Marek, Jiři

Joannes Marcus Marci de Cronland a Scientist of the 17th Century

Organon 8, 181-198

1971

Jiři Marek (Czechoslovakia)

JOANNES MARCUS MARCI DE CRONLAND A SCIENTIST OF THE 17th CENTURY

In 1967 the 300th aniversary of the death of the important scientist Ioannes Marcus Marci de Cronland (1595–1667) was celebrated. Since Marci lived in Bohemia, an International Symposium on the Revolution in 17th Century Mathematics and Physics was organized at Prague. Historians of science of all the world discussed the achievements of mathematics and physics during the 17th century.

The discussions pointed out the difficulties of an appraisal of the scientific evolution in this period. The cumulation of discoveries in mechanics, optics, astronomy and mathematics grew to an extent unknown to previous centuries so that the development in this century was declared a revolution in science. But this term was not accepted without objections. There were different opinions about the significance of what was accomplished in science during the 17th century. The diversity of opinions presented at the Symposium seems to indicate that we are far from universally agreeing to one definition of the course of the development of science in the 17th century and as to what was actually done in this period.

Professor Vasco Ronchi, who was chairman of the last session of the Symposium characterised our current knowledge of science in the 17th century by pointing out that we are not sufficiently acquainted with the documents of this period. As an example he selected precisely the work of Ioannes Marcus Marci de Cronland. As we shall see below, his work is interesting with respect to the development of mechanics and optics in this period and could influence the evolution of world science. [1] But it is only recently that it attracts some greater attention from historians of science.

This opinion can be illustrated especially by the development of the knowledge of sources to the history of optics in Bohemia.

[1] J. Marek, V. Ronchi, *Atti della Fondazione Giorgio Ronchi*, 22 (1967), p. 494.

Balthasar Conrad (1599–1660) professor of mathematics at the Jesuit College of Prague, [2] was also interested in optics, but at present we do not know any book of his own in this field of science.

We know that Conrad was preparing a large book about the telescope, but he wrote only a few chapters, which have been lost after his death in Wrocław in Silesia. Some time before his death, Conrad sent an open letter to all European mathematicians with five propositions about the improvement of the telescope. In this letter Conrad invited the addressees to cooperate in the improvement of the telescope. This letter can be read, for example, in Huygen's correspondence. [3] At that time, Huygens was working with the telescope and discovered new phenomena on the celestial bodies. Since Huygens was obviously interested in the improvement of the telescope, he welcomed Conrad's letter with enthusiasm and replied to it with a long letter of his own. [4]

Besides being interested in the improvement of the telescope, Conrad studied also the problem of the spectral colours. In 1646 the book *De natura iridos* was published in Prague [10]. It was a thesis that M. B. Haněl (1627–89) defended when he was working with Professor Conrad. In this thesis the authors discuss the properties of the rainbow, of the spectral colours and of the corona.

This thesis reports an important observation. There are eleven Problems appended to the text of this book. In the eleventh Problem Conrad describes his observations made on a *camera obscura*. These observations are a continuation of those of Ch. Scheiner (1573–1650), who had measured the apparent diameter of the celestial bodies by means of the *camera obscura*. [5] Conrad constructed a more perfect *camera obscura* than that of Scheiