onwards, the power of experiencing thoughts as reality was decreasing, and only then, there occurred the doubt in the ability to penetrate into reality through pure thinking. Only in modern times philosophy begins to doubt itself, and starts posing questions regarding the actual usefulness of the philosophy's existence at all. At the same time, a doubt in reality of thoughts stirs the suspicion that our thinking is able to provide any truthful content except the one, which can be quantitatively verified. This attitude will reach its culmination through the formulation of Kant's philosophy. Because, from the moment the thoughts are no longer considered reality, thinking has to rely on purely sensuous content.

The only area in which the modern culture has maintained a sense that reality can be reached through pure thinking is the mathematics. This is because mathematical notions can always be verified by the sensuous perception, unlike, for example, aesthetic and ethical notions that cannot be verified purely by the sensuous perception.

But the modern culture, on the one hand; must face the abuse of mathematics, when thinking in mathematical terms tries to replace reality itself, and on the other hand; the modern culture will have to re-master the capability of thinking that penetrates reality. Again it will have to be accepted that thoughts are real, and that they consist of a certain kind of substantiality, the substantiality of aether.

The concept of aether, is the concept which had been cherished in the ancient physics. Ancient physics had considered that beyond realities which can be described with the concepts of space and time (e.g. matter), there are also realities which cannot be described with the concepts of space and time. Ancient philosophy had cherished dualistic understanding of nature, in the meaning of existence of material phenomena – that exist in space and time; and immaterial phenomena – that do not exist in space and time, in the same way as material phenomena.

All phenomena out of space-time category had been regarded as aethers. E.g. thoughts cannot be brought into relationship with space-time concepts, and therefore it is pointless to talk about, for example, the "speed of thought propagation"; but the ancient physics, or as it had been called "natural philosophy", had not considered this fact a reason to proclaim the thoughts non-existent, but the above fact had been considered a reason to extend the classification of natural phenomena. Due to the fact that thoughts cannot be connected with the spatial-temporal relationship, thoughts had not been proclaimed non-existent, but they

had been annexed to the categories of aether. Everything that does not belong to space-time category; had been considered as aether. [44]

Since aether cannot be described with concepts of space-time, aether is a phenomenon that does not comply with any conventional notion of speed, i.e. with what the speed is presented in the mathematical model – space and time. Consider how the theory of relativity originated.

Facts of life have led to the awareness that light does not obey classical notions of velocity. The speed of light cannot be subtracted or added to the speed of material object. [LXXXI] *When we measure the speed of light from the moving material object, it is always the same, whether we approaching the source of light, or moving away from it. But as it was rejected that light is of aethereal nature, and that aethers do not obey the laws of velocity in a classical way – i.e. that it is impossible to sum the speed of aether and the speed of material object; one has crashed the second part of the equation for speed, one has crashed the only thing that remained – distance (i.e. space) and time (v=Δs/Δt).* [45]

This was possible, because, in the formula of speed, the speed of the object is reality, and space and time are just our notions, just our understanding of reality of speed. Only the left side of the equation is something that objectively exists (v). The right side of the equation is a mathematical model of reality (Δs/Δt).

Relativistic theory is merely a consequence of the inability to accept the reality of aether and a result of the inability to accept that there are phenomena which are not applicable to the velocity of material objects.

However, we cannot speak about the essence of aether, purely through sensuous phenomenology. To describe ethers, we need the additional forces of knowledge, which do not exist in purely sensuous phenomenology. This would exceed the framework, set by the author as a limitation of the content of this book.

[44] In modern physics, rigid attitudes that a man with his perception and thinking represents a world separated from the external nature, were first shattered by Werner Heisenberg, with the principle of uncertainty, which claims that is impossible to simultaneously detect both the speed and mass of particles. Before Heisenberg, the attitude of physics was that everything in the external nature is determent by the concepts of space and time. Soon, one started to speculate that an observer could influence the outcome of the experiment, which has led to a speculation that classical mechanics cannot explain human consciousness. These theories are nowadays known as 'Quantum mind", more on http://en.wikipedia.org/wiki/Quantum_mind.

However, as long as physics does not accept the reality of aethers as a natural reality, through which one could be able to connect the external nature and human thinking, any speculation of this kind would be tapping in the dark. A/N.

[45] In the early and mid-19th century physics, the conception of light aether was alive through the conviction of e.g. A.J.Fresnel, G. Stokes, etc. However, through such theories, one tried to relate the concepts of aether to the space-time concepts, which proved impossible. The theory of relativity and quantum mechanics collapsed such a conviction.

6) Sketches from the Goethean Physics

The Goethean approach will not allow being deceived with artificial divisions on subjective individual and objective reality, and will not allow to be limited only to a quantitative study of natural phenomena. In the fields of the Goethean physics, the quality in nature will always be taken into consideration.

In this spirit, let us examine some of the luminous phenomena.

1) Reflection of Light

The experiment of light reflection from the mirror serves as a demonstration of the principle of geometrical optics, namely that the angle of the incident light ray is equal to the angle of the reflected light ray $\alpha_1=\alpha_2$. Goethean physics will not deny this fact, but it will always emphasize that the incident and reflected rays are not the same. Something has changed in light after the reflection, something qualitatively.

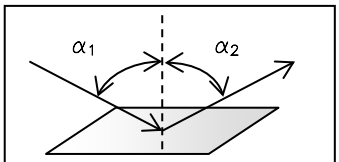


Figure 99 – Reflection of light from a mirror

Now, instead of a mirror, let us examine a colored surface. If we analyze the phenomena with the help of the geometrical model of light using the notion of light ray, we would say that the incident and reflected angle, reflected from the colored surface are the same. However, the light ray of incident and reflected light are by no means the same, because the reflected light is now colored. If we want to hold on to reality, it should be said that the reflection of light from a colored surface, imprints the image of the surface into light.

It is common to say that e.g. the Moon reflects the sunlight. Yes, but the moonlight is not a mere reflection of sunlight, because after reflection, the image of Moon's relief is imprinted into the moonlight. The quality of moonlight is different from the quality of sunlight.

2) Reflection of Light from the Black Surface

Now as a picture, let us take the black square on a white surface. According to the notions of official physics, light is being reflected only from the white surface under the law of equal angles of reflection, while the black surface does not reflect any light. Black surface appears black precisely because it does not reflect any light.

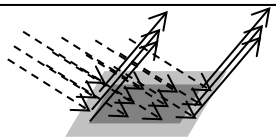


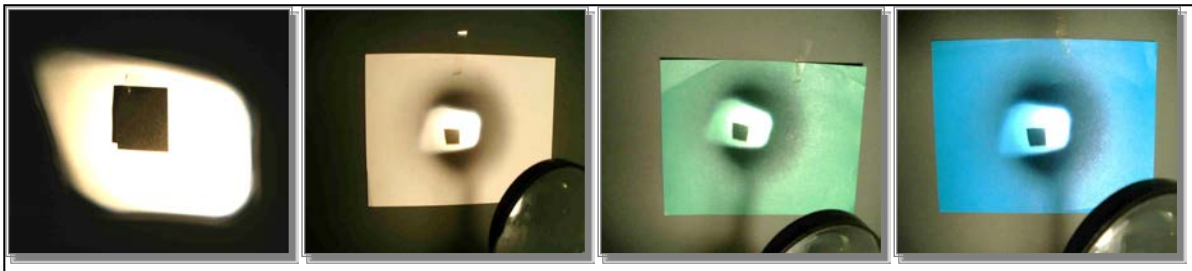
Figure 100 – Notions of modern physics on the light reflection from the black surface

However, it was noticed that the illumination of the black surface, heats up the black body itself; the temperature of the body is increased. There is an interpretation that the black surface absorbs light, i.e. light falling on the black surface is not reflected, but it is absorbed by the black surface and converted into heat. [LXXXII]

On the one hand, the interpretation of light absorption on a black surface (so-called the black-body radiation), in astrophysics, led to the conclusions on the surface temperatures of

the stars. Therefore, it is said that e.g. the red stars have a surface temperature in a range 2000^0-4000^0 K, while the white stars have a surface temperature in a range 8000^0-16000^0 K. This assumption was utilised for measuring the size of stars leading to the classification of stars into red giants, white dwarfs etc. On the other hand, theorising on the black body radiation was used for the development of the quantum theory (Planck) in the year 1900, as an elementary part of energy; and in 1905, the theory of photon (Einstein), as an elementary part of light.

With what kind of delusion we are dealing with, shows up as soon as the reflected light of the black square is projected onto the illuminated screen. If the image illuminated by light is focused by the lens, on the screen we see a picture of the black square on a white background. If the image of the black square, and not just the white background, was not reflected in the output light beam, then the output beam of light would be hollow. Of course, this hole would be visible on the white screen as the white square on a white surface. If the void in a beam of light existed, the projection of the image on a green screen would have to produce the green square surrounded with white. If the screen was blue, the square would have to become blue, as well, etc.



Black square on a white background is illuminated by a projector.
Other images show the focus of that image on different screens.

Trial 25 – Reflection of light from the black surface

The matter is interesting, so let us consider in more detail. The whole quantum physics is based on the following reasoning:

In the mid-19th century, it was deduced that certain amount of heat can always be presented with a certain amount of mechanical work. E.g. if we have water in a vessel heated up to 100^0C, the same vessel can always be heated up to a temperature of 100^0C by a certain amount of mechanical work, by friction. Thus, through the works of J.R.Mayer, it was introduced the term "mechanical equivalent of heat". [46]

On the other hand, material bodies are considered a set of tiny particles, a set of molecules. It was noticed that when bodies are physically compacted or put under pressure (which are all kinds of motion), then their temperature increases. The reason for the temperature increase is sought in the increase of the internal motion of particles. The temperature increases because the outer motion (pressure) increases the internal motion (a friction of the body particles contacting each other).

A mechanism with blades is placed in a vessel filled with water. When the blades rotate, a thermometer reads the temperature increase.

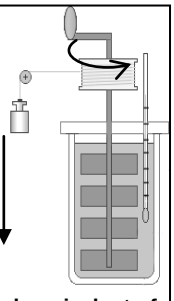


Figure 101 – Mechanical equivalent of heat

This fact can be nicely studied in the Brownian motion. E.g. the particles of pollen or soot in water, seen through a microscope, are in a chaotic motion; and as the temperature increases, particles begin to collide faster and faster. (By the way, here is a neglected matter of crucial importance, namely the Brownian motion can be observed only in fluids – if the water was

[46] More on thins in e.g. http://en.wikipedia.org/wiki/Julius_Robert_von_Mayer

frozen, there would be no Brownian motion, i.e. there would be no heat below the freezing point of fluid – here too, we are dealing with disregarded facts that do not match the theories, one attempts to prove).

*Then, it was forgotten that Mayer said "**the equivalent** of heat"; so the conclusion was deduced that the heat of a body, as well as the motion caused by mechanical work are all the same. Since, on the one hand; a body is composed of tiny particles, of molecules, and on the other hand; as it is considered, a temperature of body is just a reflection of the internal motion of particles in a body – this means that heat and mechanical work are the same things, i.e. it was said: "Heat is just a form of motion" – of course, no one has ever explained why it was not said: "Motion is just a form of heat". [LXXXIII]*

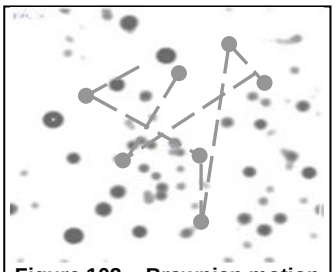


Figure 102 – Brownian motion

On the one hand, such logic of permanent theorizing served to proclaim the law of conservation of matter and energy ("matter and energy are converted into one another, and they were neither created nor did they disappear"– that is being claimed) [LXXXIV] On the other hand, it was noticed that a temperature of a black surface illuminated by light is increased. According to the logic of unique force, light and heat are proclaimed to be the same phenomena. Therefore, if heat is already just a form of mechanical motion, then light is also just a form of mechanical motion. Hence, when a light ray strikes the black body and raises its temperature, it must be because now the light ray carries a particle of light, i.e. a particle of light in collision with a surface of the black body, transfers the kinetic energy, which is manifested as higher temperature of black surface. In this way, the photon was invented. [47]

This is a beautiful picture of our modern science that is prone to introduce new hypotheses based on previous hypotheses, which themselves are not sufficiently clarified. First it makes the equivalent of two completely different phenomena (mechanical work and heat), and later it introduce the claim that they are the same phenomenon; then in a third completely different phenomenon (light), one tries to push notions which are valid for the first one (now the notions of mechanical work are being pushed into the concept of light). One assumption ("Heat is a form of motion"), is introduced in the interpretation of another assumption ("Light does not reflect off of the black body"), to invent a third assumption ("Light consists of photons"), and since in the end – you can't make head or tail of it – just mix it all together ("A photon is both wave and particle" – de Broglie, the dualistic nature of light, 1924).

Heat, light, chemical radiation (ultraviolet rays), electricity, magnetism, radioactivity – these are completely different phenomena. Heat is not the same as light. The difference between light and heat is that light illuminates space creating images we can see with our eyes, while heat warms us, and it can burn our fingers. Increasing of the body temperature after exposition to a beam of light is a phenomenon that must be completely separated from the phenomenon of the light reflection. [48]

The point is that in a beam of sunlight illuminating a surface, the light is mixed with what is known as the infrared and ultraviolet radiation (for the latter, it would be more appropriate to say "chemical radiation", as the radiation affecting chemical reactions). There is no conversion of energy in a way that the present-day physics imagine. During the light reflection, light is not converted into heat by the exchange of kinetic energy.

[47] Practically, a photon is supposed to be a particle that behaves like an electromagnetic wave, it has no mass but only energy, and is an essential element of light. More on e.g. http://en.wikipedia.org/wiki/Photon.

[48] In the Aristotle's physics, light and heat are considered as different phenomena. With this compare endnote LXV.

The phenomenon of thermal radiation reflection from a black body must be completely separated from the phenomenon of light reflection from a black body. For thermal rays (infrared radiation), one might presume that they are absorbed by the black surface, but the infrared radiation must be completely separated from light, and then both must be completely separated from electromagnetic waves. In what we see as white sunlight, two completely different things are mixed – light and heat (thermal radiation). Light is what carrying images, and thermal radiation is what creating the effect of temperature increase.

The tragedy of nowadays science is that whenever it spots any analogies in the phenomena, it rushes to prove that it is about the same thing. The reason for this attitude, and desire that all phenomena in nature are being pushed into one single force, is a completely abstract definition of energy.

So it is said that energy is the ability of a body to perform work. This led to a belief that for instance, a body that moves has a certain amount of kinetic energy, and a body at certain height has a certain amount of potential energy. Warm body has a certain amount of thermal energy. When a body in a free fall bounces off of the surface, the potential energy of a body is transformed into kinetic energy of a body. The energy is just transformed from one form into another.

It is forgotten that a body in motion is launched by something, and a body at certain height is risen up by something. A warm body is warmed up by something. It is not energy, as a mathematical notion of a body state, something that has been transformed – a body state is changed. The above definition of energy only sees the outcome of previous actions, not its cause. And as long as only the consequences of the state of bodies are being noticed, without desire to qualitatively investigate the cause of such a state, a false faith in the existence of one single force will live on.

It is complete nonsense to say that both light and heat are electromagnetic waves, and that light differs from heat only in a fact that light affects the senses of sight, while heat affects the receivers of heat on the skin. [49, LXXXV] *Modern people must learn to trust their senses again, and above all, to trust themselves. If we experience two things in a completely different way, then their qualitative equalization is out of the question.* [50, LXXXVI]

In the modern physics' textbooks, initial lessons of optics usually begin with the definitions of the concepts of light sources and dark bodies. Then it is said that light sources are bodies that radiate light. And bodies that do not glow with their own light, are called dark bodies. [LXXXVII] *We can see the dark body only by illumination with light. But, if no light is reflected from the dark body, how do we see the dark bodies on the screen at all?*

This definition of a dark body is complete nonsense. Every body is dark; it is precisely the essence of material body – to be dark. Both a white body and a black body are dark bodies. Matter is darkness reinforced to tangibility. A black surface reflects light as well, as a white surface, or any other colored surface. There is no void in the light beam. A black surface reflects light as well; just the image illuminated by light and mirrored from the black surface is of the black color.

The black color is visible and exits, as well as the white or any other color.

[49] According to modern physics, since both light and heat are practically the same things, it would mean that the sense of vision and the sense of heat are practically the same senses. Thesis is, of course, complete nonsense.

[50] Goethean physics will always emphasize the inaccuracy of modern categorization of forces into electromagnetic, gravitational, weak nuclear and strong nuclear. The development of physics will show the deficiencies of this categorization.

3) Refraction of Light

The same mistake as in the interpretation of the light reflection exists in the interpretation of the light refraction.

When we look at some text through glass from a slant direction, it appears to be at another place than it really is. The interpretation is given that the light beam reflected from the pad, has fallen on the glass surface and passed through double refraction on the transition from rarer (air) into a denser medium (glass) and vice versa. Due to the changed speed of light, the letter appears in another place than it really is.

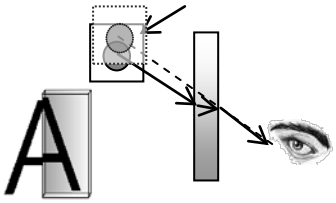


Figure 103 – Refraction of light from a black body

However, if we study refraction of the black point on a white background, we can notice that the whole picture is shifted upwards, as well. According to modern physics, light is not reflected from the black point, so the black point should make the cavity in the beam of light. This cavity – which should be the lack of light – should not be shifted or to have any refractive index. In other words, according to the official interpretation, when black text is viewed through the glass, only the image of white page should be shifted up, while the image of black text should make a cavity in the beam of light.

But, this is not the case. Black surface cannot be separated from the white background in any way. Modern physics cultivates notions of different indices of refraction in transparent materials, depending on a wavelength of incident light rays. [LXXXVIII] *Modern physics considers that the indices of refraction of light rays depend on the wavelength, i.e. the color of the light ray. According to these notions, a red ray of light has a lower refractive index than purple one. But, no matter what kind of picture is placed behind glass, with white, black, or any other color; again the entire picture altogether and not just its parts is uniformly shifted. The degree of picture displacement depends only on our point of view, and not on the color of a pad.* [LXXXIX]

Trial 26 – Refraction always shifts the entire field of view

The fact that the different colored light beams are differently refracted in prism should be brought into relation with the point from which we view the image. Where the refractive index is lower (the red region of the spectrum), the position from which we watch the picture is less tilted; where a refractive index is bigger (the violet region of the spectrum), the position from which we watch the picture is more tilted. The more we are tilted, the greater is the shift.

1. When we look at an object through the glass plate, the displacement of the visual field occurs, and the object seems to be in another place than it really is.
2. A prism can be presented as two glass plates tilted with the respect to each other, which besides shifting of the image, linearly magnifies the image. The linearly magnified image is presented as the dotted image.
3. The smallest magnification has the upper part of the image seen through the prism, where the glass is the thinnest. As the thickness of the glass increases, so does the image magnification.
4. In the upper part, we watch a distortion of the image on a bright background, while on the bottom part, we watch the distortion on a dark background. Colors appear in a way that we have already studied.

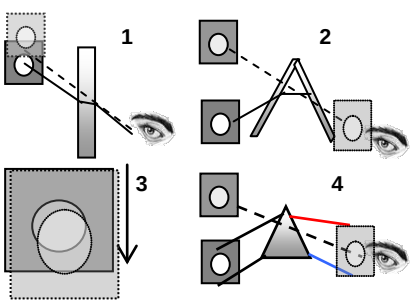


Figure 104 – Appearance of the prismatic colors

For light, there is only the whole image, not just part of the image. And this notorious truth can be verified by the following experiment.

Actually, there has been an awareness of the fact that light does reflect from the black body, because it is just what the facts of life indicate. However, since the existence of darkness was interpreted as a lack of light (i.e., that there is a void in the beam of light created by a black body), the concept of absolute black body was introduced. This should be a body that does not reflect any light, unlike a real black body that always reflects at least a part of light. [51]

The absolute black body is a hollow object with a small opening and inner walls that do not bounce off light. E.g. an absolute black body can be modeled as a hollow sphere with a small hole, coated inside with dark material that does not reflect light, for example with soot. [XC] *When a light ray passes through the cavity, it is poorly reflected off of the walls of the body, so it can never get out of this hole. It means, this hole behaves for light as a bottomless pit, as a hole absorbing all light, i.e. as a black hole – this idea was subsequently utilized in astrophysics.* [XCI]

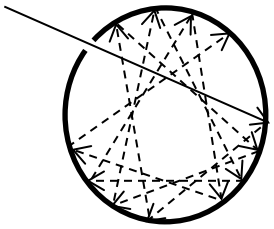
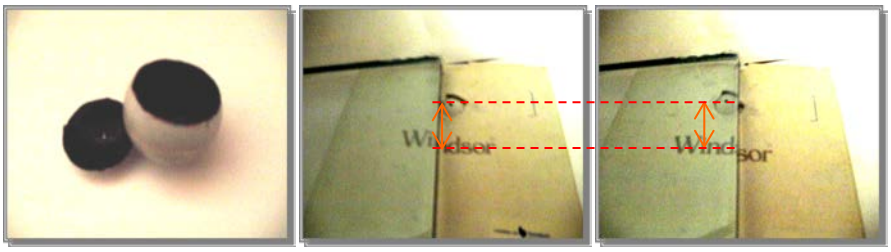


Figure 105 – Model of the absolute black body

Well now, let us place under the glass plate, instead of a black point, our mini black-hole. Again we notice that the entire image is shifted up, no matter that a black hole swallows all light in its domain (this is believed). A black hole neither made a void in the beam of light, nor it remained below the image of surface, which is raised due to the refraction of light.

A table tennis ball is cut and drilled on the one place. The interior is coated with soot. Then, the mini black hole is placed in a cardboard box. The glass plate was placed on the box. It can be noticed that the entire visual field is shifted, i.e. the distance from the label to the hole is always the same.



Trial 27 – Refraction of light from the absolute black body

There is no hole in the beam of light – and of course there are no black holes in the universe. Because, it is completely irrelevant whether we look through the glass plate at the Ping-Pong ball hole, or we look through the glass plate at the black part of the sky – for which we believe that is a black hole. The black part of the sky is being shifted behind the glass, in the same way as white. If the black hole absorbing all light were there, by the projection of the image of a black hole onto a red screen, the image of a black hole should become red, because through created hole we should see the screen itself; black can be seen, black is not an invisible color.[52]

[51] The notion of "absolute black body" was introduced by G.R.Kirchoff in 1862.

[52] The whole story about a black hole is formed as a result of misunderstanding the effects of black and white on the eye. The question of what happens when the stars lose their shine i.e. when they "die", is very old and dates back to antiquity. Already Tycho Brahe has remarked that the crescent Moon (when darkened), looks one fifth smaller than the full moon (when bright). Black clothes make people look slimmer than bright ones. Out of the fact that we experience black as a reduction of the figure, subsequently emerged the theory that dying stars are being transformed into black holes that "attracts" everything around it due to the enormous gravity. In his book Goethe thoroughly deals with experiences of black and white.

The model of "absolute black body" is just an incorrectly drawn sketch of a camera obscura, which is presented in a way that "absolute black body" absorbs all entering light. If a black hole existed in the universe – it would be just a gigantic camera obscura on the screen of which, we would see an inverted image. As so often in life, one confronts reality with faith instead of facts. This attitude denies the fact that with faith one cannot prove anything – just facts may prove something.

4) Image in Camera Obscura

Let us look at the figure made by the light passing through an opening of camera obscura. Light rays form a central-symmetric figure behind the opening.

Nevertheless, let us now look at the picture of a burning candle on a mirror which is illuminated from one side, in total darkness. A beam of light creates a picture of the candle on a mirror that we watch through the opening. According to the corpuscular theory of light, the rays of light are the corpuscles of light reflecting from the smooth surface under the law of the same angles. If the light corpuscles followed the law of bouncing, then no ray of light would pass through the opening of camera obscura, which is not in the path of the light beam. This would mean that behind the opening of camera obscura, no ray of light would enter the eye of the observer.

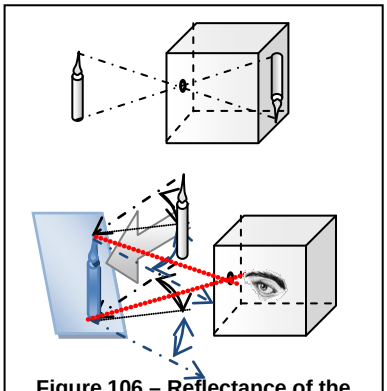


Figure 106 – Reflectance of the image seen through the opening

However, this could in no way explain why it is possible to see the image of the candle through the opening of camera obscura, no matter that we do not look at a source of light directly, but at the picture of the source of light.[53]

Huygens' notion on the oscillatory light front is something that is supposed to overcome the problem of light propagation behind a small opening. Huygens is a physicist who puts forward the wave theory of light. The wave theory of light was inspired by the way in which turbulent water transmits the energy of waves. E.g. if we hit the surface of calm water, we notice that the wave energy expands in concentric circles.

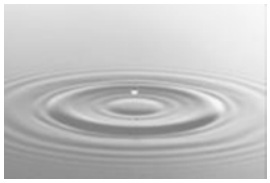


Figure 110 – Expansion of water waves

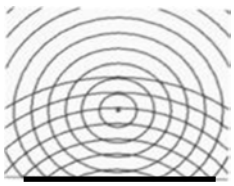


Figure 110 – Repulsion of water waves

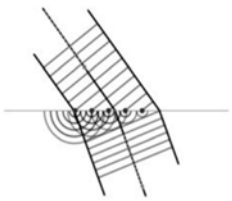


Figure 110 – Fraction of water waves

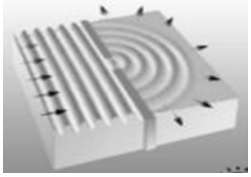


Figure 110 – Expansion of water waves behind the breakwater

This notion was used for the interpretation of light propagation from light sources. Or, when waves splash over steep coast, we can see the wave rejection in concentric semicircles from a coast. This notion is used for the interpretation of the light reflection. Again, when wave transit from rarer into denser environment, their speed is changed causing a fracture of the

[53] One tries to explain this problem by the diffuse scattering of light rays on the surface of the material. The diffusion of light will be discussed later.

shock wave front. This notion is used for the interpretation of the light refraction and this way of thinking led to an idea on optically rarer and denser mediums. According to the mathematical model, optically rarer mediums should be the ones with lower speed of light than optically denser mediums.

And when waves crash into breakwater, because of the manner of the wave energy transmission behind the breakwater, on the opposite side of the breakwater, new waves are being formed i.e. opening behaves as a new source of wave energy, and the obstacle does not prevent the wave energy propagation behind the barrier. This notion is used for interpretation of light transmission through the opening of camera obscura.

Practically, according to the wave theory of light, light does not reflect coming from the light source in the point of the body (light rays), but the light reflects off of the body in a manner that the light front spreads from the points of the body. When light passes through an opening, in fact, a surface front of light enters the opening, so the opening behaves as a new punctual source of light. This is provided as an explanation for ability of the light appearance behind the opening of camera obscura.

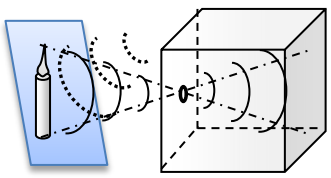


Figure 111 – The wave interpretation of the camera obscura phenomenon

Let us consider the shock wave front of light, which expands from the opening. Light front increases, means the image is increased. This is true for light, because as light propagates, the image carried by light becomes larger and larger. But, for our eyes this is not true at all, because it would mean that the image details would be better visible, as we are farther distanced from the opening. But just the opposite is the case. We will better see the image details as we approach closer the opening.

Present day culture considers itself enlightened, because it got rid of ancient superstitions which through e.g. Empedocles and Plato claimed that during looking, some rays come out of the eye. [XCII] *However, if we want to believe in light oscillations spreading from the opening, then precisely something like that must to be taken into account regarding the human eye.*

Because, precisely the facts of life suggest that beside the assumed input front of light emanating from the object towards the eye, or from the opening to the eye; we should also assume the front of visual field emanating from the eye towards the object, i.e. from the opening towards the object. The image carried by light increases by increasing the distance from the opening, but the image details are better visible if we are closer the object.

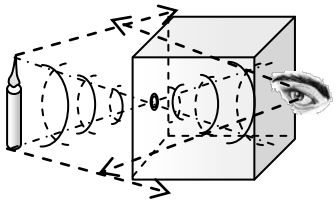


Figure 112 – Light approaches the front of visual field

Openings do not restrict the light-image. Openings only restrict our field of vision. We see a part of the picture through the opening. But the visible part of the picture changes with the distance change between the eye and opening.

This must be taken into account when an image illuminated by light is being observed through small holes.

5) Rectilinearity of Vision

Let us consider one more time the camera obscura phenomenon. If light is presented as a set of light rays, we have a problem with the image projection of slant illumination on the screen of camera obscura, which cannot be explained with the rays of light. Again, if light is presented as an oscillation front, then another problem arises, that did not exist in a presentation of light with the rays of light. It is not clear at all why the figure should be rotated for 180^0. In fact, it is not clear at all, how can we see the image imprinted in such imagined waves?

Where is the picture of the candle that we see, in the notion of light as an oscillatory front that spreads in concentric circles?

Corpuscular school of nature of light has emerged from the notions of geometrical optics, from the interpretation of light as a set of light rays. Wave school of nature of light has emerged from the interpretation of the propagation of oscillatory motion. Both schools have problems in facing the facts. All this indicates that both interpretations of luminous phenomena only deal with notions, not with facts.

In geometrical optics, there is a notion that light propagates rectilinearly. It is, in fact, only a notion of encountering of two things – the light-image encounters our field of view. The boundary of the area between the light-image and the visual field determines what is being presented as a boundary of the rectilinear propagation of light. Rectilinear propagation of light is just a notion, only the interpretation of the light phenomenon derived from geometrical studying of vision.

Physical, rectilinear propagation of light means nothing else except that we see a picture in a straight line, not behind the angles.

6) Diffusion of Image

According to the notions of modern physics, light reflects off of the surface following the law of equal incident and repulsive angle of the light ray.

If we have the reflection of light from a smooth surface, the light rays bounce off of the surface parallelly. On a rough surface, reflection is not uniform, which might be presented with the non-parallel light rays. [XCIII] *The scattering of light due to the irregularities in materials is called light diffusion.*

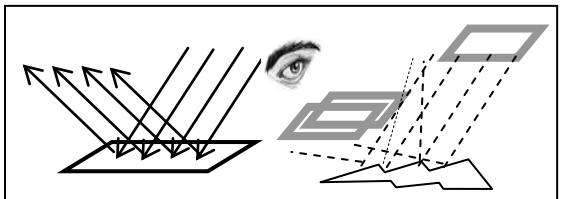


Figure 113 – Diffusion of image

However, let us clearly bring to mind that in optics, we always deal with an image, and that the light rays do not exist in reality. Notion of parallel light rays only shows that the image illuminated by light is seen without distortion. Again, the notion of non-parallel light rays shows nothing else but the appearance of image distortion, the image has lost its sharp contour. Image loses its sharpness whenever the light-image encounters a visual field, at the border of the material, leading to an irregular enlargement or reduction of an image.

If we look at the beam of laser light on the mirror, and if we consider that light reflects off of the surface according to the law of equal angles, then the question arises, how do we see the laser light, because no kind of the light ray should reach our eyes.
In modern physics, the diffusion of light is used for the interpretation of this problem, so it is added that during reflection, light is diffusively scattered from the surface of the mirror, due to irregularities of material. Diffusion of light is used as an answer to the question, how do we see the illuminated objects?
This would mean that when the surface is more polished (smaller scattering of light), less rays should be reflected into our eye i.e. on a more polished surface, objects should be less visible than on unpolished ones. But just the opposite is true! It is forgotten that, in reality, there is no such a polished mirror on which we do not see a red dot. The point is that, in optics, we deal with the image, we see the image of the laser pointer in the mirror.

To detailed description of the reflection of light, we shall return later.

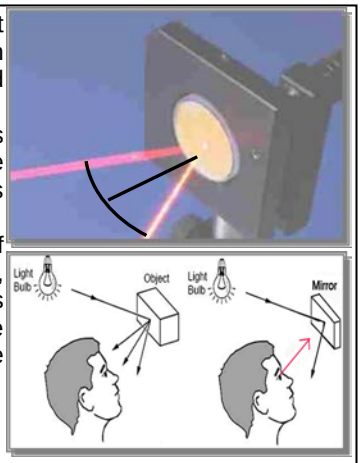


Figure 114 – Diffusion of image on a polished surface

7) The color appearance on Small Openings

The lens behaves like a camera obscura, where the magnification of figure is determined by the power of the lens (in a camera obscura, only the distance from the screen determines the size of the figure).[54]

Since a lens is never of an ideal circular shape, light and field of vision never encounter on an exact ideal straight line. There, an area where light apparently deviates from the rectilinear path occurs. In other words, the image loses sharp contours, i.e. on the border of the image the area of semi-shadow appears. Of course, if the semi-shadow is illuminated, now on the edge of the image illuminated by light, it comes to the appearance of colors, because light and darkness mix.

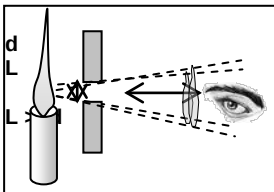


Figure 115 – The image enlargement on a small opening

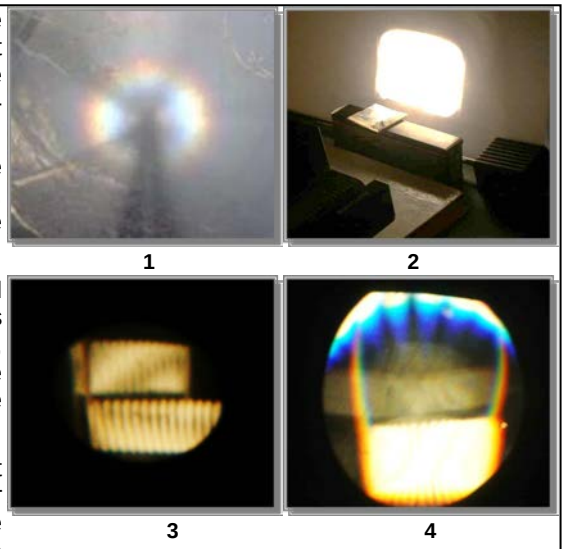
The appearance of colors on the edge of the lens is called the chromatic aberration.

The first picture shows the diffusion of light. These are colored borders that can always be seen around the light source with the presence of mist or vapor causing the image aberration and, hence, the color appearance in the semi-shadow area.

The second picture shows the light from the projector on the screen. The light is dazzling white. In front of the projector, there is a small cardboard plate with a small opening in the alufoil.

When the plate is placed in the projector, we get a third picture on the screen. It shows that a small opening sharpens the image, so now on the screen, instead of the dazzling light, we see the glowing filaments. It is the glowing filament of the halogen projector lamp, with a back reflector directing the light of the projector.

Now, if instead of the plate placed inside the projector, we put a piece of alufoil with a small hole in front of the projector aperture, we get the fourth picture on the screen. The image of glowing filaments is no longer sharp, and the blurred image creates an area of illuminated semi-shadows, enabling the appearance of colors in a way that we have already studied.



Trial 28 – Image sharpening and chromatic aberration on small slit

[54] Compare to the chapter "Color Intensity depends on Contrast of Light and Darkness" pg. 48. There is shown that a small opening i.e. the camera obscura, in fact, enlarges the image, which can be geometrically presented as the bending of light.

Anyhow, the phenomenon of the chromatic aberration Goethe called the "colored aura". Due to the image diffusion colors may appear on the edges of the object, whenever the image is dispersed, either because of the object's shape, or because of e.g. the presence of fog around a light source.

Official physics explains the color appearance on small slits by the light diffraction. Nowadays physics seeks the cause of such colors in the wave nature of light. It is believed that the trajectory of light has bent allowing light to enter an area of its own shadow, in the same way as a wave motion behind the breakwater propagates in concentric circles entering the area which is sheltered by the breakwater. [XCIV] *Since it is believed that colors have different wavelengths, the appearance of colors is associated with different levels of light bending, depending on the wavelength of light.* [XCV]

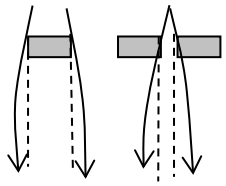


Figure 117 – Bending of light according to the notions of modern physics

The dotted line marks the border of the shadow. White arrows indicate the direction of the oscillations expansion. Red arrow marks the wavelength of the waves. Wavelength indicates the distance between points that are in the same phase of oscillation.

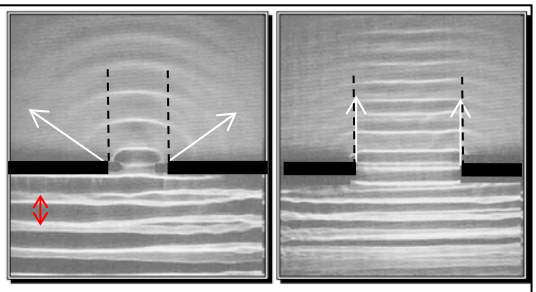


Figure 117 – Expansion of water waves behind small and large opening

55, [XCVI]

But, to be able to understand the phenomenon of light diffraction, let us first describe the phenomenon of light interference, and to diffraction, we shall return later.

8) Multiplication of Image

Studying the phenomena of light, modern physics has tried to grasp the essence of light. One of the basic issues in studying the light phenomenon is the question of how does light propagates through space.

It has already been mentioned that simultaneously with Newton – who put forward a corpuscular theory of light – in accordance with which, light is a particle that travels through space; the Dutch physicist Huygens, put forward a wave theory of light. According to

[55] When the wave oscillation encounters an obstacle, then the opening behaves as a source of oscillation. E.g. when on the water surface we produce concentric waves by an impact; by looking at an expansion of waves behind the breakwater, we can notice that the waves behind the opening propagate in concentric circles. This notion is applied to the interpretation of the luminous phenomena, and this is the so-called Huygens' Principle, which should explain why light can spread behind the barriers and enter the shadow area.

Again, in order to explain the different propagation of light behind the small and large opening, another notion of the wave motion is used – interference. Interference is a phenomenon where oscillations can be amplified or damped by other oscillations. The way the oscillations are dampened behind the opening, depends on the wavelength of the oscillation and the size of the opening.

When the opening is small compared to the distance of waves, i.e. to the oscillation wavelength; in the sheltered area behind the opening, there is no interference of the oscillations, i.e. there is no canceling of the oscillations. The limit for the appearance of diffraction are openings less than half a millimeter, which is being connected with a wavelength of light. When the opening is large, compared to the distance between waves, i.e. comparing to the oscillation wavelength, interference is responsible for the canceling of oscillations behind the opening. It is believed that behind the large opening, the trajectory of light is rectilinear.

this theory, light is not composed of particles, but it is energy that is being transmitted through space by vibrations of particles of some medium. By the medium which transmits light through space, Huygens considered the particles of aether.

Corpuscular theory of light assumes that light is a particle, while the wave theory of light attributes the expansion of light through space to particles. Subsequently, these two theories are unified in the corpuscular-wave theory, where light is practically a particle of energy, which propagates through space by energy particle, i.e. by itself. What this is supposed to mean, I could not tell. Anyway, let us consider the basic notions of the wave theory of light.

When we throw a stone into the water, it can be seen that the wave energy propagates through the water as a series of concentric circles on the water surface. By looking at the water surface, we can see that the point of water surface vibrates in a certain rhythm, the point of water surface periodically changes the position in time.

Now let us consider the case when two stones are simultaneously thrown into the water. On the water surface, two confronted waves appear. Now, a particular point on the water surface can oscillate more or less strong, depending on whether the oscillations of other waves are being added or suppressed in a particular point. The appearance of super-imposed oscillations in physics is called the interference of waves.

The same phenomenon can be observed in sound waves. E.g. when two identical sound forks vibrate at the same time, we can notice that the newly obtained tone changes the volume; it becomes stronger or weaker, depending on whether the vibrations are added or canceled.

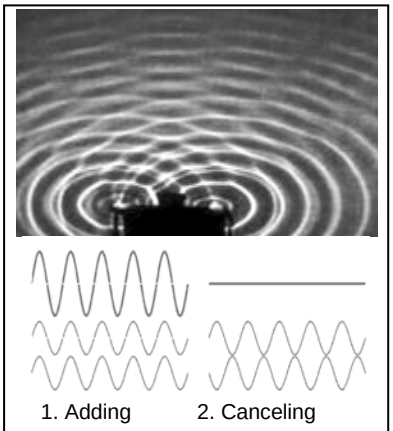


Figure 118 – Interference of waves

Huygens assumed that light is of wave nature, and it could have been expected that in the field of luminous phenomena, one could notice the same principles that are valid for other wave motions. However, it has not been noticed that two different light sources can mutually amplify or cancel the light beams.

The appearance of light strengthening or weakening was obtained in Fresnel's interference experiment (1821), which confirmed the expectations of a wave school of nature of light.

- - -

Let us take two mirrors of black glass. These are the mirrors that have only one surface which reflects light, unlike the common mirrors in which light – from both the protective glass plate and the polished metal surface – is being reflected. Such mirrors do not create multiple figures when the picture on them is viewed from a slant angle. Put mirrors at an angle of almost 180^0, but only a little tilted towards each other, just enough that a figure reflected in the first mirror may appear on the second one.

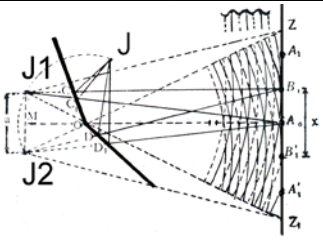


Figure 119 – Fresnel's experiment of the light interference

Let us illuminate mirrors with the monochromatic green light source J. Rays of light reflected from the mirrors produce two imaginary light sources J_1 and J_2, which are projected on a

screen. According to the wave theory of light, each light ray is practically a presentation of the oscillatory shock front, so the oscillatory fronts of light are being merged causing interference. [XCVII]

And indeed, on the screen we can notice the appearance of dark and bright green stripes; we see the places where strengthening and weakening of the light oscillations appear. If we use – instead of a monochromatic light source – a white light, we get spectral colors on the screen.

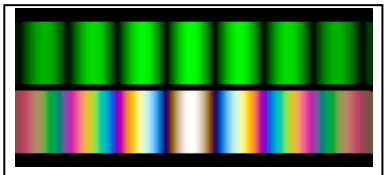


Figure 120 – The interference of light

Since nothing similar has ever been obtained from two sources of light, there was an interpretation that different sources of light are incoherent (uncorrelated), because the oscillations of excited atoms producing light are incoherent, and consequently, the light of two light sources is of different phase and frequency. [XCVIII] *Since the two light sources are correlated neither in phase nor in frequency, their oscillations cannot be amplified or canceled. And precisely for this reason, interference can be obtained with a single light source, when the two mirrors practically provide the necessary coherence of light, because light is now correlated in both phase and frequency. Practically, two mirrors simulate the two coherent light sources depicted by two imaginary punctual sources of light J_1 and J_2.* [XCIX]

The same effect, Fresnel managed to get with a biprism. Biprism is a combination of two triangular prisms that are on the back only slightly tilted toward each other (actually, the slope is the same as in the two mirrors in the above experiment). When the monochromatic light passes through biprism, the interferential stripes can be seen on the screen.

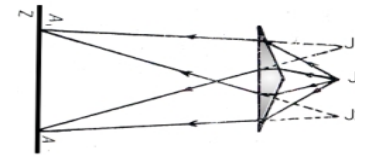


Figure 121 – The interference of light with the biprism

Even before Fresnel, in 1803, the English physicist Thomas Young obtained the light interference in another way. When light is let through two very narrow slits, the interfering lines can be seen on the screen. In this experiment, two small slits now serve as a source of coherent light. There is an interpretation that the rays of light from two slits pass through the different length of optical paths causing that in some places on the screen, the light waves are added up, and on others they are canceled out.

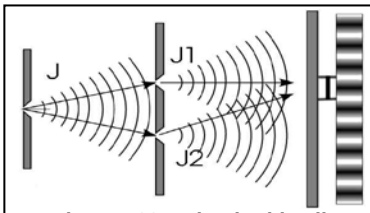


Figure 123 – The double slit interference of light

Subsequently, the interference experiments were confirmed in countless cases. Another way in which one can get the interference of light is using a thin transparent plate tilted at a small angle, on the mirror. If the plate is illuminated, interfering lines can be noticed on the screen. These and similar experiments are called the interference on the thin-film and are associated with the way colors appear on a soap bubble or on a thin film of oil, spilled on a water surface.

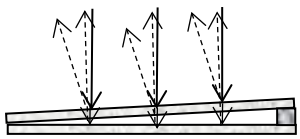
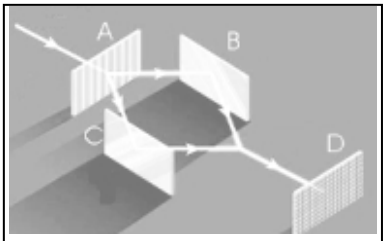


Figure 122 – The thin-film interference of light

It is important to notice that in all interference experiments, the necessary light coherence is obtained by kind of separation of a single light source into two beams of light.



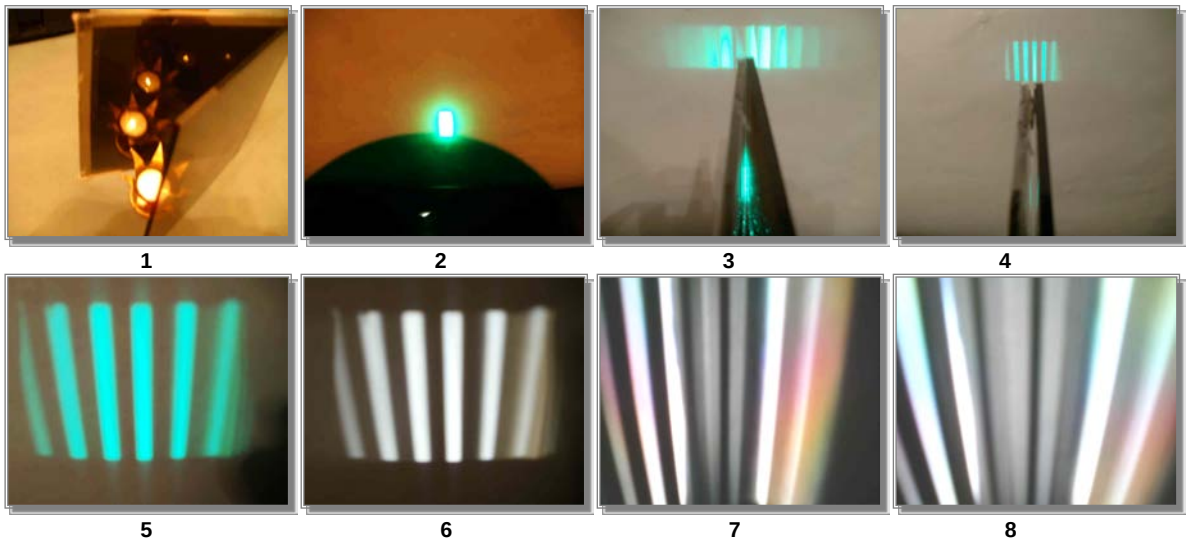
A – Beam splitter, B and C opposite mirrors, D – screen

Figure 124 – Conceptual scheme of the light interference experiment

The success of the experimental confirmation of the wave theory of light was the reason for its ultimate triumph in the interpretation of the nature of light.

- - -

Let us place two black mirrors opposite one another at an angle. Look at the picture of candles in a black mirror. Due to manifold reflection of an image from mirrors, the figures are being multiplied. This is a known case of multiplication of figures in mirrors, which reflect an image mutually. Do notice that each successive figure is getting weaker and weaker.



Trial 29 – Creating the effect of interfering stripes with two plates of black glass

Now, instead of watching multiplied images of a candle, illuminate the plates with the green light obtained from a rectangular slit. On the screen, one can see the figures of the multiplied green square on a black background. The strongest figure is the central figure, while by distancing from the center, the strength of the green stripe is getting weaker. Reduce even more the angle spacing between the plates. On the screen, we obtain the green "interfering" stripes.

Remove the green filter. On the screen, we get white stripes. And to get the colored stripes, it is necessary to create an area of semi-shadows, and thus allow pervading of light and darkness. One of the ways to achieve this is with a help of a narrow slit as in Young's experiment. Thus the image dispersion is created i.e. scattering of the image contour. Now the image of white narrow slit with colored borders is multiplied with glass plates, and one can see the colored "interfering" stripes. Undertones look like the one we can see on a soap bubble. [56, C]

Observe the sketch of the biprism. Through the biprism, look at the green square on a black background.

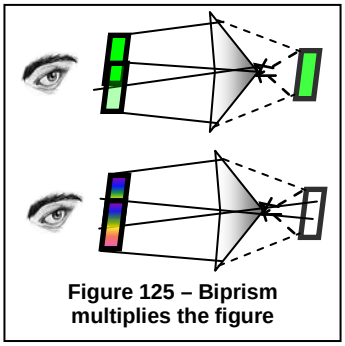


Figure 125 – Biprism multiplies the figure

From the image of a single green square on a black background, the biprism will make at least two images of the green square on a black background. Each point of the image of green square on a black background is doubled, and this is presented in the sketch with the two imaginary light sources J_1 and J_2. There can be many more images, all depends on the angle of observation. For

[56] Thus, Newton's complaint becomes clear, namely that the shadow cannot participate in the appearance of colors, because it is noticed that on a soap bubble, the colors change, even if the bubble is illuminated with a light source of constant intensity. The point is that a thin surface film of a soap bubble spins and thus creates different ways of image multiplication, which causes appearance of different colors on the surface. Compare endnote.

simplicity, let us hold on to the description of two images. Two images overlap. If we now merge these two images, we get the green "interfering" stripes.

Now, instead of the green square on a black background, let us take a white square on a black background. With the help of the prism we get the stripes of spectral colors, in the same way as in the experiment with prism. It is just that the prism distorts one image, and biprism simultaneously distort more images. The images overlap and on the screen we get spectral "interfering" stripes.

Now instead of the biprism, let us use two black mirrors. What is in the textbooks of optics being presented as an imaginary light source J_1 and J_2, on the sketch of Fresnel's experiment – it is a geometrically disguised fact of the appearance of a figure doubling. The images overlap in the same manner as with the biprism and we get the same effect.

Observe more carefully the Figure 120 pg. 88. On the lower picture of interfering spectral lines, we have nothing else but a multiplied image of the white rectangle on a black background with colored borders, where the distance from the image increases, as the rectangle is more distanced from the central rectangle. This is because the multiplied figures of two mirrors are apparently getting farther and farther. This creates an effect of greater mixing of colored borders, as when in the chromatic aberration experiment, the prism is distanced farther from the pad.

The experiment of the "light interference" is not in any way related to the superimposing of waves. It is the multiplication and overlapping of images of the one and the same figure.

- - -

How pointless is the notion of light interference and how dangerous is to believe in fabricated mathematical models, and not in reality, is best shown by the diffraction of light theory. Let us go back to the mathematical model of the oscillatory motion on the small and large opening.

It is believed that when the opening is small compared to the wavelength of light, light behind the opening spreads in concentric circles, where due to the light interference, a small opening behaves as a source of light. Hence, there appears as if the light is entering the shadow area. Again, when the opening is large, interference of waves behind it is responsible for the canceling of oscillations, which now do not spread beyond barriers, but form a rectilinear path of light. [CI]

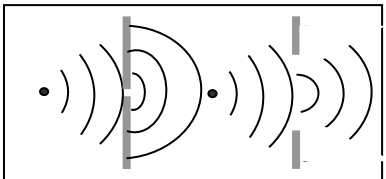


Figure 126 – Diffraction of light on the small and large opening

On the other hand, let us consider the way in which light actually illuminates an object, for example, when the Sun shines on a planet. The Sun as a light source creating the area of shadow and the area of semi-shadow. This is because the Sun is large compared to the size of planet. That is why, we have a partial and a total eclipse. When the obscuration of the Sun occurs in the area of semi-shadow, an eclipse is partial; when the obscuration of the Sun occurs in the area of shadow, an eclipse is full. The Sun is not a punctual source of light; the Sun creates a shadow and semi-shadow.

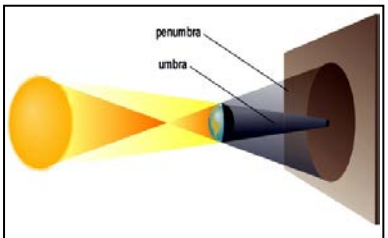


Figure 127 – Light sources create shadow and semi-shadow

Let us return to the theory of coherent light sources generated by excited atoms. Since the opening is very small, the light source is very large compared to the opening. There is no any punctual light source!

If we want to hold on to reality, the light source on the small opening should be drawn as a set of punctual sources of light, which exceeds many times over the width of the opening. Since it is a single source of light, light would have to be coherent, i.e. correlated in both the phase and frequency. As it is correlated in both the phase and the frequency, interference would have to appear both before and after the diffraction slit.

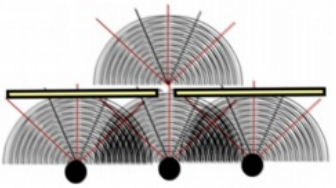


Figure 128 – For small openings, the light source is large

This means that the interferential stripes should be seen both before and after the small slit, they should be seen whenever we watch the beam of light which is smaller than the limitation size of the opening for the appearance of the diffraction phenomenon. These openings are the ones smaller than half a millimeter.

Of course, that is something nobody has ever seen. The whole thing is based on a fabricated notion of atoms as small light-oscillators that generate fictional coherence of light. The atom is supposed to be the light source that casts a shadow, and never a semi-shadow. From the notion of punctual source of light, it has appeared the idea of an oscillating atom. It has been forgotten that the punctual source of light is just a notion of geometrical optics, but instead of giving credence to reality; the credence is given to drawn lines. Rather than trying to keep the pure phenomenon by stating: "The burning body shines – it is a description beyond which one cannot go"; it is attempted to achieve cognition by adding something that cannot be seen in an obvious fact, arguing, "The atoms are small light oscillators!".

The experiment of light diffraction has nothing to do with the bending of the light's path, but with a distortion of the image we look. The light diffraction experiment shows that on a small opening, an irregularly enlargement of the image occurs, and the notion of rectilinear propagation of light is only the notion of the way in which the image contour we look increases, with increased distance from the object.

When we watch a picture through the diffraction glasses that instead of a glass have a transparent plastic with lot of small holes, it is clearly visible that the diffraction of light just produces a multiple distortion of the figure we observe.
Where the distorted image is being viewed on a bright background, a pair of red-yellow appears; where the distorted image is being viewed on a dark background, a pair of blue-violet appears. It is all about, that in an experiment with a prism, the visual field is always shifted from a thin toward a thick part of the prism, while in the attached experiment, visual field is shifted radially, from the center to the periphery.

Figure 129 – Diffraction of light I

We have mentioned that the eye merges impressions into one, when the image is too small to be distinguished. But, if the image is large enough, the impressions will not be merged, but the opening will act on the field of view as a magnifying glass, each lens is nothing else but a camera obscura. Due to improper image magnification, in the area of semi-shadow, the colors appear.
Now, if the image is being viewed through two openings, it is the same as when the image is being viewed through two lenses. However, if small openings are very close, now two openings produce a doubling of the image, i.e., instead of one figure, we see at least two. Practically, in Young's experiment of light diffraction with two small openings, we have the same thing.
Anyway, the same phenomenon can be observed looking at figures through any perforated object, e.g. through the curtain made of perforated textile.

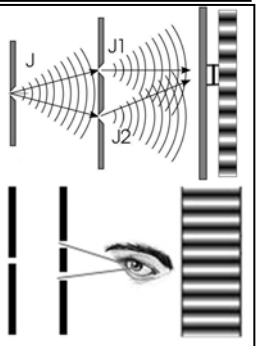


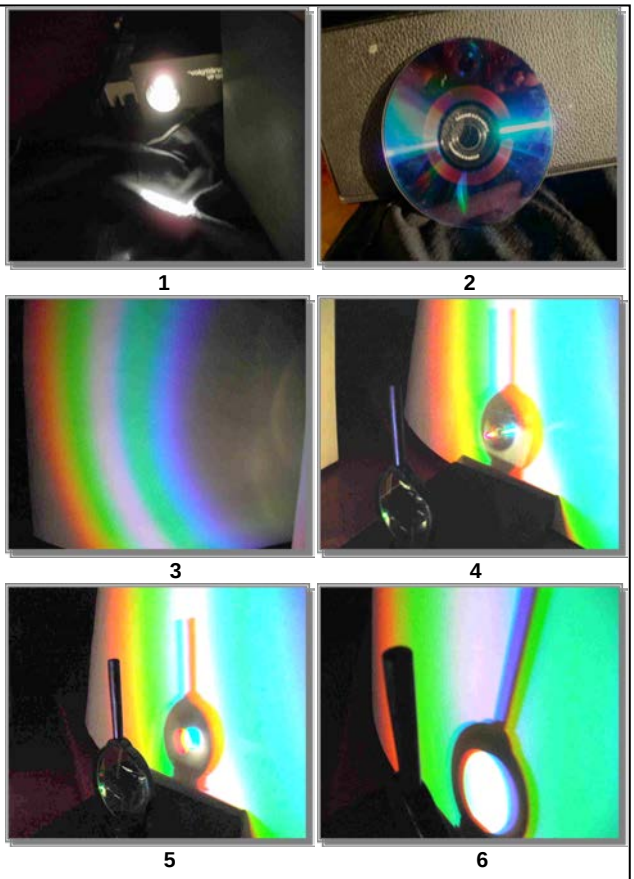
Figure 130 – Diffraction of light II

There are two types of diffraction gratings. When we have a material with a lot of very narrow slits, it is a transmissive diffraction grating. If slits are engraved into a material that reflects light, it is a reflective diffraction grating. The surface of a CD represents a reflective grating. The experiment shows that the diffraction grating only multiplies figures and the original image can again be obtained by focusing the light.

The first picture shows the round aperture of a projector as a source of light, i.e. as the initial image. The image is projected onto the CD, where on the surface, we see the undertone.

Then, the image from the CD is projected on the screen where we see the diffraction lines. When the projected image is focused on the screen, we see a picture of CD. If the loupe is getting closer to the screen, now the image focus shows the aperture of the projector as a fuzzy image. With decreasing the distance between the loupe and the screen, we start to see the original image of the round aperture of the projector. One should pay attention to the shadow cast by the loupe holder. It can be seen the double shadow, which is a clear indication that the image is doubled. Practically, here, the colors appear in the same manner as in Goethe's experiment with colored shadows. The surface of a CD duplicates figures and illuminates shadows.

The experiment is as simple as convincing because it clearly depicts that the theory of interference of light is wrong. If interference of light existed, one could never be able to obtain the original image from such light.



Trial 30 – Obtaining the original image from the diffracted light

9) Multiplication of Image due to Shifting of Field of View

Let us put two flat glass plates at angles of 57^0, and observe a double reflected beam of monochromatic light on the screen. If we rotate the upper glass plate P_2, we can notice that the intensity of projected light beam changes on the screen, and at some angles of rotation, the light beam can completely disappear. E.g., if the angle of rotation is 0^0, the light spot is visible on the screen, at angle of 90^0, the spot totally disappears and reappears at an angle of 180^0, then again disappears and reappears etc.

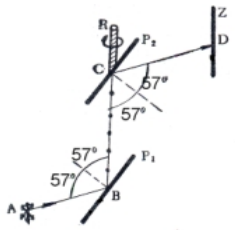


Figure 131 – The experiment of light polarization

If the angle between the plates is not 57^0, a possibility of changing the intensity of a projected light beam by the rotation is smaller, and at a certain inclination angle between the plates, the light blur completely disappears. The angle between the plates under which the strongest range of light intensity occurs, is called the boundary angle of polarization or Brewster's angle. [CII]

Light reflected from the first glass plate seems to behave as it is not the same in all directions; it behaves as if it has poles. The reflected light from the first glass plate gained such properties that it appears that the reflected light is not equal in all directions. Now, it can be reflected from the second glass plate, but only if the properties of polarized light match the tilt of the second glass plate.

The first glass plate, the plate that produces the effect of polarity of light is called a polarizer. The second glass plate, the plate that "recognizes" the polarized light is called the analyzer. E.g. a polarizer which produces the polarized light can be put on the car headlights. If we wear glasses with an analyzer, then such a light will not daze our eyes in encountering a car from the opposite direction.

In modern physics, the phenomenon that light acquires properties that are not equal in all directions, is called the polarization of light, and is interpreted by the wave nature of light.

The given interpretation reads as follows:

The input light beam is of round shape, i.e. the oscillations occur in such a manner that the cross-section of a light beam rhythmically increases and decreases. Such a surface mode of oscillation is called the transverse oscillation. When light bounces off of the first glass plate – of the polarizer, then it starts to oscillate in a single plane.

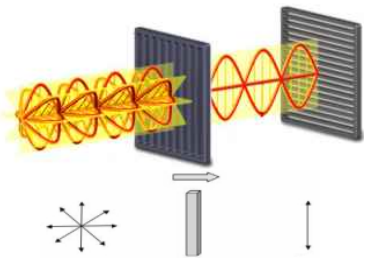
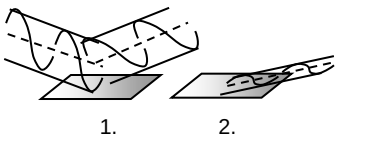


Figure 132 – Polarized light

When the polarized light bounces off of the second glass plate – of the analyzer, it can happen now that the only remaining plane of oscillation is canceled, so finally, the light beam disappears. Whether the light beam can be reflected or not, depends on whether the oscillations coincide or not, with an inclination of the second glass plate.

E.g. in the position 1, light can be reflected, because the plane of oscillation of light and the glass plate inclination match. But in the position 2, light cannot be reflected, because the plane of light oscillation and the plane of the glass plate inclination do not match.



1. 2.

Figure 133 – Reflection of polarized light

On the one hand, the experimental confirmation of light polarization was used for justification of the wave nature of light (Young and Fresnel, 1817), on the other hand; it is used for a proclamation that light oscillations are transversal (in a plane), unlike sound vibrations that are longitudinal (in a line).

- - -

That the matter about the interpretation of light polarization is not so clear, the following facts indicate:

The facts of key importance have been completely neglected. The experiments confirmed that the polarization does not occur in the reflection of light from metal surfaces. This fact is just stated in the books of modern optics, without any explanation. [CIII]

Secondly, one did notice the relationship between the boundary angle of polarization and boundary angle of refraction, but without any explanation, in what kind of conjunction these facts might be.

Therefore, let us examine in detail the phenomenon of light refraction.

When we look at an object through e.g. water or a glass plate, the object seems to be at other place than it really is. A phenomenon is explained by the fraction of the light trajectory. It is said that when light passes from a rarer into denser environment and vice versa, a double fraction occurs. Here, the above notion is consciously sketched with the light rays, i.e. the focus is placed upon the projection of the image point we look.

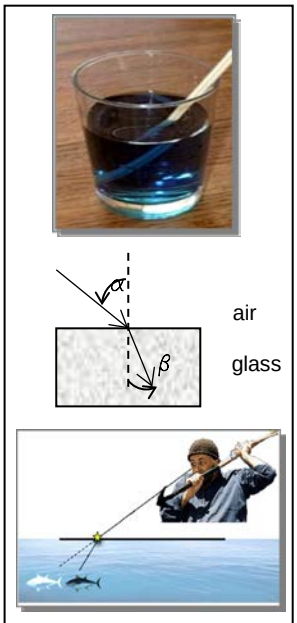


Figure 134 – Refraction of light

This notion allows defining a so-called refractive index, as the ratio between the sine of the incident and the refracted angle:

$$n = \frac{\sin\alpha}{\sin\beta}$$

In glass, the refractive index is 1.53.

Light rays are more refracted if the angle of incidence is larger. However, it turns out that there is a maximum angle of incidence, above which light refracts no longer, but begins to reflect. This angle is called the boundary angle of refraction having magnitude of $41^0 48'$ for glass. [CIV]

This means nothing else than that through a glass plate, we can see images that are shifted due to the shifting of vision field, but only when the plate is tilted below the boundary angle. Above the boundary angle, we can no longer see the figures through the plate, but we can see only the reflection of the figures from the other side of the plate. Or, we have an identical case when we watch a river or sea floor from a slant direction. Due to the refraction of light caused by water, the floor seems closer than it really is i.e. water along the coast always looks shallower than it really is. However, the shallows is visible only at a certain angle of inclination, because above the boundary angle of refraction, just a reflection on the water surface starts to be noticeable, but not the river or the sea floor.

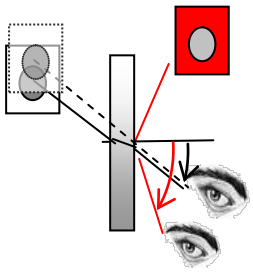


Figure 135 – Boundary angle of refraction

A third thing we have to pay attention to, in studying the phenomenon of polarization, is so-called Brewster's Law. David Brewster noticed that the strongest polarization occurs when the ray refracted from the glass plate creates an angle of 90^0 in respect to the position of the reflected ray of light. [CV]

Let us express this fact by the index of refraction:

$$n = \frac{\sin\alpha}{\sin\beta} = \frac{\sin\alpha}{\sin(90^0 - \alpha)} = \frac{\sin\alpha}{\cos\alpha} = tg\alpha$$

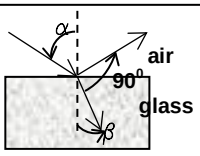


Figure 136 – Brewster's law

This is a so-called Brewster's law that establishes the maximum angle of polarization. In the glass, for n=1. 53 we get ($\alpha=57^0$).

Now, just connect the above three facts. It will explain the phenomenon of polarization.

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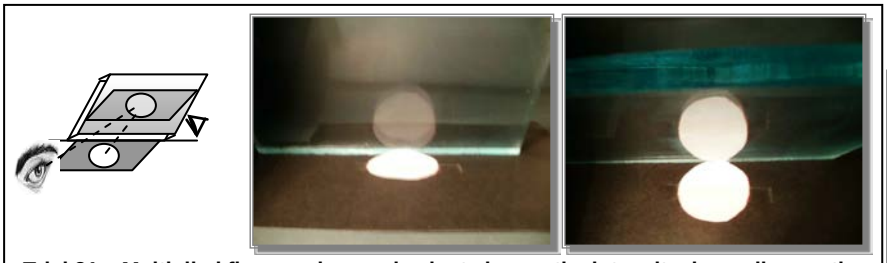
Let us look from a slant direction at the multiplied images of the white circle on a black background.



Trial 31 – Multiplied figures observed aslant change the intensity depending on the angle of observation

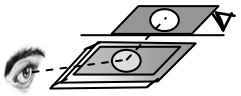
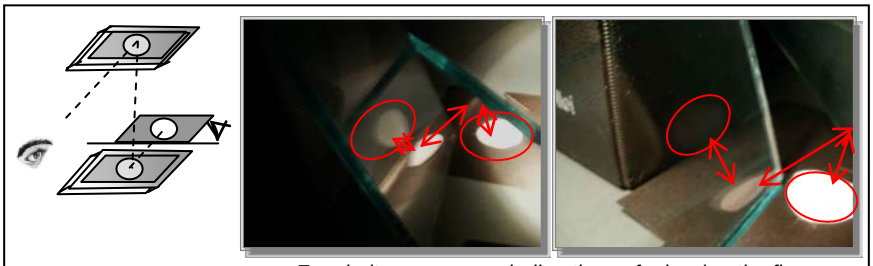


Figure 137 – The same experiment with changed positions of the observer and the object

We can notice that the multiplied figures change the intensity, as the slope of the glass plate is changed. If the angle is smaller than the boundary angle of refraction, the image is scattered in more figures and is weaker. If the angle is larger than the boundary angle, the figures overlap and the overall image is more conspicuous.

Of course, we get the same thing if the glass surface is on the pad, and the image of the white circle on a black background rotates around the axis.

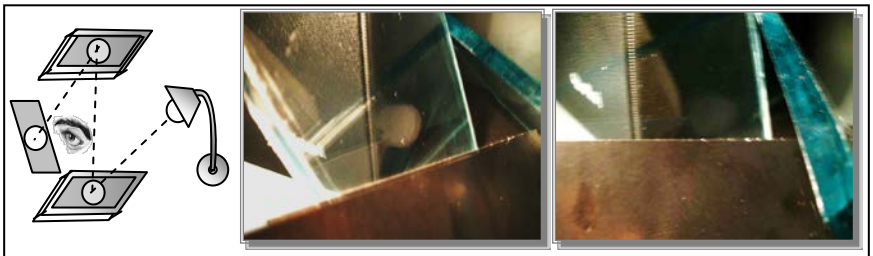


For clarity, arrows mark directions of mirroring the figure.

Trial 32 – Multiplication of figures from two glass plates under two different points of view

Now, let us reflect multiplied figures from one glass plate to the other glass plate. We can notice that multiplied figures are best seen if the observer and the other plate are in the same plane. Because if they are not, now the second plate multiplies the figures as well, and because of the multiple redundancies, the original figure can completely disappear.

At the end, only do two things, first – instead of looking directly at the picture, look at the projection of the picture on the screen; second – instead of the image of a white circle on a black background, place the light source with circular beam of light. We get a polarization experiment.



Trial 33 – The polarization light experiment where the original picture is sheltered from the sight of observer

In the "polarization" experiment, there is no any kind of polarization of light. It is about oblique reflection of figures from a transparent surface, or surface that creates a refraction of

visual field. There is no essential difference between interference and polarization, both phenomena are about multiplication of figures; it is just that in interference, reflected images participate in multiplication, while in polarization, both reflected and refracted images participate. If we create the conditions for light and darkness interpenetration, e.g. by illuminating semi-shadows which form multiplied figures, then, besides the change of figure intensity, as in presented experiments, colors can appear on the edge of the figure. [CVI]

Because there is an angle of observation where the multiplied figures are the strongest, the largest angle of polarization occurs, and it is in connection with the boundary angle of total reflection. The first glass plate, i.e. the polarizer, did not create any kind of orientation in light, or any poles in light – a polarizer has just created multiplied figures by shifting the field of vision. Depending on our point of view, the image appears as more or less conspicuous.

E.g. polarizer can be made as a series of 8-10 glass plates placed in a cylinder with an opening. Each polarizer can be used as an analyzer, too. When the image is viewed through the polarizer, the image illuminated by light has not disappeared; the image has just – by the shifting of the visual field – became so bent that the observer cannot see it.

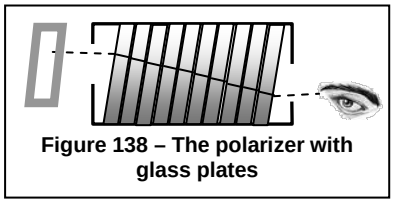


Figure 138 – The polarizer with glass plates

The image will appear if we look through the analyzer, which is able to display even those images illuminated by light, which are strongly inclined. Practically, here again we have a play with a field of vision. The polarizer has removed the picture outside the range of our field of vision, and the analyzer has returned this picture into the range of our field of vision.

Now it is clear why the phenomenon of polarization does not occur on metal surfaces. Metal surfaces do not under any condition create the refraction of light, so there are no conditions for the appearance of multiplied figures by shifting the field of vision, and thus also no conditions to create an illusion the analyzer is able to recognize as the "polarized" light.

10) Nature of Light

From the historical development of physics, it is evident how the notions on the nature of light have been changing.

The corpuscular theory of light emerged from the presentation of the luminous phenomenon as a series of parallel light rays. However, the corpuscular theory of light could not explain how light spreads behind small openings. Then, it was introduced the wave theory of light out of the presentation of light as the water wave.

To make this theory sustainable, firstly, the experiment of "light interference" was designed that is completely misinterpreted, denying the fact that from the two different light sources, one has never been able to get the interference of light. The concept of coherent light sources was completely artificially introduced, without any experimental confirmation. Then one continued deliberately falsifying facts, just to sustain the unsustainable. The phenomenon of light diffraction is now being interpreted with "proven" interference of light, using a completely false image of the punctual sources of light.

One kept insisting that in luminous phenomena, the polarization can appear, deliberately denying the fact that there is no evidence of polarization of light on metal surfaces, and denying such an obvious fact that the boundary angle of polarization must be in some

connection with the boundary angle of refraction. In the end, from a mathematical calculation, it was derived the conclusion that light is of electromagnetic nature, negating a notorious truth that light phenomena are qualitatively completely different from electromagnetic phenomena. In an earlier chapter I have set the rhetorical question: "If light and electromagnetism are already the same things, why has it not been said that electromagnetism is of the light's nature?".

Here's why – because if it had been said "the electromagnetism is of the light's nature", then everyone would have asked – "yes, but why do we then see light, and we do not see electromagnetism?". But when deception is hazed in a statement "light is of electromagnetic nature", then the illusion is created that something has been cleaned, because the one thing you do not know – light, has just switched in the field of other, even less familiar phenomenon – electromagnetism. In the same way, an unconscionable cleaner sweeps the garbage under the carpet, creating the illusion of a clean room …

I strongly emphasize, in proving of the wave nature of light, it is no longer the matter of errors in thinking, but about a deliberate falsification of facts. These things can occur when proving of theories is set as a principle of scientific research. Because, when a theory is being proven, the facts are no longer relevant – it is essential to prove a theory. That is why Goethe said "All factual is already a theory". If modern science had established a description of the facts as the principle of scientific research, such errors could have never happened. Because only theories need a proof. Facts do not need a proof. A fact is a proof in itself.

The corpuscular theory of light, tries to describe luminous phenomena with notions of mechanical work. The wave theory of light, tries to describe luminous phenomena with notions of the wave propagation speed. The cause for a tendency to relate the concept of speed with optical phenomena should be sought in Newton's corpuscular theory of light. Newton interpreted the refraction of light by changing the speed of light corpuscles, during the transition in different mediums, or as it is nowadays said in environments with a different "optical density". He argued that the light corpuscles accelerate during the transition from a rarer into a denser medium.

Wave school of nature of light, has just changed its view of speed alteration, but conceptually, the wave theory did not yield anything new. A preliminary design of the wave theory completely stayed on the trace of Newton-Descartes' idea that the light speed changes during the refraction. Without any intention to now provide a detailed description of e.g. Foucault's experiment of measuring the light speed, I can only note that through a mathematical transformation one can always get that the refractive index is proportionate to the light speed.

However, slowing the speed of light in "an optically denser medium" is something we cannot observe in the phenomenon itself. Reality is the refractive index of the visual field caused by the material, not the speed of light. ***Matching the symbols in mathematical formulae, need not lead to the matching of purport!*** [57]

On the other hand, insisting on the application of the notions of wave motion in the field of luminous phenomena, the wave school of nature of light has led to a conviction in the existence of so-called the Doppler Effect in optics (Christian Doppler, 1842).

[57] Here is paraphrased Goethe's thought from the book "Teaching on Colors". Goethe was accused for his unscientific method due to his lack of mathematical knowledge. Goethe never claimed he knew mathematics, nor he claimed that mathematics is unimportant in the process of cognition. However, he emphasized the fact that a mathematician is subjected to errors and misinterpretations of the phenomenon, in the same way as a nonmathematician. Knowledge of mathematics does not guarantee a comprehension of the truth.

In the field of acoustics, the Doppler Effect is a phenomenon where we hear a ton higher than it is, if we are getting closer the source of sound. However if we move away from the source of sound, we hear it lower than it is. The wave school of nature of light has pondered like this – light is a set of wave motion with a range of wavelengths, and colors are lights of a strict wavelength. The longer wavelength has light of red color; the shorter wavelength has light of violet color. If now, a light source is getting closer to us, then the wavelength of light is altered upwards, i.e. a color of light source is now shifted to violet. Again, if a light source moves away from us, the wavelength of light is changed downwards, i.e. a color of light source now shifts to red.

The properties of speed are now associated with colors!

However, observing the phenomena of the appearance of colors in nature, in the phenomenon itself, one cannot see that color has anything to do with speed. But lo, this is exactly what the official doctrine wants to convince us.[58]

Then, one has been gazing in the stars with different colors coming to the conclusion that the universe is expanding. And the universe is expanding because a long time ago it exploded! [CVII] *Then conclusions on the genesis of the Earth or about the origin of life on the Earth have been derived from such theories.*

There is even experimental evidence that the color of light changes due to speed, not taking into account that light is image and that with the magnification or reduction of image, a pseudo effect of the color appearance can be created.

Two rotating wheels have blades with mirrors. The yellow light of a mercury lamp is reflected from the blades and analyzed with the spectrometer S. It has been noticed that the rotation of wheels affects the spectral composition of light. This phenomenon is explained by varying the light speed depending on the way the wheels revolve. If they revolve in opposite directions, a path the light needs to cross is larger, so it is a simulation of distancing the light source farther from the observer. If the wheels revolve in the same direction, a path that light needs to cross is shorter, so it is a simulation of the light source moving toward the observer.

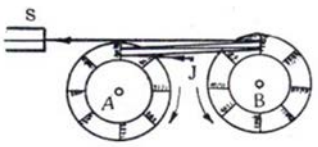


Figure 139 – Experimental confirmation of Doppler-Fiseau effect in optics – A.A. Belopolsky, 1900.

So, what is light? Only two irrefutable facts can be said about light:

1) *Light is the projection of image*

2) *Image changes its size in space (it does not travel through space, but changes its size)*

We can interpret the luminous phenomena with the light ray (the corpuscular school nature of light), or with the oscillation of light waves (the wave school nature of light), but those are just our notions on the phenomenon of light, only our interpretations of the luminous phenomenon. Both interpretations try to describe light with help of an abstract notion of energy as the ability to perform work. It is just about that the corpuscular theory of light interprets such energy with the terms of mechanical motion, while the wave theory of light interprets such energy with the terms of oscillatory motion.

[58] The following presentation will show that the Doppler Effect in optics origins from an inversion of the fact that color is related to the "color experience of perspective" i.e. that on painter's canvas, it looks like red is getting closer to us, and blue is moving away from us – of course it just **looks like that**.

If we hold on to the phenomenon itself, about light it can be said only that light is a projection of image, which changes its size with the changed distance from the observer.

11) The Goethean understanding of light

Due to the misinterpretation of the nature of light, modern physics has become abstract, even in the interpretation of the simplest optical phenomena.

Let us examine so-called the experiment of "reflection" of light. When we have a source of light, things are presented in a way, which make you think that the light source sends light in a form of set of light rays towards the surface of the object. The surface of the object bounces the light rays off in the opposite direction. For our consideration it is now completely irrelevant if these rays of light are assumed as particles, or as waves, or as something else.

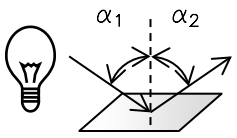


Figure 140 – Reflection of light

But bring clear to mind that what we perceive as light is nothing else but the image. The surface of the object is illuminated by the light source image. In our example of the artificial light source, the brightest objects of the image are glowing filaments. If we use sunlight, the brightest object of the image is the sun. But on the image, it is enough to focus the image, to see that the whole image within our field of view is mirroring on the surface.

The light source does not send light towards the object. The image of light source is mirrored on a shiny surface. What the modern culture sees as the light bouncing off of a shiny surface is a misinterpretation of the fact that a shiny surface mirrors the image. Precisely, the faith in the existence of bouncing of light, has led to the faith that light does not reflect off of the black surface. In fact, no matter how paradoxical it may sound now, that is true. What needs to be understood is that there is no reflection of light from the white surface, as well. Reflection of light which goes from the light source towards the observer does not exist at all; the only thing which exists is the mirroring of image on a surface.[59]

Once this becomes self-explanatory, "the reflection of light from an absolute black body" will be understandable. Only then it will become understandable how it is possible to project the image of the black square on a white background on the screen of any color. When we observe the full Moon, it is not that the light from the Sun is reflected from the lunar surface, and then afterwards it came to us, but we are the ones who look at Moon's surface that mirrors the image of the Sun. [CVIII] *The moon is full when the entire Sun is portrayed on the lunar surface.*

What is in optics defined as the law of light reflection, namely that the size of the incident and repulsive angle of light ray are equal – is an abstract description of the spatial relationship between the observer and the bright object in relation to the image of the object on the mirroring surface. If we want to hold on to reality, the law would have to be formulated as the angle of direction of a visual field, and the angle of position of a bright object in relation to the mirroring plane are equal.

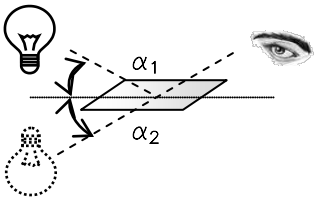


Figure 141 – The law of reflection of light presents a spatial relationship between the observer and the observed image

[59] It turns out that Alhazen's theory – that the perception of image occurs due to the bouncing of light rays off each point of an object – is wrong, because if that was the case, in addition to the reflection of light, we should talk about the reflection of darkness.

Misunderstanding the nature of light has resulted in misreading the behavior of the light sources. The thing is really confusing taking into account the effect of light on matter. E.g. when sunlight is focused by a loupe, then we can ignite the piece of paper or wood. It appears as if the rays of light have come from the light source and set the paper on fire.

However, the light source does not send any rays of light on objects; we are the ones who look at a picture of the light source. The light sources make the field of vision bright, allowing the perception the picture we watch. Light is an image, an image cannot ignite matter. It is all about that light is mingled with heat; radiant heat and bright image of the light source are mixed together in a single phenomenon.

If we want to stick to reality, the experiment should be sketched with rays that go from the light source – and this is a notion of radiant heat, together with the rays that links an observer with a light source – and this is a notion of a way of image perception. And that this seemingly incredible thing, still has something to do with reality, is proven by the fact that the light source of a so-called "cold" light (e.g. fluorescent or phosphorescent light) do not act upon matter, although the picture is still visible.[60]

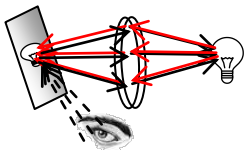
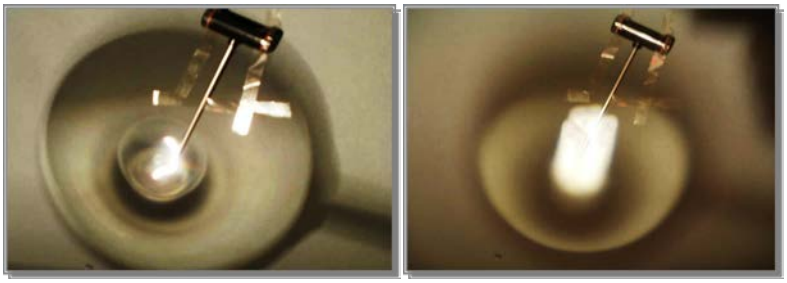


Figure 142 – Warm light sources should be presented with double rays

Specifically, this means that when the temperature of the solar spectrum is being measured, it must be borne in mind that the intensity of thermal radiation from the red part of the spectrum to the violet part of the spectrum falls, but it is the phenomenon of thermal radiation and should not be confused with the visible light.[61]

Two bulbs of 100 watts are taken, first is a common, with glowing firmaments, and the second with a neon tube. The light is focused by the loupe with a diameter of 10 cm on a probe of the digital thermometer. Even this primitive equipment shows that the temperature in the focus of warm light is raised for about 2^0 C within a minute, while the temperature in the focus of neon light stayed the same.



Trial 34 – Thermal effect of warm and cold light source

When this becomes accepted, then it will be comprehended that e.g. in a laser beam, it is not the light something what cuts a material, but here again, we have light mixed with some other radiation (electromagnetic radiation, thermal radiation, or something else). The laser is an image in which some additional radiation is impressed.

1 – medium (gas)
2 – **energy pump**
3 – mirror
4 – semitransparent mirror
5 – laser beam

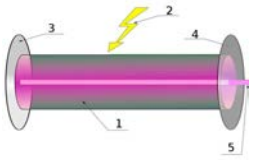
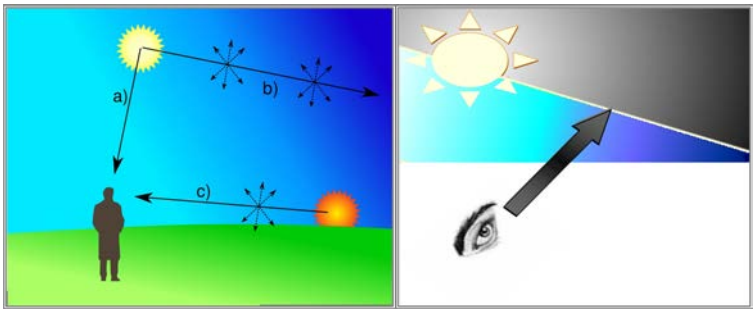


Figure 143 – Principal scheme of obtaining of the laser light

[60] "Focus", in Latin means the hearth, fireplace and formal, we can speak about the "fireplace" only if we consider the heat rays. In luminous phenomena, it can only be considered the projection of the image into the point.

[61] In modern physics, it is believed that heat can be related to wavelengths. The very idea of relating temperature and wavelength is based on the temperature measurements of different parts of the solar spectrum. However, here we are dealing with mixed notions of light and heat, which in cosmology led to a number of unconfirmed theories. To this, compare the chapter "Reflection of Light from the Black Surface" and what is said about the classification of stars.



According to modern notions, the sky is blue because the white light propagating from the sun loses part of the spectrum, in respect to the length of the path traveled. In case a), when the sun is at its zenith, the sky is white, because the light is not scattered due to short path. In case b), the atmosphere scatters part of the blue light spectrum that reaches the eye of the observer causing the blueness of sky. In case c), when the sun is on the horizon, the light travels the longest path, so most of the light is scattered, and only the red part of the spectrum reaches the eye of the observer. Therefore, morning or evening afterglow appears. Yet, if this were true, in the case b, the sky should gradually change its color from blue to green, yellow towards red. In fact, a careful study of the phenomenon shows that the sky is always less blue on the horizon than in the heights.
Light does not travel from the light source; it illuminates the visual field. In reality, from illuminated earth, we look at the darkness of cosmic space through the atmosphere. Weakened field of vision creates the impression of a blue color. Conversely, when we look at the bright sun's circle from the dark earth, the red color appears, because the visual field is reinforced. Precisely because of different background's darkness, the sky is brighter on the horizon than in the heights.

Figure 144 – Light illuminates the field of vision

We have a similar shifting the field of view in the appearance of "sundog" (perihelion). Here, we look at a picture of a bright solar circle on the clouds or ice crystals in the atmosphere. Where the field of view is reinforced by bright background, a yellow and red color appears; where the field of view is weakened, a blue color appears. We see the same phenomenon in the rainbow, only here, we look at the bright sun's semicircle on the horizon, opposite to the sun.

Figure 145 – Sundog and rainbow

Let us pay attention to the basic law of photometry claiming that the intensity of light decreases with the square of the distance. If we look at the rays of light source on the three screens distanced in proportion 1:2:3, we can notice that the illuminated areas are in proportion 1:4:9, respectively. Since it is considered that the light source sends the rays of light onto the screen, it was concluded that the intensity of light decreases with the square of the distance. [CIX]

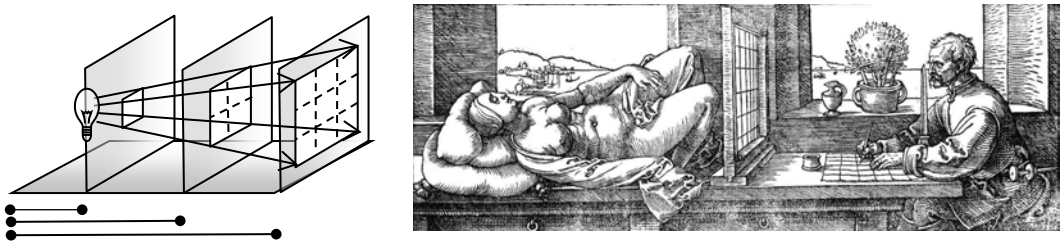


Figure 146 – The basic law of photometry

However, the very same law is also valid for a shadow. If the shadow of unit size is projected on the screen, we can notice that the shadow weakens with the square of distance. Because, the reality of light phenomena is the image, regardless of looking at the bright part of the image or the dark part of the image.

The experiment just shows that the image size decreases with the square of the distance from our eyes, and a projection of the image increases with the square of the distance from our eyes. In other words, what our culture considers the abstract law of intensity of light sources, is nothing else than the law of perspective. And what in modern physics is shown as experimental evidence of decreasing the light intensity with increasing of the distances, is nothing else but a painter's grid the painters use when they paint figures in perspective. With the help of it, a painter more easily determines the size of figures on canvas, according to the given perspective distance.

Light is an image, the laws of geometrical optics are nothing else than abstractly formulated principles of perspective.

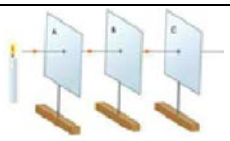
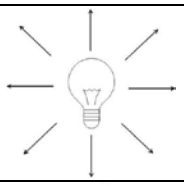
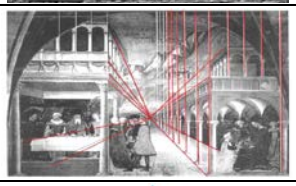
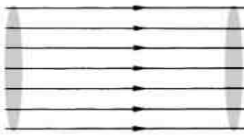
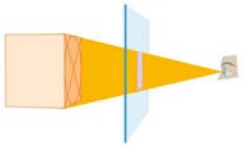
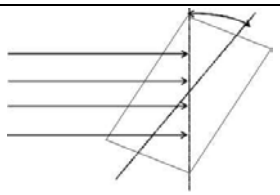
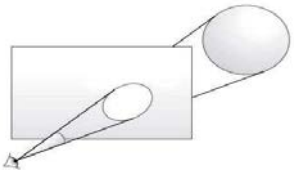
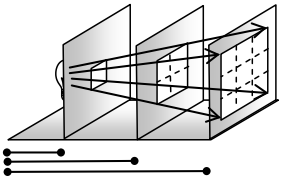
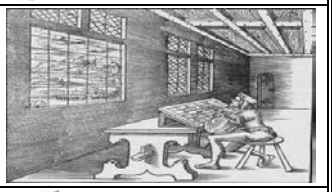
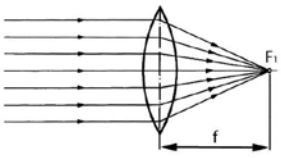
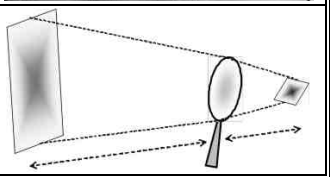
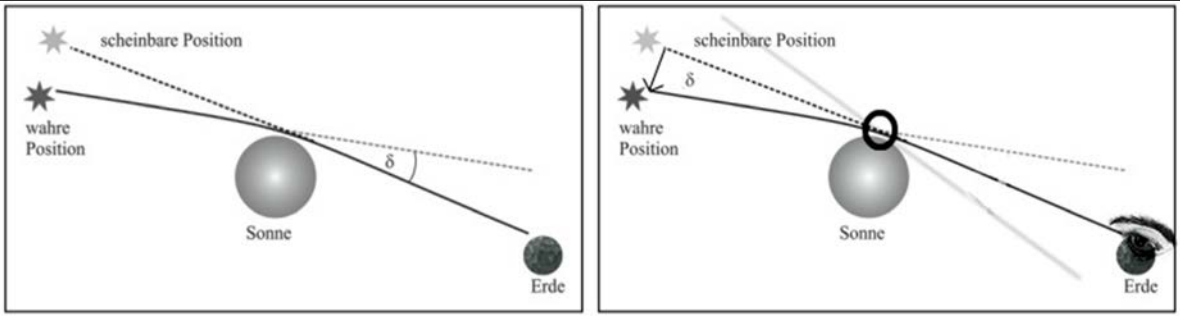
THE LAWS OF GEOMETRICAL OPTICS		***PRINCIPLES OF PERSPECTIVE***	
Light propagates rectilinearly.		The vista stretches straight ahead.	
Light spreads radially from light sources.		The image disappears in a vanishing point the projection of which is located between the eyes.	
The light beam consists of a set of parallel light rays.		Objects observed directly are seen as undistorted.	
The intensity of illumination in the oblique fall of light rays is equal to the product of the intensity of direct illumination and the cosine of incident angle.		Objects observed from a slant angle are deformed. The contours are deformed according to the cosine of visual field angle in relation to the plane of projection.	
The intensity of light decreases with the square of the distance.		The image area decreases with the square of the distance.	
The light rays falling on the convex lens parallel to its main axis – by the fracture of light rays – are collected in one point, which is called the focus of a lens.		The image seen through the openings or the optical apparatus is focused on the focal distance of the opening from the screen.	

Figure 147 – The laws of geometrical optics are the principles of perspective

Complete chaos in understanding the nature of light has emerged because it was forgotten that the essence of optics is image, and the rays of light are just geometric notions of the spatial perception of image points. When the above table becomes accepted, then it will be understandable, what indeed means a notion representing that e.g. during the light diffraction, the light trajectory is being curved. Because, the real phenomenon is the image magnification. During the diffraction, the outline of image loses its sharpness. When objects at large distances obscure our view, or the same, when we look at objects through the small openings, the picture we watch loses the contours becoming deformed on the edge. For a wide field of view, a small opening acts as a lens, an opening can magnify a picture that we watch.

Also, when one accepts this way of thinking, it will become understandable how incredible is the idea that there are black holes as objects having such a big mass that they can curve the light's path. To believe that the mass of an object can bend the light's path is the same as to believe that mass can bend the vista. [CX]



The first picture represents Einstein's interpretation of the phenomenon where during a solar eclipse, it is possible to see the peripheral stars sheltered by the Sun. There is an interpretation, that because of the bending of the light's trajectory due to the mass of the Sun, it is possible to see objects that are not in the direction of light's rectilinear propagation.
However, it is all about that the modern physicists try to demonstrate the phenomena in nature as like a man does not exist. In reality, we look at the image of distant stars sheltering an opaque object. If the object that we watch is farther, the image is smaller, so the image seen on the edge of the screen is increasingly deformed; objects are magnified around the perimeter of the screen; so when this fact is represented geometrically, it turns out that the projections of the image points on our retina are no longer rectilinear. (Compare to the sketches of the diffraction of light on pg. 86 - Figure 117).
Of course, the magnification of image by a small opening is not in any way related to the mass of opening through which we watch the image. To believe that mass i.e. gravity can bend the light's trajectory, is the same as when we believe that the image viewed through a small opening is being deformed due to the mass of opening. The size of image magnification depends only on the size of opening, the smaller the opening, the larger the magnification of image.

Figure 148 – "Gravitational lenses", according to the notions of modern physics

Because of the above stated, when in the geometrical optics a shadow cast by an object is sketched, it should not be imagined as if light from the light source came to the object and then could not penetrate it. Screens should always be presented as unpolished mirrors, where due to reduced glare; we see only the brightest part of picture. In reality, we are the ones who look at a projection of picture on the screen, and the object has just sheltered the bright image of a light source.

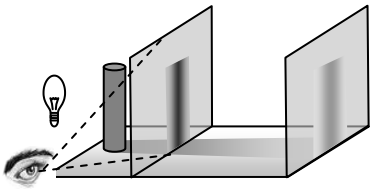
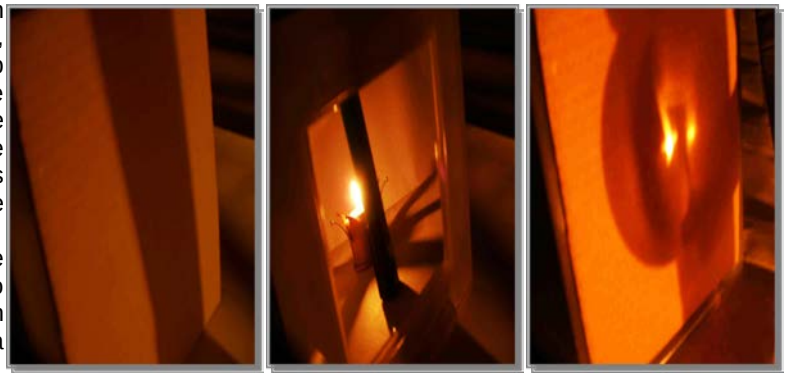


Figure 149 – Shadow is a projection of the turbidness formed by materiality

The darkness of matter manifests itself as a black shadow of object. The essence of materiality is the property of sheltering the images we see, the property of opacity. The shadow of an object is nothing else than the area of opacity for our view.[62]

[62] In the physics of Aristotle, materiality had always been brought into connection with opacity, while light was a medium allowing transparency to our vision.

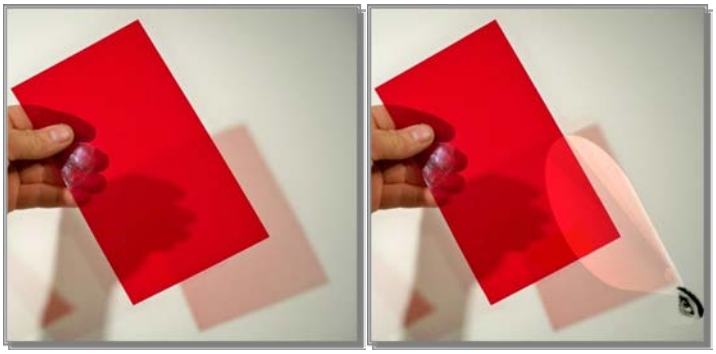
What we experience on the rough surface, as the play of light and shadow, it is the image having no sharp contours. In a particular case, what we see on the screen as the light – is the glowing flame of a candle, and what we see on the screen as the shadow – it is the backside of a marker. We can see the sharp image on a mirror.
To be able to discern the whole picture on a rough surface, it is necessary to enhance the image contrast, which can be achieved by focusing the image by a lens.



Trial 35 – On the screen, we see the projection of the opaque part of the image

Such thinking will illuminate the essence of opacity of bodies. Since light does not travel through space, opacity is a property of matter that obscures images and not a property of matter that prevents the penetration of light.[63]

When we look at an image through semi-transparent materials, we should not imagine that they limit the penetration of light from the light sources. Light filters, in fact, cast colored shadows on the screen, and what we see on the screen as a colored shadow of a light filter, is nothing else but a projection of the image of the unilluminated side of a filter. The fact that the light filter "casts" a colored shadow, just shows that, on the rough surface, we watch the unilluminated side of the red foil on a white background.



Trial 36 – Filter casts colored shadow

Opaque sticks of plasticine are illuminated with the light from a single source. If light traveled from the light source to the screen, then material objects would prevent the penetration of light, and we would see the black shadows on the screen, all the time. However, if sticks are brought closer to the screen, we can clearly notice differently colored shadows cast by colored sticks.
The experiment clearly shows that, on the rough screen, we see the backsides of the sticks as the black shadows. To be able to see the back sides as a picture, and not as a black shadow, it is necessary to enhance the shadow, and this can be achieved by bringing the sticks closer to the screen.

Trial 37 – Light does not travel through space

Incorrect notions of the light sources as objects sending the light rays in space, have led to yet another deception, and that is the faith in the existence of light pressure. It is believed that light travels from the light source "crushing" into the material bodies. Thus, it was introduced the concept of light pressure.

[63] Such reasoning will also explain the appearance of colored shadows. Because if in the above trial, the filter is placed obliquely to a light source, thereby the white background becomes obscured by the filter opaqueness, and on a rough surface we look at the unilluminated side of the red foil, but no more on a bright, but on a dark background. If we look at the shadow of an object, next to red shadow, a green shadow will also appear. Compare to the trial no. 11 pg. 42.

It was introduced by Maxwell's theoretical work. Allegedly the theory was proven by an experiment. This is an experiment of P.N. Lebedev from year 1900. The essence of the experiment can be shortly resumed that the reflected light, which strikes the rotating pendulum of a shape as in figure b, initiates the rotation of the pendulum. [CXI]

Lebedev's experiment is based on the attempt of improving Crookes's radiometer (William Crookes, a radiometer from 1873). Radiometer is a device that has a rotor the blades of which are on one side coated with a thin layer of silver, and on the other side painted in black. The entire rotor is housed in a glass ball with sub pressure. When the rotor is illuminated with sunlight, the blades begin to rotate. From this fact and Maxwell's speculation, arose the conviction that the light pressure revolves the rotor.

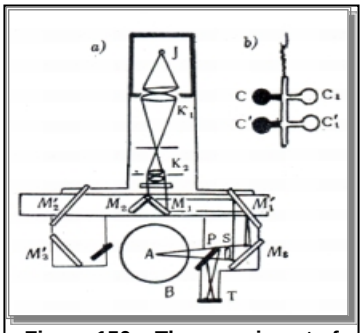


Figure 150 – The experiment of proving the pressure of light

However, later it was realized that:

1) *The rotor does not revolve in a pure vacuum.*
2) *The direction of rotation agrees with the black surface, not with the silver plated surface.*

Afterwards, the error in theory that the light pressure can revolve Crookes radiometer was recognized, because if some light pressure did revolve the rotor, then the direction of rotation would be in agreement with the silver plated surface from which light should "bounce off". Additional tests have revealed that the rotor can rotate in a dark, it is just enough to put the palm on the glass ball. Or, if an ice cube is placed next to Crookes radiometer, then the rotor begins to rotate in the opposite direction. It turned out that the temperature differences drive the stream of air molecules in the sub pressure, which then revolves the rotor. [CXII]


Figure 151 – Crookes radiometer

Therefore, it is interesting to enter a small historical consideration of the source of speculation about the light pressure, and what this speculation subsequently has caused. The idea had originated from astronomical observations, since Kepler's time, when one had tried to figure out why a comet's head always faces the Sun. After radiometer, the idea was transformed into Einstein's explanation of the photoelectric effect – the light photons hit the surface of the material causing changes in electrical resistance by ejecting electrons from the surface of the material. [64]

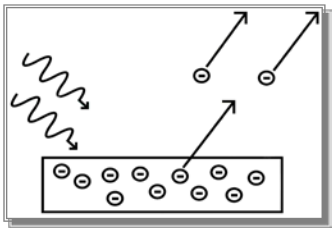


Figure 152 – Photoelectric effect, according to the notions of modern physics

Unfortunately, the experiment with the light pressure with the radiometer was refuted, but the faith in the light pressure remained.

In fact, from the point of force, light acts as an antagonistic force of gravity and in its nature carries a force of counter-pressure, the suction power. Light in terms of force acts levitational, only modern physics has just the initial notions on this fact. When this idea of counter-pressure becomes further illuminated, it will become clear that the concept of

[64] More on f.e. http://en.wikipedia.org/wiki/Photoelectric_effect

antimass that modern physicists have foreboded is a concept that should be applied to light. Light is of aethereal nature, and aethers have no mass. [CXIII]

At the end, let us consider the light refraction experiment. If we look at a picture through the transparent material, we see the picture shifted by the material. The material has not "fractured" the light's path, because looking from a slant angle; the black point is being shifted, as well. So, if we give ourselves the right to talk about the refraction of light, then we could also talk about the refraction of darkness.

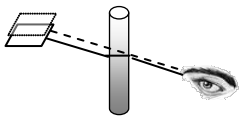


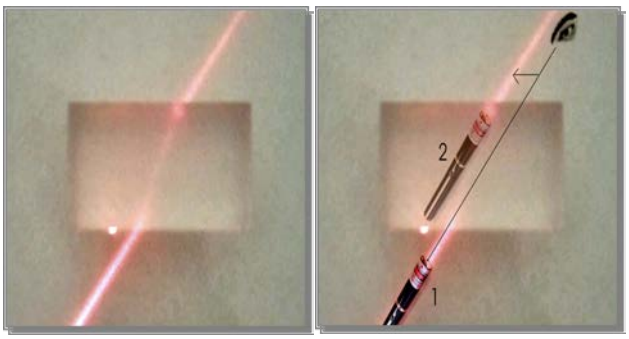
Figure 153 – Refraction of light shifts the field of vision

The material has shifted only our field of vision. The rays of light emerged from the erroneous conviction that the light source sends the light rays that travel towards the object. But without eye, rays of light do not exist; in the experiment of the light's path "fraction", they can only be used as a mathematical model for studying the properties of materials in the shifting of visual field.

The image is being shifted only depending on our point of view of the image, and not depending on the color of surface. Where our point of view is more tilted with respect to the plane of the displacement of the field of view, shifting of the visual field is larger. In the experiment number 26 pg. 80, the upper magenta stripe is the most shifted, because it is the point of observation that is most tilted in relation to our field of view. The lower turquoise stripe is shifted the least, because it is the point of observation, which is tilted the least in relation to our field of view. Shifting of a visual field has nothing to do with the ghostly wavelengths of light, but only with our position of the image perception.

Shifting of the image is the property of material that has affected our field of vision, not a property of light source. The point is that through the mathematical model, the illusion has been created that something applicable to material can be attributed to light.

In modern physics, there is an interpretation that the beam of light is refracted when passing from the optically rarer into the optically denser medium and vice versa. The figure shows a laser beam that is "let through" the crystal.
It is being forgotten that the entire field of view of the observer is shifted. If we look directly at the laser source, rather than from the side, the laser itself would be shifted, not just the bright red point of the laser light source. The point is that in the attached experiment, shifting of the image is not observed directly, but from the side, which creates the illusion that just the bright part of the image is displaced..



1 – the actual image, 2 – the image that we see

Figure 154 – Shifting of the visual filed of observer

When these things become accepted, then it will become clearer that all proofs of the electromagnetic nature of light are based on erroneous observations. The fact that, for example, strong magnets rotate a plane of polarization (Faraday's effect) and similar, should be brought in connection with the effects of magnets on our field of vision, and not in connection with the nature of light.[65]

[65] To this, compare the chapter "Concerning the essence of light" and what was said about the evidence of electromagnetic nature of light.

12) Speed of Light

Wave theory of the nature of light has led to the faith that light is a set of vibrations of different wavelengths. Through the faith that the white light can be decomposed on monochromatic lights, it has emerged a conviction that the monochromatic color of light is an oscillation of strictly specific wavelength. Therefore, it is said that e.g. red is the light with wavelength of 780 nm, while e.g. yellow is the light with wavelength of 590 nm, etc.

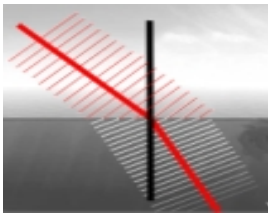


Figure 155 – Refraction of sound waves

On the other hand, the phenomenon of refraction of the field of vision was interpreted as the change of the velocity speed of oscillatory motion, in the transition from rarer into denser environment, in the same way as in the phenomena of sound. E.g. the speed of sound in the air is about 340 m/s, while the speed of sound in water is about 1500 m/s. When sound vibrations pass from air into water, both the speed and trajectory are changed causing a fraction of the shock sound front. In the luminous phenomenon, refractive index of a visual field in the material is brought into relation with the speed of light. [CXIV]

$$n = \frac{c_0}{c}$$

where is n – refractive index
c_0 – the speed of light in vacuum
c – the speed of light in the material

Refractive index of glass is 1.5. Hence the assertion of modern physics that the speed of light in glass is 200.000 km/s. [CXV] *It was not important to anyone that in other oscillations, in the denser environment the velocity increases, the speed of sound is higher in water than in air. However, it was important to prove the theory.*

Then, the mathematizing continued and it is said that, if the oscillation speed can be expressed as the product of wavelength and frequency, then the speed of light can also be expressed as the product of wavelength and frequency of light:

$$n = \frac{c_0}{c} = \frac{\lambda_0 \nu}{\lambda \nu} = \frac{\lambda_0}{\lambda}$$

where is λ_0 – the wavelength of light in vacuum
λ – the wavelength of light in the material
ν – the frequency of light (constant in all mediums)

From the above equation derives the statement of modern physics that the wavelength of light in some medium of a refractive index n, is n-times smaller than the same wavelength of light in a vacuum. [CXVI] *Nevertheless, let us connect the upper equation with reality.*

Refractive index of water is 1.33. The red light in a vacuum has a wavelength of 780 nm. Illuminate the water with the red light. The wavelength of light that is red in a vacuum, is now decreased in the water, and according to the above formula, it becomes:

$$\lambda = \frac{\lambda_0}{n} = \frac{780nm}{1{,}33} = 590nm$$

According to the wave theory of light, it would mean that when the water is illuminated with a red light, it becomes yellow?! [66]

[66] And, it is completely irrelevant whether we believe that the frequency of light in an optically denser medium remained the same. Because the eye sees neither wavelength nor frequency, the eye sees the picture.

Modern physicists, due to the habit of thinking, imagine that light is a material object that propagates from point A to point B obeying space-time concepts. With this mentality of thinking, most are unwilling even to consider any contradiction in a formula which links the two outperceptive notions: "a speed of light" and "a wavelength of light" ($n = c_0 /c = \lambda_0 /\lambda$). One of the very few physicists, who was thinking about the contradictions of the concept of the light ray speed, was J.B.Stralo, who in his book, "Concepts And Theories Of Modern Physics", says:

> *"We experience the sensation of white light when all the chromatic rays of which it is composed strike the eye simultaneously. The light proceeding from a luminous body will appear colorless, even if the component rays move with unequal velocities, provided all the colored rays, which together make up white light, concur in their action on the retina at a given moment; in ordinary cases it is immaterial whether these rays have left the luminous body successively or together. But it is otherwise when a luminous body becomes visible suddenly, as in the case of the satellites of Jupiter, or Saturn, after their eclipses. At certain periods, more than forty-nine minutes are requisite for the transmission of light from Jupiter to the earth. Now, at the moment when one of Jupiter's satellites, which has been eclipsed by that planet, emerges from the shadow, the red rays, if their velocity were the greatest, would evidently reach the eye first, the orange next, and so on through the chromatic scale, until finally the complement of colors would be filled by the arrival of the violet ray, whose velocity is supposed to be the least. The satellite, immediately after its emersion, would appear red, and gradually, in proportion to the arrival of the other rays, pass into white. Conversely, at the beginning of the eclipse, the violet rays would continue to arrive after the red and other intervening rays, and the satellite, up to the moment of its total disappearance, would gradually shade into violet."* [CXVII]

In the physics of Aristotle, light was a medium allowing transparency to our vision; it has been perceived through the concept of transparency. In contrast to light, there is darkness as the concept of opacity, a concept that is linked to materiality. The rays of light represented the principles of perspective, a schematic diagram of our observation of images. In this understanding of light, light has not been perceived as something that travels through space, but as something that illuminates space. The concept of speed i.e. propagation from point A to point B had not been relating to the concept of space illumination.

The very idea of a possibility of connecting the light phenomena with the concepts of the speed of material objects, dates back to the Arab school of optics, 9^{th}-13^{th} century, in which light begins to be seen in atomistic terms – as a medium composed of something smaller, the light rays or similar. According to this way of thinking, it was self-evident that light propagates through space with certain finite velocity. Later, from the astronomical observations one tried to find the confirmation for the veracity of those theories.

Therefore, let us consider in detail some of the notions that light can be related to the concept of speed. [CXVIII]

1) Bradley's method of determining the speed of light

In 1727 an English astronomer James Bradley introduced a method for measuring the speed of light by measuring the aberration angle of the stars.

The annual aberration of light of some star is considered the phenomenon where the angle at which a star can be seen from the Earth, depends on the position of Earth during the year.

In one part of the year, the star can be seen in the telescope eyepiece without any correction, while in the other part of the year, the telescope must be rotated for angle α in order that the star can be precisely in the center of eyepiece. The angle of rotation is called the angle of stellar aberration, and it can be measured. Because of aberration, the stars closer to the ecliptic, form a small circle during the year, while the stars near the horizon, form the linear motion first in one, and then in other direction.

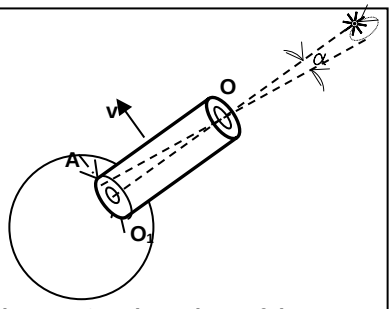


Figure 156 – Aberrations of the stars

This phenomenon is used for measuring the light speed. So, it is said that the stellar light needs a certain time to cross the distance in a telescope, while the telescope itself is moving, because the Earth rotates. The light traveling through a telescope needs a certain time to reach from the lens A to the eyepiece O_1, and during that time, the Earth has already passed across the path O_1A. From such reasoning, a relation is deduced:

$$tg\alpha = \frac{O_1A}{OO_1} = \frac{vt}{ct} = \frac{v}{c}$$ *where is* v *– the speed of Earth*, c *– the speed of light*

Data on the light speed are obtained from this calculation.

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Observe the figure through the camera obscura. No kind of the light ray exists – the rays of light are mathematical notions of the projection of the picture points. Light rays do not show anything else than where a point of a picture that we watch is located.

The whole image of the heavenly vault in a range of the visual field is in the opening of camera obscura. The opening has restricted only our field of vision. One point of the image i.e. a light ray of one star can in no way be separated from the entire image. The only thing that can possibly be limited is our field of vision on one image point. It can be said $tg\alpha = O_1A/OO_1$, if the observer is being moved, because the field of vision is being changed. But, now to say $O_1A/OO_1 = vt/ct$ – it has no longer any connection with reality.

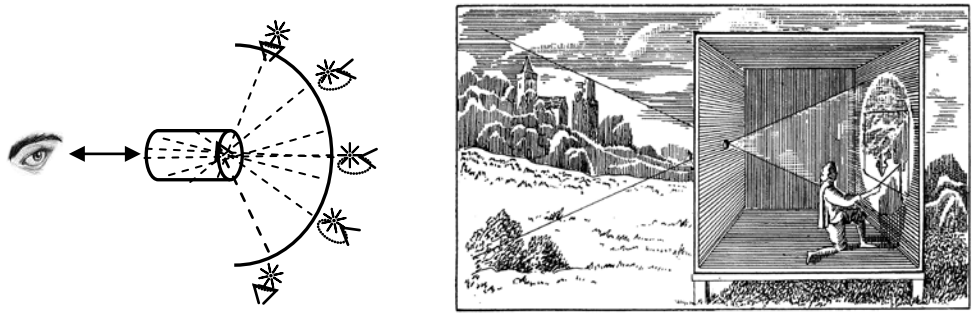
Figure 157 – Entire visual field can be seen through the opening

Projection of image points has nothing to do with the speed of projection itself. The projection of a point is being changed with our motion. The projection of the image is inextricably linked to our eye! And light is such a projection of the image.

If in the above example, a tube through which we watch could be removed and there would not be the speed of light, because the tube does not exist – but the aberration remains. It is not the tube that has produced the aberration phenomenon, the aberration exists whether we notice the aberration or not. The tube is only helping us in order to better spot the image detail.

Projection of the image is never late; it is always there, regardless of how the field of vision moves.

2) Römer's method of determining the speed of light

Even before Bradley, in 1676, a Danish astronomer Olaf Römer devised an astronomical method by which the light speed was determined for the first time. The method is based on the duration of the eclipse of Jupiter's moons. Römer noticed that the time needed for exiting of Jupiter's moon out of Jupiter's shadow, varies depending on the distance between the Earth and Jupiter.

When the Earth is farther distanced from Jupiter (the position E_1), the eclipse of Jupiter's moon is about a thousand seconds longer than when the Earth is closer to Jupiter (position E_2). Römer interpreted this phenomenon by the duration the light needs to travel across the distance from Jupiter to the Earth. When the Earth is farther distanced from Jupiter, the light needs more time traveling from the Sun to the Earth, via the reflection from Jupiter's moon, than when the Earth is closer to Jupiter. That is why, it takes longer to notice the moon's coming out of Jupiter's shadow, when the Earth is farther distanced from Jupiter, than when the Earth is closer to Jupiter.

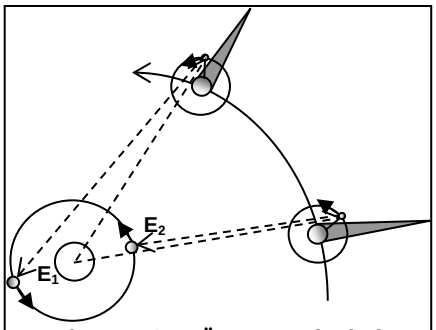

Figure 158 – Römer's method of determining the speed of light

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Observe the picture above in more detail. What does it lack?

It lacks the truth.

If we were some creatures who do not want to descend to the Earth, but wish always to view things from a lofty perspective of heaven – then the above image would perhaps have some connection with the truth. But you see, we are ordinary mortals who actually can observe things only from the ground – from the Earth.

Jupiter does not look the same in the sky at all, if it is closer or farther from the Earth! When the Earth and Jupiter are closer, the apparent size of Jupiter in the sky is greater than when the Earth and Jupiter are more distant. [CXIX] *The distance in the light phenomena has nothing to do with speed, but only with perspective!*

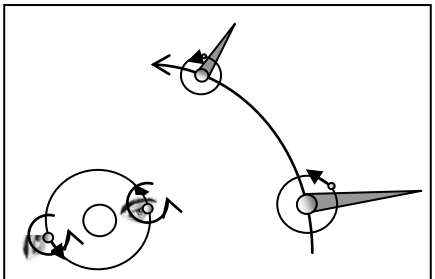

Figure 159 – Actual picture of the eclipse of Jupiter moon's

The closer we are to the object, the better we see the object, because it is bigger.

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Consider a point that is entering the shadow of a moving screen. If we are closer to the screen, then the field of vision obscured by the screen is different than when we are farther distanced from the screen. If the screen moves at some speed, it will sooner terminate to obscure our field of vision, if we are closer to the screen, than when we are farther distanced from the screen. In other words, the point A will enter our field of vision in a shorter time, when we are closer to the screen.

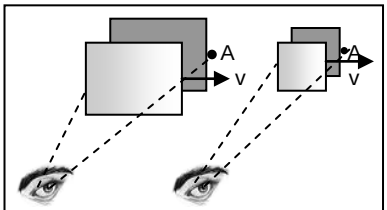


Figure 160 – Parallax of the body behind a screen

We can do vice versa. The screen can be static, and we can move. If we are closer to the screen, we need to move less to the left so that the point A comes out of the shadow of the screen. The phenomenon where the different perspective manifests in the different apparent motion of objects at different distances, is called the parallax (gr. parallaxis– change) and in astronomy is used for measuring the size of celestial bodies.

- - -

Now, instead of looking at the screen, watch Jupiter, and instead of looking at the point A, watch Jupiter's moons. Of course, we are on the Earth that rotates around its axis. When the Earth and Jupiter are closer, due to Earth's rotation, Jupiter's moons that are in the shadow of Jupiter will enter our vista in a shorter time; when the Earth and Jupiter are distanced, our vista is longer sheltered by Jupiter. Time span needed for the emergence of moons out of Jupiter's shadow is the same, only our perspective is changed.

Römer's method of measuring the speed of light is in connection with the parallax of Jupiter's shadow, and not with any kind of speed of light. [CXX]

3) Physical methods of determining the speed of light

Now when it seemed that the proven astronomical methods for measuring the speed of light did exist, there were designed the experiments with which one tried to determine the speed of light by the physical methods.

The first physical method for determining the speed of light was developed by the French physicist Hippolyte Fizeau in 1849. The method is drawn in the sketch.

The light source produces a light ray. It falls onto the semitransparent mirror M_1, which partly reflects the ray of light on mirror M_2. The observer watches the light ray reflected from the mirror M_2 through the toothed wheel. The distance between mirrors M_1 and M_2 is 8 kilometers. When the wheel rotates, it may be noticed that at a certain speed of wheel rotation, the observer sees a white blur. If the speed increases twice, the blur is not visible. At triple speed of the wheel rotation, the blur reappears, etc.

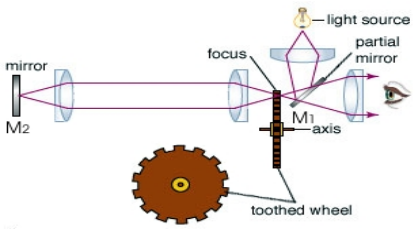


Figure 161 – Fizeau's method of measuring the speed of light

There is an interpretation that the light ray travels from the mirror M_1 to the mirror M_2, and then from the mirror M_2 back to the observer. Light ray needs some time to travel across that distance. If the speed of wheel rotation is such that the light ray that spends some time traveling across distance is not sheltered by the following tooth of the wheel, then the observer sees a white blur. But if the wheel turns just at the moment when the ray should reach the observer, then the blur is not visible. The appearance and disappearance of the white blur has been interpreted by the time the light needs to pass across the distance, depending on the speed of the rotating wheel with teeth.

The second physical method for measuring the speed of light was also developed by a French physicist, Léon Foucault in 1850. The method is similar; here we are also dealing with rotating parts.

The ray of light travels from the source S to the rotating mirror R_m, and then to the mirror M. From the mirror M, it again travels to the rotating mirror R_m. On the screen S, the light reflected from the rotating mirror forms a light blur J-J_1.

When the mirror rotates, we see the light blur on the screen S. If the mirror turns around a full circle, the blur of light appears and disappears, then reappears when the mirror returns to its original position. If we now speed up the rotating of the mirror, at about 15 revolutions per second, the blur on the screen becomes permanent, because the light impressions are merged together. If we now increase the rotation speed of the rotating mirror, one can notice on the screen that the shifting between the incoming light ray J and the exit light ray J_1, starts to increase.

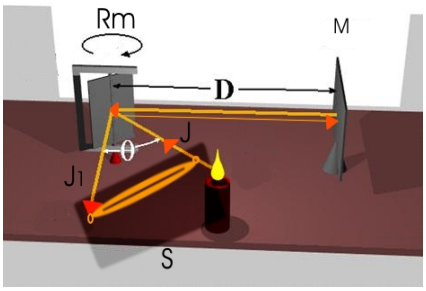


Figure 162 – Foucault's method of measuring the speed of light

There is an interpretation that the shifting increases because the light takes time to travel across the path from a light source to the screen. If the mirror rotates very quickly, then the ray of light cannot reach the angle of the mirror R_m, from which it was firstly reflected on the screen. Exactly because of that, the reflection of the light ray from the rotating mirror occurs, but now under a different angle. This different angle causes a shift between the exit ray J_1 and the input ray J. The speed of light is calculated based on the formula:

$$C = \frac{d\Theta}{dt}\frac{2D}{\theta}$$

- - -

Let us draw twelve sequences of the horse gallop on the cardboard plates. Now stick these twelve sequences to the wheel with slits.

Turn the wheel around and watch the pictures through the slits. Rotation creates the impression of the galloping horse. This is because when we look at the images that change quickly, our eyes merge images into one single impression. Our eye can see single impressions up to about fifteen frames per second. Above that, the impressions are being merged. The phenomenon of merging the images that change quickly is called the stroboscopic effect. [CXXI]

Figure 163 – The zoetrope

Children in the nineteenth century were playing with the toy that creates a stroboscopic effect. Then the light phenomenon in the toy was utilized as an experimental proof for the existence of the speed of light.

- - -

Instead of the twelve horses on a zoetrope, let us draw black and white squares interchangeably. When the zoetrope spins with the speed that allows spotting fifteen frames per second, we will see a square that appears and reappears. However, if the zoetrope spins twice as fast, the impressions change so fast that the eye does not have time to notice the next picture. E.g. if the eye is focused on the white square, now the wheel spins so fast, that rather than our view switches onto the next image, the image of black squares; the eye skips the black square and then sees the white square again. In this case, we see only white squares. If we increase the speed triple, in the focus are now just black squares, so we see a picture of black squares. If the background is dark, we do not see anything but blackness. If the speed increases fourfold, again we see the white square, etc.

The same phenomenon we have when e.g. we watch the wires on the rotating wheel of the bike. If the speed of the wheel rotation is lower, the impressions of wires are being merged into one image, so it appears as if the wheel in the center has a tin plate instead of wires. But, if the rotation of the wheel is even faster, then we begin to see some wires, so it appears that the wheel turns backward.

Have a look at Fizeau's method for measuring the light speed. This is nothing but a game with a stroboscope, where a toothed wheel creates a stroboscopic effect.

- - -

Take a piece of ember and fasten it to a steel wire. When we start to rotate the wire, due to the stroboscopic effect, instead of pieces of ember, we see the path which the ember creates. If we rotate the wire at a lower speed, the light's impressions are not completely merged, and the ember is seen as a set of bright points on the trajectory. The faster the wire is rotated, the more merged are the light's impressions, so we see the trajectory of the ember's path as a red circle.

Look again at Foucault's method for measuring the speed of light. Now instead of ember, we have a circular bright blur formed by a rotating mirror R_m. When the mirror rotates faster, the impressions are better merged and our eyes can now better spot a white circle. On the screen, it can be noticed as the larger shift of the exit "ray of light" J_1 from the input "ray of light" J.

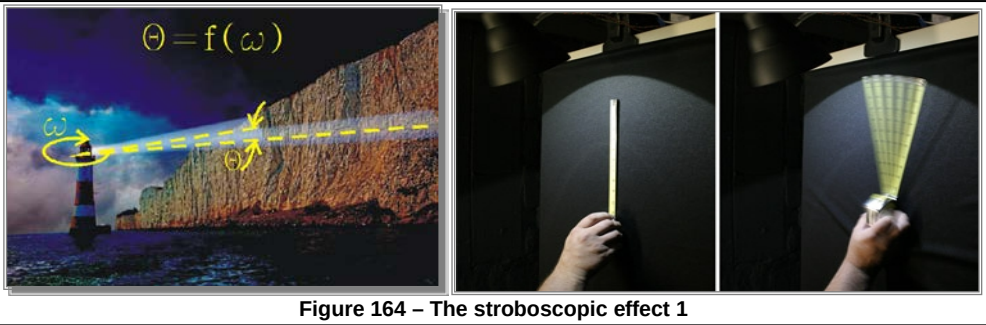
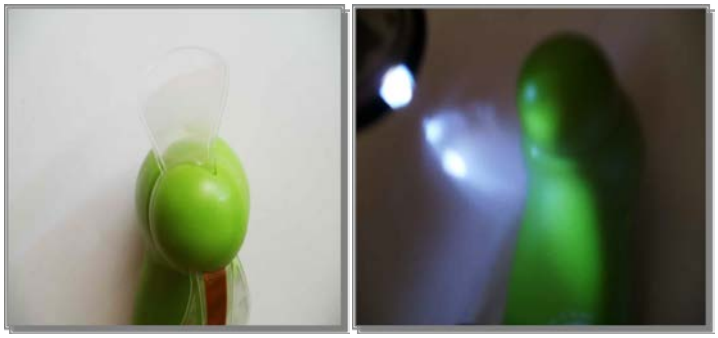


Figure 164 – The stroboscopic effect 1

When the light source is mirrored on a rotating foil of a pocket fan, due to the stroboscopic effect, the impressions are merged, hence the film of the rotating fan behaves like a little mirror. When a rotor slows down, the mirroring image of the LED is being interrupted. As the rotor rotates faster, impressions are better merged, causing a more expressive mirroring image i.e. the blur of light is "longer".
Practically, in Foucault's experiment of measuring the speed of light we have the same thing.



Trial 38 – The stroboscopic effect 2

- - -

Place different colored collage papers on the rotating wheel. If we spin the wheel, due to the stroboscopic effect, the image we watch starts blending, so instead of a single color, we begin to see the blended image as a gray color. As we turn the wheel more quickly, merging of the impressions is getting stronger, and the gray nuance becomes brighter.[67]

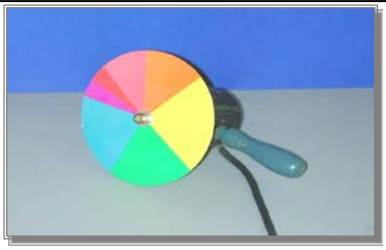


Figure 165 – The wheel of colors

- - -

Put the prism in a tube of a camera obscura. Thus we get a device called a spectrometer. With the help of it, we can analyze the image distortion we watch. When we look at some image through a spectroscope, on the contours of the objects we see colored borders. The farther the spectroscope is distanced from the image, the wider is the area where the colors appear.[68]

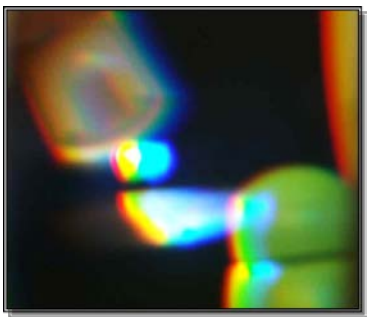
Now, instead of studying the chromatic aberration of a static image, e.g. an image of the white circle on a black background, let us study images obtained dynamically. All images obtained by the stroboscopic effects are obtained dynamically. Let us watch an image of the white circle on a black background mirroring on the rotating wheel. Here, the width of the area where colors appear does not depend only on the distance between the prism and the image, i.e. the distance from the spectrometer to the image, but the width will depend on the rotation speed of the wheel, as well. This is because now the speed of rotation causes that an observer sees the fusion of images differently. If the wheel spins slower, a weaker merging of impressions of the white circle on a black background creates the impression that the white circle is darker gray; if the wheel rotates faster, stronger merging creates the impression that the white circle is brighter gray. When this image is being viewed through a spectroscope, we see that the size of the area in which we see colors depend on the rotation speed of the wheel. In other words, the results of spectral analysis of the image will depend on the speed of the wheel rotation.

Have a look at Belopolsky's method – Figure 139 pg. 98, which serves as a proof for the Doppler Effect in optics. Here again, we have a play with a stroboscopic effect, where the direction of a rotation of the two rotating mirrors, creates a more or less conspicuous image. This is manifested as a different spectral composition of light, depending on the rotating mode of mirrors.

[67] Compare to the chapter "Concerning Correction of Goethe's Teaching" on pg. 65 . There is mentioned that the mixing of colors is a phenomenon of merging the impressions occuring either when the image is small, or when the impressions are being changed fast.

[68] To this, compare the trial no. 3 pg. 28.

The image of a light source is mirrored on the foil of a pocket fan. The image is viewed through the prism.
Depending on the speed of a fan rotation, the area of chromatic aberration is changed i.e. it is changed what is in modern physics called the "spectral composition" of light.



Trial 39 – The spectral analysis of the stroboscopic image

Now, instead of viewing the rotating mirrors, let us watch an object that sparkles. Of course, the result of spectral analysis will be different if the object sparkles, than when the object does not sparkle. When we look at the sparkling stars, the result of a spectral analysis will be different from the case when we look at the planets that do not sparkle. The stars will make the shift in spectral lines, the planets will not. Not because they move away from us, but because they sparkle.

In astrophysics, the faith in the existence of the Doppler Effect in luminous phenomena has launched an avalanche of new theories. The existence of binary stars and the expansion of the universe are just some of them. [CXXII]

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It is interesting that the physicists have always had problems to accurately determine the light speed. Sometimes the result was slightly less than 300,000 km/s, and sometimes slightly higher. Hence, they have been constantly devising new methods for measuring the light speed, which were nothing but modifications of the above two experiments. E.g. Michelson's method from 1926, is Fizeau's method, where instead of a flat mirror, an eight-angled mirror was used. Or, in 1928, A. Karolus and O. Mittelstaedt, used Foucault's method, but instead of a gear, the impression of a light beam was interrupted by an electric cell. In 1950, E. Bergstrand used the same method and more perfect equipment. [CXXIII, 69]

However, it turned out that different methods suggest the different speeds of light. They have never tried the one and the same method on different people. Because had they tried, they would by no means have noticed that they can accurately determine the speed of light, because the different people would have measured the different speeds of light.

This is not surprising, because they have been using the stroboscopic toys. Different people have a different reaction time of the eye on the stroboscopic effect. For some, the impressions are being completely merged at fifteen frames per second, for others at sixteen frames per second, etc.

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[69] There are some more modern methods of measuring the speed of light. E.g. in 1950 Essen and Gordon-Smith used a hollow resonator to measure the speed of microwave radiation – this can be done as long as it is mistakenly believed that light is electromagnetic wave. The other method was used by Froome in 1958, applying the interference of radio waves, and by Evenson in 1972, applying the interference of laser. On the faith in the light interference and the electromagnetic nature of light, enough has been said, and I would not specifically comment these experiments.
More on e.g. http://en.wikipedia.org/wiki/Speed_of_light

It is completely pointless to introduce any concept of speed addition into the luminous phenomena. Why?

For material objects, it is valid that the apparent velocities can be added up. When we travel in a car at a speed of 50 km/h, and another car is approaching us at a speed of 50 km/h, in passing by, it may look as if we are standing, and the car at a speed of 100 km/h is getting closer.

However, light is not a material object, it is an image. If light travels, it is the notion of our perspective changing. The speed of the material object and the speed of changing perspective cannot be added. [70, CXXIV] *If image travels at some speed, it is because our visual field changes at that speed. In other words – we are the ones who travel, our image is being changed, our perspective is being changed. Any limitations to speed, attributed to light by the modern physics, only refer to the constraints in our ability to perceive the speed of perspective changing, not the limitations that are associated with light. The famous 300,000 km/s that modern physicists attribute to the speed of light, is nothing else than a mathematically fabricated notion of just fifteen frames per second, the average person can receive singly, without merging of impressions.*[71]

Relativistic theory that time slows down and space distorts, in approaching the speed of light, appeared as a result of misunderstanding the fact that, in perspective, objects appear bigger or as if they need different time to travel from one to another point; but in reality, both the size and the speed of object is always the same. The fact that the apparent size of the object changes when we travel at some speed; it is the property of the image we observe, and not the property of objects. Objects have a constant size, regardless of the fact that the projection of image of objects depends on motion. And light is such an image projection.

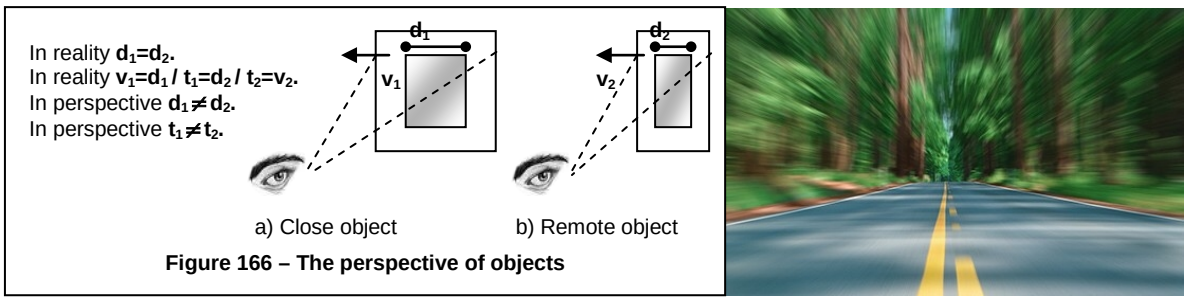

Figure 166 – The perspective of objects

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Light cannot be connected with the notions of the speed of light. There are no delays in the image perception. Light does not travel vast distances over time. There is no light year.[72]

[70] Once this is understood, it will become self-explanatory why the speed of light is the same in all referential systems. If we measure the speed of light from moving objects (in other words, if the toys for the stroboscopic measurement of the light speed are put into motion), we always get c '= c"= c"' = c. This is because the speed of light does not exist, and not because space contracts and time slows down as we approach the speed of light.

[71] Of course, to avoid any confusion, here we are talking about the speed of light, not about the speed of radio-waves.

[72] The light year is supposed to be the distance light travels per year.

The faith in a "light year" brought complete chaos in the modern understanding of the universe size and age. When we look at the stars now, we do not look into the past of the cosmos; we look into what it is. Supernova, noticed by Kepler in 1604, is exactly what happened in 1604.

The stars do not travel in terms of a permanent increasing the distance from one another; the stars are "fixed stars" as they used to be called in the ancient Greece. The universe does not expand, and it was not created by an explosion, in the "Big Bang".

And as there is no the speed of light, so there is no the speed of darkness. Light is an image that does not travel from the light source to the observer. Darkness is the force that weakens light and is fixed to a material object. The problem of the speed of gravity with which modern physicists struggle, originated from a misunderstanding of the nature of light and darkness. [CXXV]

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In modern physics, it is completely unthinkable to talk about magnetism in non-polar terms. It is completely pointless to talk about e.g. the north pole of a magnet, without taking into account that with the north magnetic pole, there is always the south magnetic pole. It is similar to electricity. It is completely pointless to talk about a positive charge, without being aware that simultaneously with a positive charge, a negative charge appears, too.

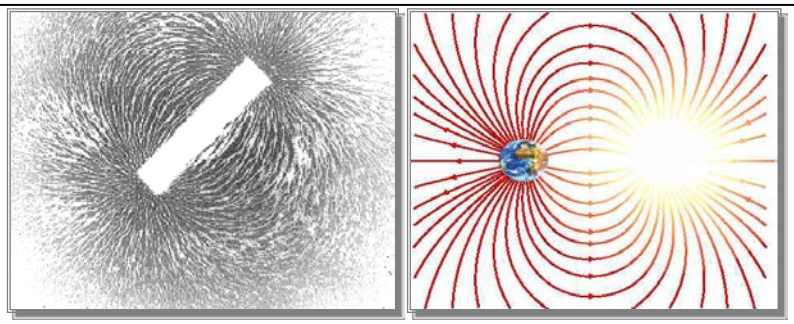

Figure 167 – Light and darkness as the two polar entities

If the modern physics wants to start holding on to reality, a similar polarity in luminous phenomena must be accepted as fact. Again, it must be brought back to the awareness that darkness is the polarity of light and whenever light appears, as the polar opposite phenomenon we have the appearance of darkness.

Light and heaviness are the polar oppositions. If we imagine a gravitational field as a force acting in such a way that it attracts material objects, in a manner of trying to increase the density of the material body from which it acts; one must be aware that in meanwhile, the light sources act in such a way that they try to reduce the density of material bodies, they scatter the materiality of the body. Both forces are related to the square of the distance.

When these things become accepted, it will become clear that the direction of the effect of light in terms of force, is not attraction toward a light source, but repulsion from the light source. Then, it will become understandable that the popular idea of the existence of black holes in a universe as objects that swallow the entire matter is the inversion of reality.

There are no black holes in the universe swallowing all matter. But there is something else. There is the Sun that scatters the density of matter below the level of vacuum. To think that the

Sun is a material object where nuclear reactions take place, is the cheapest possible superstition of modern physics.

There are no black holes. The only thing that exists is a white hole – our Sun. [73]

[73] The idea that the Sun has a mass is born out of the one-sided interpretation of the role of gravity in the Solar system. The idea of the Sun's mass, only indicates that mass of the modern physics' hypotheses need to be verified. Conceptions of the Sun as an immaterial object had been cherished in Greek philosophy, e.g. by Empedocles. The Sun had been considered the concentrated etheric nucleus. Subsequently, out of Newton's equation of gravitation $F = m M / r^2$, the credence was given to faith that the Sun is the material object, and one begun to speculate about the mass of the Sun. However, considering the force occurring between light and gravity, we should talk about antimass, about ethers, i.e. approximately $F = m (-M) / r^2$. I mention this just as a curiosity, not as fact, things should be considered from a lot of different viewpoints. Anyhow, in the modern physics, a concept of negative mass was revived by Hermann Bondi in 1957. In this regard, it is interesting to read an article about the Casimir effect on http://en.wikipedia.org/wiki/Casimir_effect. The article shows that the modern physics is near of reviving the aether concept that had been cherished in ancient physics.

7) Concerning the Aesthetic-Ethical Influence of Colors

The ideal of contemporary science is that in the process of nature cognition, the subject of cognition (i.e. man), excludes completely from the object of knowledge (i.e. nature). The ideal of the Goethean physics is endeavoring to make the subject so impartial that he does not change the facts of sensuous perception. The first ideal would be achieved if machines completely took over the observation of nature. The second ideal would be achieved if a man evolved in a completely objective being. The first attitude is antihuman, the second pedagogically-developmental.

From the mentality of thinking stating that a man can experience the external reality only subjectively, an attitude emerged that colors do not exist in nature. In nature, only different reflections of light rays exist, and what we perceive as a surface color is just "a psychical experience caused by the physical inducement".

Goethe was not deluded by this kind of false philosophy. Goethe was aware that there are colors on objects. If I look at the red square on a white surface, I look at something that really exists, something that is not a fiction of my brain. And now, if I close my eyes and in front of them, I see a green colored square, it is not because I am conceiting something, but because my eye actively experiences the sensory reality. The eye is not a passive organ of image perception, our eye is a painter. The eye itself seeks supplementation of the sensory perception, it seeks harmony. [74] *The educational mission of the chromatic is to shed light on the aesthetic laws of colors.*

Aesthetics is striving for harmony. The aesthetics of colors is a quest for achievement of harmony in a world of colors. Harmony of colors can be studied when we notice that in the experiment with a prism, each image can be projected onto darkness, by three different colored pictures – red, green and blue projection. Conversely, in the experiment with a prism, each image can be projected onto light as well, by three different colored pictures – yellow, purple and turquoise projections. We can arrange these six colors in a circle. Thus we get Goethe's color circle.

Since a color in its being carry a certain expression, some peculiarity, we can pose the question: "What is the nature of red?" "What is expressed by blue?" Again, in color relations, we seek for harmonious or disharmonious combinations. The quest for the color harmonies, we can begin with the question: "How is the character of red related to the character of turquoise?" "How is yellow related to purple?"

With questions like this, Goethe was thoroughly engaged in the last chapter of his book.

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The laws of aesthetics are not any kind of subjective rules. The laws of aesthetics are fully grounded both in sensory phenomena, and in our interior. It is not about "taste which is not debatable". All people will see the red square as green, after a strong sensory perception, because red is in a completely objective manner complementary to green. It is just that these things should be acquainted and further developed.

[74] The eye is not a hollow sphere, as taught by Alhazen. Our senses are not any kind of apparatus which mechanically reacts to stimuli.

Goethe's color circle can be further supplemented, too. Put the transitory colors among the six primal ones. Thus, we get a circle of twelve colors ordered by tonal similarity. When we, in this arrangement, count every seventh tone of color, we get a new circle presenting an analogy to the quint circle of musical tones.

Figure 168 – Quantitative and qualitative orders of colors

Aesthetic color relations of a chromatic quint circle are in detail described in the author's book "On the Imaginative Thinking in Art". Thence, curious readers, I shall just refer to the contents of that book.

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Modern culture has acquired completely wrong notions on the light's essence. This is the main reason why the modern culture cherishes completely wrong notions about the way a man perceives images. Modern psychology cherishes false notions on vision, built on false physics. According to the official psychology of the visual system, the rays of light are transformed into a bunch of electrical impulses via the stimulation of cells in the retina. Then in the brain, such neural impulses are interpreted in the image we perceive. Thus, the image perception, in a hazy way, is transferred from the eye to the brain – a brain, in some mystical way, converts electrical signals of the neurons to our experience of the image.

This is a completely wrong conception, the image is already here, light is already the image. And most stubborn researchers of nature still have to admit that Nature always seeks the most efficient solution – a solution that is also the wisest. Why would the image be transformed into electrical impulses, and again transformed back into the image in our brain?

Without any intention of providing a detailed description of a human vision process in this book, yet, the falsity of modern theories of visual systems must be emphasized. The description of the visual system, which wants to correspond to reality, will have to satisfy the following physical facts:

1) *Light is already an image, there cannot be any speech that the image is converted into some other information, and that the brain again interprets that information as the image perception.*

2) *Light does not consist of the light rays. No ray of light in a form of photons irritates cells on a retina producing the image perception; in each ray of light is the whole image. The retina may consist of cells, but the light-image is not composed of image points.*

3) *The eye is not the camera obscura. On the screen of camera obscura, the image is inverted for 180^0. There can be no speech that the cells in a retina are irritated by an inverse image, and afterwards, in a brain, in some inexplicable way, the image is again inverted for 180^0.*

4) *According to the official theory of a visual system – the theory of color sensation by three colors (Young, Helmholc), there are three types of cells in a retina that respond to three colors – red, green and blue. Their stimuli form a perception of a point of the image, which is transformed into the perception of the whole image in a brain. When there is no*

irritation, the perception of black color is produced. [CXXVI] *However, black is a color like any other color, black is not an absence of light. Since there is no void in light, hence there is no speech that the perception of black is caused by the lack of stimuli. The eye responds to both white and black.*

5) *Psychology of the image perception will have to be thoroughly involved in chromatic and visual proportions the eye seeks.*

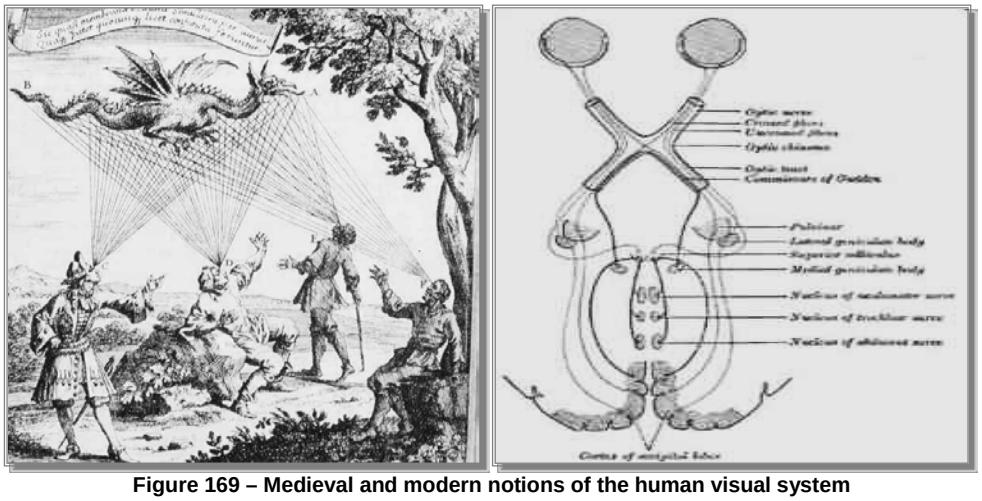

Figure 169 – Medieval and modern notions of the human visual system

The Middle Ages cherished notions of the image perception, as the rays of vision exiting out of the eye. In the modern culture, this notion is seen as the worst possible superstition. However, how the understanding of the human visual system will have unfolded, the notions we nowadays consider the exact science, will be portrayed as the worst possible superstition. [75], [CXXVII]

- - -

A man responds to the colors. Red color will agitate all people; blue color will calm all people. It might be needed to add – all the healthy people. There are ill people who cannot react to impressions. It is just about that their disease should not serve as an excuse of the contemporary culture for a declaration that the reaction of the human psyche on colors is a matter of individual, of something subjective. Subjective might be my experience of redness. Subjective might be my relationship to red.

The reaction of my psyche to red color is completely objective.

Thus we have approached the medical aspect of the Goethean physics. Colors can be used for therapeutic purposes. The Goethean physics considers this issue as self-evident. It is just that this fact can and must be further developed.

The Goethean physics knows that colors do exist on objects. But the Goethean physics also knows that the power of color exists in matter as well, and that a color in matter may tell more about the properties of matter itself. As in the field of zoology, it cannot be considered an irrelevant play of nature that a wasp is dressed in black and yellow combination, because

[75] A complaint addressed to e.g. Plato was "If a ray of vision exits the eye, why cannot we see anything in a complete darkness?". However, Plato had clearly distinguished the external light that makes the visual field bright, and the inner light (luminiferous aether we carry in ourselves), which allows the process of visualization (compare to the allegations at the end of the book). When these facts again become understandable, it will be self-evident that the expression "light is the image carrier" that has constantly been used in the book, is only a figurative description.

through his clothes, a wasp wants to tell us something; also in the field of chemistry, it cannot be regarded as a mere play of nature that gold is yellow, copper blue-green etc.

In his book, Goethe began with such observations. Principally, it is valid that the red-yellow color of the mineral salts refers to acidic compounds, while the blue-purple color of the mineral salts refers to alkaline compounds.

On the other hand, such thinking can extend the way we experience colors. Colors can be correlated with tastes. Red-yellow is related to sourness, blue-purple to bitterness. It is just about that these things need to be further developed.

We can break a color free of matter, from the iron embrace of darkness, when we ignite the material, when we put it in a flame. E.g., let us take a substance that colors a flame in green. For example, let us take some copper salt. Green is the color in the middle of a rainbow, neither hot nor cold. Green is a reflection of a balance. Thus, copper in its being has something balanced, carries a tendency towards equilibrium. This means that copper salts can be used as the bases for remedies that will have beneficial effects on various physiological imbalances.

In the Goethean physics, nowadays color therapy – that is more used in psychiatry, and drug therapy – that targets the treatment of various physiological disturbances, will be united in a natural way.

Epilogue

"Nothing hurts a new truth more than an old error."

J.W.Goethe

Experiments of physical colors described in this book should have to refer to a danger when something uncontained in a phenomenon itself is added to the phenomenon of nature. Goethe was aware of this fact. Therefore, he has always stressed out the importance that in studying the phenomena of nature, the phenomenon should not be complemented with theories, but one should try to get to the essence of the phenomenon.

If the experiment with a prism serves for speculation that light is being decomposed – it is a supplement that does not exist in the phenomenon itself. Again, if in the experiment with a prism, we see the appearance of colors on the border of light and shadow – it is the beginning of perception, which can lead to the essence of the phenomenon. The essence of color phenomenon is an experiment with the opaque fluid through which we look at light or darkness. This is the most basic phenomenon of the color appearance by weakening light (yellow-red), or by strengthening darkness (blue-violet). Newton not only made a mistake in the conclusion, Newton made a mistake in the approach. The experiment with the prism is not a basic experiment with colors; the experiment with a prism is a complex experiment with colors, which is already consisting of more elementary phenomena.

The essence of the phenomenon, Goethe used to call the primal-phenomenon ("Urphänomen"). We can represent the primal-phenomenon as an elementary observable pattern that can be recognised in all other newly spotted phenomena. In the field of chromatic, an elementary observable pattern is the appearance of yellow or blue color, which can afterwards be recognised in the rainbow or the experiment with prism. In the field of optics, an elementary observable pattern is the appearance of image on the screen of camera obscura, which can afterwards be recognised in all optical phenomena. The task of a natural investigator is to provide a description of the primal-phenomenon, in a way that the overall image complies with the descriptions of all primal-phenomena. In harmony of such descriptions, cognition can be born.

By seeking to answer the question of how to reach the objective truth, Goethe came to the conclusion that one cannot reach cognition by attempting to explain the facts. Facts should be described, not explained. Through his book, he tried to show on a practical example, what the Goethean approach in studying nature should mean. Two hundred years ago, official science rejected Goetheism as unfounded.

Have we learned anything in the past two hundred years? [CXXVIII]

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The intention of this book is to point out that, in the historical account of the physics development, J.W.Goethe must be remembered as an ingenious physicist.

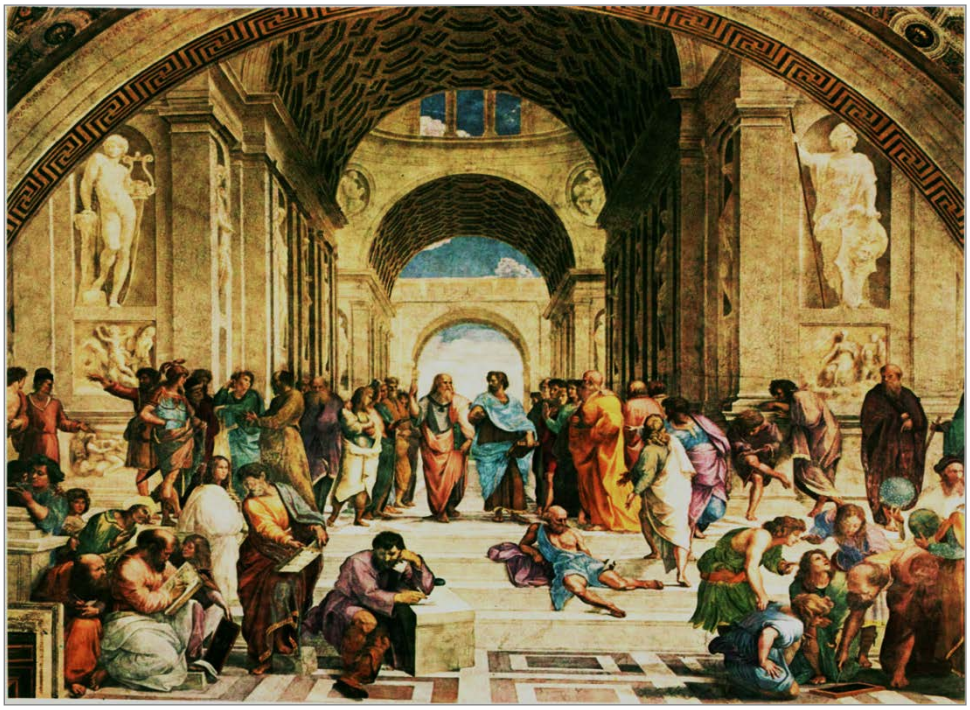
The intention of this book is by no means to claim that it provided the ultimate truth about the essence of colors and light.

This book gives a final judgment regarding the past. Goethe was an ingenious physicist.

This book does not give a final judgment regarding the future. From what is yet to come, understanding and supplements are expected.

Therefore, let us end this overview in terms of the spiritual father of Teaching on Colors, in terms of Goethe:

"Through sacrificed light, by darkness refined
Strewn in the world filling us with joy
Seen by the eye, worn in soul
In glory divine, colors are shown!"



Equipment list

1. *Digital Camera 14MPx, 5 x optical zoom*

2. *Two amateur loupes, Φ100 mm and Φ75 mm*

3. *Equilateral dispersion prism , N-SF11 glass*

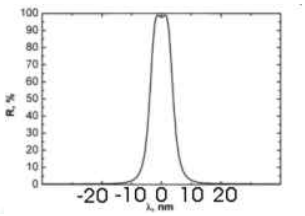
Part No.	Material	nd	vd	Aperture (mm) width x height prisms
PES3535	N-SF11	1.785	25.8	35 x 35 (No coating)

4. *Colored Foils, 19 x 19 cm*

5. *The slide projector, halogen lamp 250 W*

6. *Three table lamps, light bulbs 40 W*

7. *Interference light filters 10nm, 4 pieces*



Part No.	Wavelength (CWL nm)	Bandwidth (HBW nm)	Peak transmission (%)
480FIB12	480	10	45
490FIB12	490	10	45
580FIB12	580	10	50
600FIB12	600	10	50

Dimensions
Diameter: +0,-0.3mm
Thickness: 5-6mm
Clear aperture:
12.5mm dia. 8.6mm

Specification

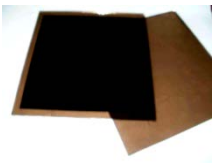
Range	Fin	FIB (<1100nm)	FIB (=1100nm)	FIJ	FIR	FIW
CWL tolerance (nm)	+0.7,-0.4	±2	±3	±2	±5	±7
HBW tolerance (nm)	+0.7	±2	±3	±2	±5	±8
Bandwidth ratios						
10%BW/HBW	1.74	1.35	1.74	1.35	1.13	1.05
1%BW/HBW	3.21	1.99	3.21	1.99	1.30	1.18
0.1%BW/HBW	6.09	2.92	6.09	2.92	1.60	1.36
0.01%BW/HBW	12.68	4.41	12.68	4.41	2.04	1.69
Blocking type and specification	Induced transmittance filter10?? absolute, 200-3500+			Dielectric stacks:10?? ave,10?³ abs, x-ray to 1150nm		
No of cavities (min)	2	3	2	3	5	7

8. *School collage papers*

9. *The pipe for alufoil as camera obscura, if necessary, opening is closed with the peace of alufoil*

10. Two glass plates 20 x 15 x 1 cm

11. Two plates of black glass 20 x 15 cm



12. CD

13. Mirror 10 x 10 cm

14. The digital thermometer

15. The pocket fan

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III. *Rudolf Steiner "Light and Darkness as the Two Polar Entities," lesson from 5th December 1920, Dornach*

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V. *Rudolf Steiner "Philosophy of Freedom", the Society for Waldorf pedagogy, Croatia, 1993.*

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XI. *Gábor Áron Zemplén "An Eye For Optical Theory?"*
Newton's rejection of the modificationist tradition and Goethe's modificationist critique of Newton
http://hps.elte.hu/~zemplen/ZemplenSCHNEIDER.pdf

XII. *Some technical data and drawings are taken from the site www.wikipedia.com.*

Quotes

[I] Partially revised article taken from the site http://en.wikipedia.org/wiki/Isac_Newton

[II] Partially revised article taken from the site http://en.wikipedia.org/wiki/Goethe

[III] Plato's Philebus Translated by Thomas D. Worthen [12e]
"Sokrates: You surprise me, my friend, for color, too, is like itself; in so far as that goes all of them persist in being a color. Yet from a different point of view we all recognize that black and white are not only different, but are quite the opposite. And so shape is like itself in this same way. Shapes are indeed all one type of thing; taken as parts, however, shapes may, in some instances, be absolutely opposed to each other, [13a] while in other cases their differences obtain through ten thousand instances. And we can find many other examples of such relations. Do not, therefore, rely upon this argument, which makes all the most absolute opposites into identities. I am afraid we shall find some pleasures the opposite of other pleasures."
Or Aristotle, "de Anima" III.2
"This presents a difficulty: if to perceive by sight is just to see, and what is seen is colour (or the coloured), then if we are to see that which sees, that which sees originally must be coloured. It is clear therefore that 'to perceive by sight' has more than one meaning; for even when we are not seeing, it is by sight that we discriminate darkness from light, though not in the same way as we distinguish one colour from another. Further, in a sense even that which sees is coloured; for in each case the sense-organ is capable of receiving the sensible object without its matter. That is why even when the sensible objects are gone the sensings and imaginings continue to exist in the sense-organs."

[IV] The 5th International Conference of the European Society of History of Science is organized in Athens, 1-3 November 2012 Vasiliki Papari "Color in ancient philosophy" http://5eshs.hpdst.gr/abstracts/485
"The colors are part of the oraton (which is seen, De Anima 418a26). The color is the one which has the power to set in motion the current transparent. (De Anima 418a29-418b2): "the object, then, of sight is the visible: what is visible is colour and something besides which can be described, though is has no name. What we mean will best be made clear as we proceed. The visible, then, is colour. Now colour is that with which what is visible by its essence or form, but what is visible because it contains within itself the cause of visibility, namely colour. But colour is universally capable of exciting change in the actually transparent, that is, in light; this being, in fact, the true nature of colour. Hence colour is not visible without light, but the colour of each object is always seen in light." There is nothing visible without light (418b2), we see colors through the media of air or water - which are potentially transparent, but only with light really transparent. The transparency is not bound by any particular body or elements. The transparent is colorless (De anima 418b28). The light is defined as the activity (energeia) of the Transparent (418b9). The object seen acts on the eye through a medium, the so called diaphanes (transparent). But this transparent requires arousal, it must first be made clear; this procure the colors of the objects, which are seen. They cause change to the transparent this way that it can act on the eye. What, then, has no color, can not be seen.

David C. Lindberg "Theories of Vision from Al-kindi to Kepler", pg 8
" As a state of the medium, rather than a substance, light requires no time for propagation, for the entire medium may be moved from potential to actual transparency at the same instant. Indeed, terms like "propagation" and "transmission," which imply progressive motion, are not appropriate for describing light; just as it is conceivable for water to be frozen simultaneously throughout, so the change of state resulting in light "may conceivably take place in a thing all at once, without half of it being changed before the other." If Aristotle seems, at times , to claim that motion comes from the visible object to the eye, this does not imply a temporal process, but simply identifies the source or efficient cause of the instantaneous change of state."

[V] More on http://www.press.umich.edu/pdf/0472113887-ch3.pdf
"Sweet exists by convention, bitter by convention, heat by convention, cold by convention, color by convention; but atoms and the void exist in truth. (fr. 9)"

[VI] Quotation taken from [VII], Book I, "Greeks"

[VII] David C. Lindberg "Theories of Vision from Al-kindi to Kepler", pg 2
"Among the first philosophers to propose a systematic doctrine of light and vision were the atomists. To be sure, within the atomic school there was considerable diversity of opinion, and it would be gross error to suppose that atomists from Leucippus to Lucretius spoke with a single voice. Nevertheless, there was a significant core of agreement, springing from the common premise that all sensation is caused by direct contact with the organ of sense and therefore that a material effluence must be conveyed from the visible object to the eye.5 Aetius (second century A.o.?) reports that "Leucippus, Democritus and Epicurus say that perception and thought arise when images (eidola) enter from outside"; Alexander of Aphrodisias, writing in the first half of the third century, adds that Leucippus and Democritus "attributed sight to certain images, of the same shape as the object, which were continually streaming off from the objects of sight and impinging on the eye. There is no question about the corpuscular nature of these images or eidola."

[VIII] Aristophanes in "The Clouds" (420 BC) describes the light focusing effect of a lens:
Strepsiades: Have you ever seen a beautiful, transparent stone at the druggists', with which you may kindle fire?

Socrates: You mean a crystal lens.
Strepsiades: That's right. Well, now if I placed myself with this stone in the sun and a long way off from the clerk, while he was writing out the conviction, I could make all the wax, upon which the words were written, melt.

Diocles "On Burning Mirrrors"
"Pythian the Thasian geometer wrote a letter to Conon in which he asked him how to find a mirror surface such that when it is placed facing the sun the rays reflected from it meet the circumference of a circle. And when Zenodorus the astronomer came down to Arcadia and was introduced to us, he asked us how to find a mirror surface such that when it is placed facing the sun the rays reflected from it meet a point and thus cause burning."

[IX] Compare Helmut Gernsheim "A Concise History of Photography", pg. 3
"Aristotle observed the crescent shape of the partially eclipsed sun projected on the ground through the holes of a strainer, and the gaps between the leaves of a tree. He also noticed that the smaller the hole, the sharper the image."

[X] Compare Aristotle "Problems"
"Q. Why do we see ourselves in glasses and clear water? A. Because the quality of the sight, passing into the bright bodies by reflection, doth return again on the beam of the eyes, as the image of him who looketh on it."

Or David C. Lindberg "Theories of Vision from Al-kindi to Kepler", pg 16
"Rays may represent the geometry of sight, but they have nothing to do with the physical reality. This position is evident in Ptolemy's comment that 'it is necessary to recognize that the nature of the visual ray . It is necessarily continuous rather than discrete. ' This continuous visual energy emerging from the eye has the power to perceive the objects that it encounters with a clarity dependent on the strength of the radiation."

[XI] [VII] Book I, chapter "Rene Descartes"

[XII] [VII] Book I, chapter "Francesco Grimaldi"

[XIII] "By the rays of light I understand its least parts, and those as well successive in the same lines, as contemporary in several lines".
[VIII], Book I, Part I, Definition I.

[XIV] "Refrangibility of the rays of light, is their disposition to be refracted or turned out of their way in passing out of one transparent body or medium into another… But by an argument taken from the equations of the times of the eclipses of Jupiter's satellites, it seems that light is propagated in time." [VIII], Book I, Part I, Definition II.

[XV] "Reflexibility of rays, is their disposition to be reflected or turned back into the same medium from any other medium upon whole surface they fall". [VIII], Book I, Part I, Definition III.

[XVI] "The angle of incidence is that angle, which the line described by the incident ray contains with the perpendicular to the reflecting or refracting surface at the point of incidence". [VIII], Book I, Part I, Definition IV.

[XVII] "The angle of reflexion or refraction, is the angle which the line described by the reflected or refracted ray containeth with the perpendicular to the reflecting or refracting surface at the point of incidence". [VIII], Book I, Part I, Definition V.

[XVIII] "The sines of incidence reflection and refraction, are the sines of the angles of incidence reflexion and refraction". [VIII], Book I, Part I, Definition VI.

[XIX] "The light the rays of which are alike refrangible, I call simple, homogeneal and similar; and the light the rays of which are more refrangible than others, I call compound, heterogeneal and dissimilar". [VIII], Book I, Part I, Definition VII.

[XX] "The colours of homogeneal lights, I call primary, homogeneal and simple; and those of heterogeneal lights, heterogeneal and compound". [VIII], Book I, Part I, Definition VIII.

[XXI] Formulation taken from [IX] chapter "Dispersion of Light" pg. 271-273.

[XXII] "The light of the Sun consists of rays differently refrangible". [VIII], Book I, Part I, Proposition II, Theorem II.
"Whiteness and all grey colours between white and black, may be compounded of colours, and the whiteness of the Sun's light is compounded of all the primary colours mixed in a due proportion". [VIII], Book I, Part II, Proposition V, Theorem IV.

[XXIII] "The phenomena of colours in refracted or reflected light are not caused by new modification of the light variously impressed, according to various terminations of the light and shadow". [VIII], Book I, Part II, Proposition I, Theorem I.

[XXIV] [VIII], Book I, Part II, Proposition I, Experiment I.

[XXV] [VIII], Book I, Part II, Proposition I, Experiment II and III.

[XXVI] [VIII], Book I, Part II, Proposition I, Experiment 4.

[XXVII] "All the colours in the universe that are made by light, and depend not on the power of imagination, are either the colours of homogeneal lights, or compounded of these, and that either accurately or very nearly, according to the rule of the foregoing problem". [VIII], Book I, Part II, Proposition VII, Theorem V.

[XXVIII] "By the discovered properties of light to explain permanent colours of natural bodies". [VIII], Book I, Part II, Proposition X, Prob. V.

[XXIX] "The transparent parts of bodies, according to their several sizes, reflect rays of one colour, and transmit those of another, on the same grounds the thin plates or bubbles reflect or transmit those rays. And this I take to be the ground of all their colours". [VIII], Book II, Proposition V.

[XXX] "By mixing coloured lights to the compound beam of light of the same colour and nature with a beam of the Sun's direct light, and therein to experience the truth of the foregoing propositions". [VIII], Book I, Part II, Proposition XI, Prob. VI.

[XXXI] "For the rays to speak properly are not coloured. In them there is nothing else than a certain power and disposition to stir up a sensation of this or that colour". [VIII], Book I, Part II, Proposition II, Theorem II, Experiment 6.

[XXXII] Formulation taken from [IX] when Newton's color theory is being explained, chapter "Interference of Light" pg. 310.

[XXXIII] "The actual color of a color may appear to change based on its surrounding colors. Surrounding colors can influence the way you see color. They can give color the appearance of being tinged with the complementary hue of the surrounding area. Colors that are the same may appear different, and colors that are different may appear the same. The effect is called chromatic induction."
http://www.devx.com/projectcool/Article/19987/0/page/2#Chromatic

[XXXIV] "From the time immemorial it has been known and undisputed that light is being refracted in all sorts of ways, and that there is no manifestation of colors".
[VII] Book I, chapter "Achromatic"

[XXXV] The sentence taken from Doug Marsh "The Tao Of Colours"
http://southerncrossreview.org/74/tao-colors-2.html

[XXXVI] Citation from [XI] pg. 25
1. The length of the image is greater than the breadth on clear days, but clouds even near the sun broaden the image considerably53. But this "will not, I conceve, be questioned"
2. As a more serious problem, he notes that the spectral image is at best 3 ½ time longer than broad, when the refractions are equal on both sides
3. He suggests a series of further experiments, which "would be very proper in order to a further discovery of the truth of his assertion." This seems to be a thoroughly different road than the one taken by Newton. Lucas, it seems, does not grant the demonstrative power to the experimentum crucis. The proposed experiments are:
3.1 Newton's theory supposes focal difference for different colours – yet when scarlet and violet coloured silk pieces are viewed in a microscope, there is no inequality of focus.
3.2 Different colours arranged in a line under water are seen from above. When retreating, the colours are seen "by the help of the refracted ray", and yet they remain to be in one line.
3.3 The same experiment with a second refraction
3.4 The same experiment with a third refraction, also using "some unconcerned persons".
3.5 Casting violet and scarlet from two prisms parallel to the horizon, and viewing them through another prism: colours still appear in a straight line.
3.6 Trying to see the effects of sunspots (placing a telescope behind the prism), but without success (see also Turnbull 1960: 14, note 10).
3.7 While Lucas carries out subjective experiments, he notices the difference in colour: scarlet appearing above, violet below, the opposite order as in the objective prismatic experiments. I cite one in detail (see Picture 8): "In pursuance then of my former suspicion, having fixed my prism in a steddy posture, I caused the paper C to be applyed close up to the paper circle abd: whereupon the former violet of d, and scarlet colour of c vanished into whitenesse. Next I remooved the mentioned circle from the shutts and placed it in the open window, supported onely by the edge d: whereupon, to my astonishment, all the former colors exchanged postures in the Retina, the scarlet now appearing below, the violet above; the intermediate colors scarce discernible." (Turnbull 1960: 11) Lucas not only describes the experiment, but reaches a conclusion as well: "Whence it followes, that thes colors doe in great part arise from the neighbouring light." He goes on: "Lastly I placed the paper circle anew, soe as the one halfe b was fastened to the shutts, the other semicircle a being exposed to the open aire. Whereupon the semicircle a became bordered with violet above, scarlet below; but the other semicircle b quite contrary." (Turnbull 1960: 10) In this experiment, Lucas reaches the following inferences: 1) not only light, but ambiant air also has influence on colours. What needs an explanation is not the length but the small breadth of the spectrum. 2) "were

there a more luminous body behinde the sun, we should in all likelyhood have the colors of the spectrum in a contrary situation to what they appear in at present". Whence 3) the present spectrum and order of colours are not the result of any intrinsic property of refrangibility, but of contingent, extrinsic circumstances of neighbouring objects.
3.8 To test Newton's proposition 5 (see I.iii), he places a thin slice of ivory in the windowshut. This looks yellow, but when three, four, or more slices are in the way of light, the transmitted colour is red. His conclusion is that "yellownesse" is not primary, but compound of red.
3.9 He directly challenges proposition 12: One can see through red and blue solutions placed one before the other.

[XXXVII] "How surprised I was when the wall, seen through the prism, remained white as it is …". [VII], Book I, "Author's Story"

[XXXVIII] [VII], Book II, table 15 on the end of the book.

[XXXIX] William Robert Brown Jr. "Schopenhauer and Faust II",
"Goethe was among those who opposed Newton, and his years of anti-Newtonian observations were published in 1810 as Towards a Theory of Colors, a work that he felt would be the source of his lasting fame. He was disheartened by the public reaction, which ranged chiefly from critical to indifferent. He was looking for a disciple to help promote his theory, and it is in this context that he invited Schopenhauer to join him in his investigations (Safranski 177-78). Goethe kept his pupil away from the salons and other social events of Weimar; he was invited to Goethe's not to socialize, but rather to come alone and speak of serious matters. As Goethe's daughter Ottilie reports, "With others, he would chat, but with him, young Dr. Arthur, he philosophized"
http://www2.unca.edu/postscript/postscript14/ps14.2.pdf

[XL] "Who does not recognize here again the impulse of the time - from subject to object and back into the subject again - that led Hegel to the architectonics of his whole system" [IV], Chapter XVI "Goethe as Thinker and Investigator".

[XLI] W. Heisenberg, Philosophical Problems of Quantum Physics, pp. 60-76.
"Goethe's colour theory has in many ways borne fruit in art, physiology, and aesthetics. But victory - and hence, influence on the research of the following century - has been Newton's. (60)"
(Werner Heisenberg, "Bermerkungen zur Theorie der Vielfacherzeugung von Mesonen." Die Naturwissenschaften Vol. 39. 1952)"
About Heisenberg's interest in Goethe more on
http://thethoughtexperiment.wordpress.com/2010/07/20/goethe-month-theory-of-colour-day-5/

[XLII] "Dark bodies have no color per se, since their color is conditioned by the color of those rays that are absorbed from the incident light". Sentences rewritten from [IX] Chapter "Color of the Object" pg. 283.

The attitude that black surface does not reflect light, can be compared to the allegation: "Beyond the prism was the wall of the chamber under the window covered with black cloth that no light can be reflected from thence …". [VIII], Book I, Part I, Proposition I, Theorem I.

[XLIII] The law is derived from the intensity of light flux. $I=\Phi/4\pi = \Phi_1/4\pi + \Phi_2/4\pi = I_1 + I_2$. [IX] Chapter "Photometry" pg. 20-21.

[XLIV] "When we look at an object illuminated by daylight through a glass prism, we see the object as shifted due to the refraction of light. However, the light rays passing through the particular points of the surface, are simultaneously decomposed into all spectral colors. At the same time, such various spectral colors are re-mixed in front of the figure seen through the prism. They create again the same kind of composite light that illuminates the surface". Sentences rewritten from [IX] Chapter "Achromatic Prisms and Lenses" pg. 299.

[XLV] The sketch drawn in accordance with [IX], Chapter "Diffraction of Light" pg. 378.

[XLVI] "From the above we can see that light rays cannot be physically realized in terms of geometrical optics. By reducing the opening through a light pass, the beam of light is being narrowed approaching the light ray, because a narrow light beam – if an opening is small enough, deviates from the rectilinear propagation of light and behind the opening, the light is scattered on all sides". Sentences rewritten from [IX], Chapter "Diffraction of Light" pg. 379.

[XLVII] "If we put a red glass plate on the path of light rays, then at the screen we shall see only a red light. This clearly proves that a red glass absorbs all other colors except spectral red". Sentences rewritten from [IX], Chapter "The Colors of the Objects" pg. 282.

[XLVIII] According to the allegations in [XI] pg. 34, only after Lucas' complaints, Newton revised the theory of external bodies' coloration by addition that "All colours in nature are compound." This way of thinking is subsequently applied to the mixing of colored lights.

[XLIX] This is the thesis of a so-called the "Theory of Three Colors". The assumption of the theory is given by Alhazen – the eye is a passive organ for the projection of light, where vision occurs when the light rays irritate the nerves on a retina. The theory assumes that the eye has three types of cells, sensitive to three colors, namely red, green and blue. Rays of light irritate the nerve cells which in a brain create a sensation of color. [IX], Chapter "An Explanation of the Sense of the Color by the Theory of Three Colors" pg. 285.

[L] "From white light, a body absorbs one part of the spectral colors and the rest, which the body reflects, determine its color". Sentences rewritten from [IX], Chapter "Color of the Object" pg. 282.

[LI] Newton's theory names: "Lights which differ in colour, differ also in degrees of refrangibility". [VIII], Book I, Part I, Proposition I, Theorem I.

[LII] "To define the refrangibility of several sorts of homogeneal light answering the several colours". [VIII], Book I, Part II, Proposition III, Problem I.

[LIII] "All homogeneal light has its proper colour answering its degree of refrangibility, and that colour cannot be changed by reflection or refraction". [VIII], Part II, Proposition II, Theorem II.

[LIV] In his book, Goethe has repeatedly emphasizing that in optics we have to do with images. F.e. [VII]
"309
However small the opening in the lid of a camera obscura be made, still the whole image of the sun will penetrate it".
"219.
Vor allen Dingen erinnern wir uns, dass wir im Reiche der Bilder wandeln. Beim Sehen überhaupt ist das begrenzt Gesehene immer das, worauf wir vorzüglich merken; und in dem gegenwärtigen Falle, da wir von Farbenerscheinung bei Gelegenheit der Refraktion sprechen, kommt nur das begrenzt Gesehene, kommt nur das Bild in Betrachtung."
In Ch.L.Eastlake's translation from 1840, there is a wrong translation at this place:
"In the first place, we have to remember that we have to do with circumscribed objects" .

[LV] Ex. "Image of the Sun made by a direct beam of light …" [VIII], Part I, Explanation for the picture 14.

[LVI] "We have already mentioned that clear images can be obtained by using lens, only under the condition when the lens is thin and the light rays fall near the main axis. However, lenses used in practice are not always sufficiently thin and often have a large opening, so besides the light rays passing through the paraxial of lens, some light rays more distanced from the main axis are let through... Therefore, a certain defections in obtained figures occur, according to the laws we have already studied, and the figures are not sufficiently clear i.e. sharp". Sentences rewritten from [IX], Chapter "Defects of the Lenses" pg. 189.

[LVII] Aristotle "Meteorology" Book I, 5.
"For a weak light shining through a dense air, and the air when it acts as a mirror, will cause all kinds of colours to appear, but especially crimson and purple. For these colours generally appear when fire-colour and white are combined by superposition. Thus on a hot day, or through a smoky, medium, the stars when they rise and set look crimson. The light will also create colours by reflection when the mirror is such as to reflect colour only and not shape. These appearances do not persist long, because the condensation of the air is transient. 'Chasms' get their appearance of depth from light breaking out of a dark blue or black mass of air. When the process of condensation goes further in such a case we often find 'torches' ejected. When the 'chasm' contracts it presents the appearance of a 'trench'. In general, white in contrast with black creates a variety of colours; like flame, for instance, through a medium of smoke."

[LVIII] "When we watch a green plant leaf through a red glass during daylight, then the green leaf appears dark because the green light, reflected from the leaf, is absorbed from the red glass". Sentences rewritten from [IX], Chapter "Color of the Body" pg. 282.

[LIX] "When light rays fall aslant on the boundary surface of mediums with different optical density, then their direction is changed and such a change of direction is called the refraction of light". Sentences rewritten from [IX], Chapter "Refraction of Light" pg. 84.

[LX] "By measuring the wavelength of light, it was concluded that the wavelength of visible light decreases, and the number of oscillations increases, in a series of spectral color from red to purple". Sentence rewritten from [IX], chapter "Dispersion of Light" pg. 274.

[LXI] "From the equation $c = v\lambda$ one can conclude that the increase of the speed of light (in optically denser mediums) corresponds to the greater wavelength, and vice versa". Sentence rewritten from [IX], chapter "Dispersion of Light" pg. 275.

[LXII] William Thomson, Lecture on "Electrical Units of Measurement" (3 May 1883)

[LXIII] Description of Kant's philosophy taken from the article: ***Marijan Cipra*** *"Anthroposophy – The Science of inner Experience", journal "Anthroposophy – Proceedings of anthroposophical Texts", December 1990.*

[LXIV] "I heard myself accused of being an opponent, an enemy, of mathematics altogether, *which no one, after all, can value more highly than I do*", [IV], Chapter XII "Goethe and Mathematics".

[LXV] With this compare Aristotle "de Anima, II.7".
"We have now explained what the transparent is and what light is; **light is neither fire nor any kind whatsoever of body nor an flux from any kind of body (if it were, it would again itself be a kind of body)** - it is the presence of fire or something resembling fire in what is transparent. It is certainly not a body, for two bodies cannot be present in the same place. The opposite of light is darkness; darkness is the absence from what is transparent of the corresponding positive state above characterized; clearly therefore, light is just the presence of that."

Or, Christopher Lauer "The Suspension of Reason in Hegel and Schelling", pg. 44
"Gravity is nature's insistence on continual self-presence, on pulling back from expansion into the abyssal, and so is opposed to light-essence ('das Lichtwesen') , which struggles against identity to spread itself throughout the whole of nature (S 2: 369). Whereas gravity works externally on things, pulling them toward a longed-for presence, light essence begins from the all-present center and thrusts outward. And since it begins from absolute presence, this expansive force is completely atemporal. Unlike gravity, which strives to bring bodies to presence, light essence strives to bring pure presence into differentiatedness of matter, to find itself in what is not itself. It is only through this dual movement both toward and away from identity that natural things can appear: "The dark of gravity and the gleam of light-essence first produce ['bringen hervor'] together the beautiful shining of life and complete the thing to what we will call the authentically real" (S 2: 369). Nature's coming-to-shine, then, is the atemporal happening of the simultaneity of unity in totality (gravity) and totality in unity (light-essence)."

Or, R,Steiner "Origins of Natural Science", Dornach, January 2, 1923, Lecture VII:
"The reason it is less obvious in other experiences of the physical body is that the corresponding processes in the body, such as weight or gravity, are completely extinguished for today's form of consciousness. These processes, however, were not always completely obliterated. Under the influence of the mood prevailing under the scientific world conception, people today no longer have any idea of how different man's inner awareness was in the past. True, he did not consciously carry his weight through space in former times. Instead, he had the feeling that along with this weight, there was a counterweight. When he learned something, as was the case with the neophytes in the mysteries, he learned to perceive how, while he always carried his own weight in and with himself, the counter-effect is constantly active in light."

[LXVI] So-called. " Lambert's law of Photometry" $E_1/E_2 = r_2^2/r_1^2$. [IX], "Basic Law of Photometry," pg. 24.

[LXVII] Newton's mathematical formulation of the attractive gravitational force between punctual masses $F=m\ M / r^2$. Allegedly, this concept of attraction between masses had already existed in Alhazen's works.
http://en.wikipedia.org/wiki/Alhazen

[LXVIII] The idea on correlation between Lambert's photometric law and gravitational force is mentioned in Johann Ferdinand Jencken's, "Treatises On Light, Colour, Electricity, And Magnetism" London: Trubner & Co., 66 Paternoster Row. 1869 pg. 79:
"This coexistence, however, could not possibly be, if all the suns in space were created of one uniform common material. Matter cannot occupy the same space at two, different points, and space cannot contain two materials within the same limits! How, then, to account for the peripheral presence of the many sun powers represented by the stellar bodies in space, without interference one with the others? This brings me to the consideration of the law of gravitation, the concentric action, the flow from the extremist peripheral back to the central body. A parallelism must exist between these two great agents of creation. Bodies might be said to attract one another in the direct ratio of the intensity of their light. Gravitation and light, according to Schelling, stand polarically opposed to each other, as "Erste Potenz und zweyte Potenz," from centrum to centrum, outward and retro, in never-ceasing pulsation."

[LXIX] I.Newton „Philosophiae Naturalis Principia Mathcmalica", Amstaclodami, 1714, Tom. I, p. 12 (Lex, I of the "Axiomata sive leges motus"); cf. pp. 2, 358
"Corpus omne perseverare in statu suo quiescendi vel movendi uniformiter in directum nisi quatenus a viribus impressis cogitur statum ilium mutare."
"Every body persists in its state of being at rest or of moving uniformly straight forward, except insofar as it is compelled to change its state by force impressed."
Allegedly, this concept has already existed in Alhazen's works.
"He maintained that a body moves perpetually, unless an external force stops it or changes its direction of motion"
http://en.wikipedia.org/wiki/Alhazen

[LXX] "Furthermore, it was ridiculous to assume, the argument went, that the heaviest element (earth) was propelled through the universe while the lightest (aether) remained motionless. The precepts of Aristotelian physics made such motion impossible. It was infinitely more logical that the heavy Earth was stationary while the light aether possessed the movement necessary to explain observable phenomena".
http://www.scienceclarified.com/dispute/Vol-2/Historic-Dispute-Is-Earth-the-center-of-the-universe.html#ixzz1fZW5Jz7T

In Aristotelian physics, it had been considered that light aether causes the rotation of planets around the Earth. Then, through the works of Kepler, Copernicus, Galileo and others, it was introduced a heliocentric planetary system that is mathematically formulated by Newton's theory of gravity. Subsequently, one has attempted to overcome certain inconsistencies in this model (e.g., irregularity in Mercury's orbit) through the relativistic concepts of curved space and a dependence of time and a velocity of an object. A/N.

[LXXI] Taken from [IX],"Interference of Light" pg. 310.

[LXXII] "Out of Maxwell's equations of the refractive index of electromagnetic waves in certain medium, we can determine the dielectric constant of the given medium". "On the basis of such **theoretically obtained results**, according to which both the speed of light and electromagnetic waves are equal and transversal, Maxwell concluded that the light waves are identical to the electrical waves".
Sentences rewritten from [IX], chapter "Light as Electromagnetic Wave" pg. 481 and 482.

[LXXIII] "However, there are facts pointing a certain deviation from Maxwell's electromagnetic theory of light, but these contradictions are removed by accepting the electron and quantum theory. For example, the classical Maxwell theory could not explain why Maxwell's formula is incorrect for many materials and why the speed of light through various transparent mediums depends on the wavelength, while in a vacuum, it is constant regardless of the wavelength". Sentences rewritten from [IX], chapter "Light as Electromagnetic Wave" pg. 485.

[LXXIV] "There are several evidences that light is of electromagnetic nature and all are based on the fact that electromagnetism causes some effect on light. E.g. magneto-optical Kerr's effect of the rotation of a plane of polarization due to the effect of an electromagnet; Zeeman's effect of the spectral lines splitting in multiple lines, Stark's effect of splitting the hydrogen spectral lines into strong electric field, etc."
More in [IX], chapter "Light as Electromagnetic Wave" pg. 481-485.

[LXXV] "A body moves in relation to another body if its position, measured in relation to another body, changes over time. On the other hand, if its relative position does not change over time, the body is relatively at rest. So, motion and rest are relative terms; it means that they depend on the conditions of the motion of a body in relation to other body that serves as a referent point. A house is stationary relative to the ground, but it moves in relation to the Sun; when a train is passing by the station, we say that the train is moving in relation to the station. But also, a passenger in the train could say that the station is moving in relation to the train, just in the opposite direction".
L.Tanović – N.Tanović "Physics – mechanics, oscillations, waves", chapter "Kinematics" pg. 13. Svjetlost, Sarajevo 1987.

[LXXVI] In "Origins of Natural Science" (Dornach, January 2, 1923, Lecture VII), R.Steiner pointed out the absurdity of the idea on relativity of thinking whether I'm running, or earth is moving under my feet,:
"If I myself am running, I certainly cannot claim that it is a matter of indifference whether I run or the ground beneath me moves in the opposite direction. But if I am watching another person moving over a given area, it makes no difference for merely external observation whether he is running or the ground beneath him is moving in the opposite direction."

[LXXVII] In the first scientific course, R. Steiner provides an interesting example of how the concept of mass can be correlated with a loss of consciousness:
"…We experience the mass through the pressure… You make acquaintance with pressure by pressing upon something with your finger. Now we must ask ourselves: Is there something going on in us when we exert pressure with our finger, - when we, therefore, ourselves experience a pressure - analogous to what goes on in us when we get the clear intelligible notion, say, of a moving body? There is indeed, and to realize what it is, try making the pressure ever more intense. Try it, - or rather, don't! Try to exert pressure on some part of your body and then go on making it ever more intense. What will happen? If you go on long enough you will lose consciousness."
[III] / 2. discourse.
" … There is indeed another occasion in our life, when - as I said once before during these lectures - we are somehow sucked-out as to our consciousness; namely when we fall asleep. Consciousness ceases. It is a very similar phenomenon, like a cessation of consciousness, when from the lighter colours we draw near the darker ones, the blue and violet. And if you will recall what I said a few days ago about the relation of our life of soul to mass, - how we are put to sleep by mass, how it sucks-out our consciousness, - you will feel something very like this in the absorption of our consciousness by darkness. So then you will discern the deep inner kinship between the condition space is in when filled with darkness and on the other hand the filling of space which we call matter, which is expressed in "mass".
[III] / 6. discourse.

[LXXVIII] Based on the lecture [III].

[LXXIX] Aristotle "On the Soul", II/7
"Now there clearly is something which is transparent, and by 'transparent' I mean what is visible, and yet not visible in itself, but rather owing its visibility to the colour of something else; of this character are air, water, and many solid bodies. Neither air nor water is transparent because it is air or water; they are transparent because each of them has contained in it a certain substance which is the same in both and is also found in the eternal body which constitutes the uppermost shell of the physical Cosmos. Of this substance light is the activity-the

activity of what is transparent so far forth as it has in it the determinate power of becoming transparent; where this power is present, there is also the potentiality of the contrary, viz. darkness. Light is as it were the proper colour of what is transparent, and exists whenever the potentially transparent is excited to actuality by the influence of fire or something resembling 'the uppermost body'; for fire too contains something which is one and the same with the substance in question."

[LXXX] Full details in [VI].
In his book, Steiner argues that the ancient Greeks used to perceive thoughts externally – much like we nowadays perceive e.g. colors in nature. Ability to create thoughts in his interior became the ability of a man of the modern epoch.

[LXXXI] "The speed of light in all inertial systems is a constant".
L.Tanović – N.Tanović "Physics – mechanics, oscillations, waves", chapter "The Speed of Light and Law of Velocity" pg. 176. Svjetlost, Sarajevo 1987.

[LXXXII] "The laws of thermal radiation were experimentally determined by examining the black body radiation".
More in [IX], chapter "Thermal Radiation" pg. 489.

Practically, it is the Stefan-Boltzmann law of radiation and Wien's displacement law that connect temperature with wavelengths. Here, we are dealing with mixed conceptions of heat and light. A/N

[LXXXIII] "Davy and Rumford pointed out that by friction, i.e. using motion, heat can be created, namely that heat is only a form of motion".
Sentences rewritten from L.Tanović – N.Tanović "Physics - the Basics of Thermodynamics and the Molecular-Kinetic Theory of Gases", chapter "The Temperature and Heat" pg. 12. Svjetlost, Sarajevo 1989.

[LXXXIV] "Mayer was the first person who stated the law of the conservation of energy, one of the most fundamental tenets of modern day physics. The law of the conservation of energy states that the total mechanical energy of a system remains constant in any isolated system of objects that interact with each other only by way of forces that are conservative".
Taken from http://en.wikipedia.org/wiki/Julius_Robert_von_Mayer

[LXXXV] "So light and thermal radiation are essentially indistinguishable. However, for us, there is a difference only because the electromagnetic waves in the range of the visible part of the spectrum, affect our senses creating a sense of sight; while in the range of the infrared part of the spectrum, they cause the feeling of heat". Sentences rewritten from [IX], chapter "Dependence of the Quality of Thermal Radiation from the Body Temperature" pg. 490.

[LXXXVI] More on categorization of natural phenomena in [I] and [II].

[LXXXVII] Sentence rewritten from [IX], chapter "Light Sources" pg. 1.

[LXXXVIII] E.g. indices of refraction in water for the Fraunhofer lines are:

Line	A	B	C	D	E	F	G	H
Value	1.3289	1.3304	1.3312	1.3330	1.3352	1.3371	1.3406	1.3435

For other materials, we have other values. Taken from [IX], chapter "Fraunhofer Lines" pg. 294.

[LXXXIX] To this compare f.e. Johann Ferdinand Jencken, "Treatises On Light, Colour, Electricity, And Magnetism" London: Trubner & Co., 66 Paternoster Row. 1869. Pg 53.
"I will name another test given by Antonius Lucius. He placed two differently coloured silk threads under the microscope. According to the theory of Newton, they ought not to appear both at the same time clearly visible, but the one first, the other subsequently, obeying the law of different refrangibility of colours; but both are seen simultaneously. He then justly infers that Newton's theory is wrong - that colours are not differently infrangible, as supposed by Newton."

[XC] "An absolute black body can be presented as a hollow object with a small opening and inner walls that do not bounce off light. E.g. an absolute black body can be modeled as a hollow sphere with a small opening, coated inside with dark material that does not reflect light, for example, with soot". Sentence rewritten from [X], chapter "Radiation of Absolute Black Body.Stefan-Boltzmann low" pg. 361.

[XCI] "A black hole, according to the general theory of relativity, is a region of space from which nothing, including light, can escape. It is the result of the deformation of space-time caused by a very compact mass. Around a black hole there is an undetectable surface which marks the point of no return, called an event horizon. It is called "black" because it absorbs all the light that hits it, reflecting nothing, just like a perfect black body in thermodynamics."
More on e.g. http://en.wikipedia.org/wiki/Black_hole

[XCII] "Empedocles' idea, that we see objects because light streams out of our eyes and touches them, became the fundamental basis on which mathematicians would construct some of the most important theories on light and vision. Euclid's Optics expanded this idea to make an important breakthrough: We know in our minds that a faraway building is bigger, yet it is possible to position a finger such that our eye tells us they are of similar size. Euclid's elegant solution was that the eye and both the tops of finger and building must lie on the same line - thus the rays from the eye must follow straight lines; the new discipline of geometry could thus make predictions and solve problems of light and optics."
Taken from http://en.wikipedia.org/wiki/Let_There_be_Light

[XCIII] "From the rough surface, reflected light rays bounce off in all directions, so the diffusion of light we call the improper reflection of light".
Taken from [IX], chapter "The Law of Reflection of Light", The Diffusion of Light." pg. 35.

[XCIV] "Bending or the diffraction of light, refers to deviations from the rectilinear propagation of light, which occurs when the light passes through very narrow openings, with dimensions not very different from the wavelengths of light". [IX], chapter "The Appearance and the Type of Diffraction of Light" *pg. 380.*

[XCV] "Rectilinear propagation of light is the consequence of the light interference.
When the light is propagating in free space, the Fresnel zones are free and symmetrically distributed in relation to the observer's eye, so the light propagates rectilinearly. This is also valid when the obstacles, which the light waves encounter, are large compared to the wavelength of light.
However, if in some way, the free and regular arrangements of Fresnel's zones are disturbed, a deviation from rectilinear propagation of light occurs, resulting in the diffraction or bending of light. Disturbance may occur when light encounters an obstacle of very small size, so that the size of the obstacle is comparable to the size of the wavelength of light".
Rewritten from [IX], chapter "An Explanation of Diffraction of Light.Fresnel Zone" *pg. 388.*

[XCVI] "All points of medium hit by the wave, become sources of new elementary waves, which propagate on all the sides. Because of interference, the resulting wave becomes identical to the main wave propagating from the original source". Sentence rewritten from [X], chapter "Huygens' Principle" *pg. 56,57.*

The wave theory provides the two explanations of interference behind the opening.
The explanation for the small opening: "When a wave that starts from source S, in the form of concentric circles, hits a hole H, whose width is d; according to the Huygens' Principle, each point of the opening becomes a source of new waves. Since the size of the opening d is less than the wavelength of the original wave, i.e. d <λ; all the phases of waves, coming from different points, will differ very little, and because of interference, behind an obstacle the wave amplification will occur. In this way, from the opening O as a source, new wave will propagate in a form of the deformed circle, while at larger distances from the opening, it will have the form of a circle."
The explanation for the large openings: "Since the size of the opening is larger than the wavelength of the original wave, the phase difference of elementary waves will be large when they reach out beyond a barrier, and therefore, the elementary waves behind the obstacle will be diminished or canceled out".
Taken from [X], chapter "Bending of the Waves" *pg. 64, 65.*

[XCVII] Taken from [IX], chapter "Fresnel's and other Experiments of Light Interference" pg. 321-327.

[XCVIII] "It should be kept in mind that the atoms of light sources are actually oscillators, and that they emit the light rays of different frequency and phase".
Sentences rewritten from [IX], chapter "General about the Interference of Light. The Optical Path Length" pg. 313.

[XCIX] "Based on the above, we see that continuous interference can be obtained only with the help of the coherent light. A coherent light wave is emitted only by the set of atoms of the same light source".
Sentences rewritten from [IX], chapter "General about the Interference of Light. The Optical Path Length" pg. 315.

[C] Aristotle, "Meteorology" Book III, 1
"… also that in some mirrors the forms of things are reflected, in others only their colours. Of the latter kind are those mirrors which are so small as to be indivisible for sense. It is impossible that the figure of a thing should be reflected in them, for if it is the mirror will be sensibly divisible since divisibility is involved in the notion of figure. But since something must be reflected in them and figure cannot be, it remains that colour alone should be reflected."

[CI] In optics, there are two theories of diffraction:

a) Fresnel diffraction – includes cases in which the light source or a screen is located in the finite distance from the object where the diffraction of light takes place.
b) Fraunhofer diffraction – includes cases in which the light source or screen is located at an infinite distance from the object where the diffraction of light takes place.

More on [IX], chapter "Explanation of Diffraction of Light" pg. 381-403.

[CII] Taken from [IX], chapter "Polarization of Light" pg. 421-432.

[CIII] "Experiments showed that the polarization of light does not occur in the case of the reflection of light from metal surfaces". Sentence rewritten from [IX], chapter "Polarization of Light" pg. 424.

[CIV] Taken from [IX], chapter "Refraction of Light" pg. 94.

[CV] Sentence rewritten from [IX], chapter "Polarization of Light" pg. 431.

[CVI] In his book, Goethe mentions this idea e.g. [VII]
"229.
Thus we here call in mind that in certain cases refraction unquestionably produces double images, as in the case of Iceland spar: similar double images are also apparent in cases of refraction through large rock crystals …"

[CVII] A delusion that the universe came into existence by an explosion and that it is expanding is based on the faith in existence of the Doppler Effect in optics.
"The Big Bang theory developed from observations of the structure of the Universe and from theoretical considerations. In 1912 Vesto Slipher measured the first Doppler shift of a "spiral nebula" (spiral nebula is the obsolete term for spiral galaxies), and soon discovered that almost all such nebulae were receding from Earth. He did not grasp the cosmological implications of this fact, and indeed at the time it was highly controversial whether or not these nebulae were "island universes" outside our Milky Way. Ten years later, Alexander Friedmann, a Russian cosmologist and mathematician, derived the Friedmann equations from Albert Einstein's equations of general relativity, showing that the Universe might be expanding in contrast to the static Universe model advocated by Einstein at that time. In 1924, Edwin Hubble's measurement of the great distance to the nearest spiral nebulae showed that these systems were indeed other galaxies. Independently deriving Friedmann's equations in 1927, Georges Lemaître, a Belgian physicist and Roman Catholic priest, proposed that the inferred recession of the nebulae was due to the expansion of the Universe"
More on fe. http://en.wikipedia.org/wiki/Big_Bang

[CVIII] Formulation that "Moon reflects the light, because Sun's rays hit the surface of the Moon", was allegedly formulated by Alhazen.
"He disproved the universally held opinion that the Moon reflects sunlight like a mirror and correctly concluded that it 'emits light from those portions of its surface which the sun's light strikes' ".
Quote from http://en.wikipedia.org/wiki/Alhazen

[CIX] [IX], chapter "Photometry" pg. 24-26.

[CX] "The observer may then see **multiple distorted images** of the same source; the number and shape of these depending upon the relative positions of the source, lens, and observer, and the shape of the gravitational well of the lensing object".
More on http://en.wikipedia.org/wiki/Gravitational_lens

[CXI] Taken from [IX], chapter "The Light Pressure" pg. 521.

[CXII] More on http://en.wikipedia.org/wiki/Crookes_radiometer and
http://demonstrations.wolfram.com/CrookesRadiometerAComedyOfErrors
"Invented by Sir William Crookes in 1873, this device is also known as a light mill. It is still a popular novelty item. A sealed glass bulb, evacuated to about 1 Pa (~ torr), encloses a set of (usually four) vanes, black on one side, white or silver on the other, that can rotate on a low-friction spindle. When exposed to light or heat, the dark sides rotate away from the source. Conversely, if a block of ice is placed nearby, the vanes rotate in the opposite direction. The mechanism of this phenomenon was a source of scientific controversy for over half a century."

[CXIII] "In theoretical physics, negative mass is a hypothetical concept of matter whose mass is of opposite sign to the mass of the normal matter. Such matter would violate one or more energy conditions and show some strange properties such as being repelled rather than attracted by gravity. It is used in certain speculative theories, such as on the construction of wormholes. The closest known real representative of such exotic matter is a region of pseudo-negative pressure density produced by the Casimir effect".
More on http://en.wikipedia.org/wiki/Negative_mass

[CXIV] "In the transition of the wave from one to another medium, the relationship between the sinus of incident angle and sinus of refracted angle is constant and equal to the relative velocity of wave propagation in two mediums. $c_1/c_2=\sin\alpha/\sin\beta = n$ ".
Sentence rewritten from [X], chapter "Reflection and Refraction of Waves" pg. 63.

[CXV] "With these experiments Foucault found out that the speed of light is 225,000 km s^{-1}in water, 200.000 km s^{-1}in glass, and 300,000 km s^{-1}in gases".
From [IX], chapter "Physical Methods of Measuring of the Speed of Light" pg. 17.

However, reality is the index of refraction of the visual field, and the faith of the different speed of light in different materials was created through the formula $c=c_0/n$. A/N.

[CXVI] "From the equation $\lambda = \lambda_0/n$ we can conclude that the wavelength of light in some medium of a refractive index n, is n-times smaller than the same wavelength of light in a vacuum".
Sentence rewritten from [IX], chapter "General about the Interference of Light" pg. 317.

[CXVII] J. B. Stallo "The Concepts And Theories Of Modern Physics", pg. 95
NEW YORK: D. APPLETON AND COMPANY, 1, 3, AXD 5 BOND STEEET.1888.
Practically, this is the same objection used by Lucius Antonius, claiming that Newton's theory is incorrect. Compare endnote LXXXIX - A/N.

[CXVIII] Sketches taken from [IX], chapter "Speed of Light" pg. 8.

[CXIX] The apparent size of Jupiter changes in the range of -1.6 to -2.94. Practically, almost the double difference.
http://en.wikipedia.org/wiki/Jupiter

[CXX] "Five days after the discovery of Jupiter's moons, Galileo had observed their eclipses and came to the idea that, due to parallax, the phenomenon could be used for measuring of geographic longitude. The same thought came up to N.C. F. de Peiresc and in 1612 the difference of geographical length was calculated" (NenadDj. Janković, "Discovering the Universe," pg. 557)
Only some sixty years after, the parallax of Jupiter's moons is brought in connection with the idea of the finite speed of light (according to some sources, the idea is not encouraged by Römer, but by Huygens). It is interesting that Cassini opposed Römer's idea arguing that "other three Galilean moons did not seem to show the same effect as seen for Io, and that there were other irregularities which could not have been explained by Rømer's theory".
http://en.wikipedia.org/wiki/R%C3%B8mer's_determination_of_the_speed_of_light

Anyway, in more than 300 years from publishing, I do not know that anyone has attempted to verify the claims by measuring the parallax of any other celestial body, but the idea of the finite speed of light is accepted as true, by the authority of Huygens and Newton, who were their proponents.

[CXXI] [IX], chapter "Duration of Light Impression on the Retina. Stroboscopic effect." pg. 227.

[CXXII] "William Huggins studied spectral lines of hydrogen of the star Sirius and concluded that the Sirius moves away from Earth". "Around 1920 the astronomer Vesto Slipher concluded that the spiral nebulae moves away from Earth". "In 1935 Edwin Hubble established the rule of the nebulae distancing. Based on Hubble's rule and Einstein's understanding of the universe, one came to the conclusion that the universe is expanding".
[IX], chapter "Doppler-Fiseau effect in Optics" pg. 479-480.

[CXXIII] [IX], chapter "Physical Methods of Measuring of the Speed of Light" pg. 12-18.

[CXXIV] "The first experiment for measuring the speed of light in the moving system of reference, was conducted by Michelson in 1881. Similar experiments have been conducted by other scientists for years, but the result was always surprising i.e. it always turned out that the speed of light in all inertial reference systems is the same…

Einstein showed that in the introduction of Galileo's transformation, two propositions were introduced that seemed so obvious, that nobody thought they need to be explained:

a) it was assumed that the simultaneity of two events are the absolute term
b) it was assumed that e.g. the length of a wire is the same in all systems of reference"

L.Tanović – N.Tanović "Physics - Mechanics, Oscillations, Waves", chapter "The Speed of Light and Law of Velocity Addition" pg. 176. Svjetlost, Sarajevo 1987.

[CXXV] More about speculations on speed of gravity on http://en.wikipedia.org/wiki/Speed_of_gravity
"In the context of classical theories of gravitation, the speed of gravity is the speed at which changes in a gravitational field propagate. This is the speed at which a change in the distribution of energy and momentum of matter results in subsequent alteration, at a distance, of the gravitational field which it produces. In a more physically correct sense, the "speed of gravity" refers to the speed of a gravitational wave."

[CXXVI] "According to this theory, it is assumed that a retina has three types of suppositories, or cell elements, which are sensitive to colors. Some are sensitive only to red, some to green, and others to blue. Each light, either homogeneous or heterogeneous, simultaneously stimulates all three types of the irritant suppository, but to different degrees. A result of superimposing of these three impulses is the perception of a certain color... When the suppositories are not irritated, a sense of black is created."
[IX], chapter "An Explanation of Sense of Colors by the Theory of Three Colors" pg. 285. also http://en.wikipedia.org/wiki/Trichromacy

[CXXVII] "According to Plato, the light provided by the Sun is necessary for us to see the material objects so 'the God-like light' and 'an intellectual light' is necessary to see the 'forms'. ".
Taken from http://www.mlahanas.de/Greeks/IntellectualLight.htm.

For ancient Greeks, color was a quality of substances or the surfaces of things, or of surface appearance altered by transparent media such as smoke, haze or water. Many Greek texts assert that sight was a kind of touch, produced by rays emanating from the eye, and (like touch) responding to the qualities of physical bodies. The ancients seem to have made no distinction between sight and light, so that distance, darkness or disease produced an equivalent "weakening" of colors.

[CXXVIII] W. Heisenberg "Tradition in science", from "Science and Public Affairs", December 1973, pg. 7
"There has been one attempt to work on an entirely different line, which I should mention. The German poet, Goethe, tried to return to a descriptive science, a science which is interested only in the visible natural phenomena, not in experiments which produce artificial new effects. He objected to the separation of the phenomena into their objective and their subjective side, and he was filled with fear of the destruction of Nature by an overflowing of technical science. In our time, when we know of the contamination of air and water, the poisoning of the soil by chemical fertilizers and atomic weapons, we understand Goethe's fear better than his contemporaries could. But Goethe's attempt did not really influence the course of science. The success of the traditional method was too overwhelming"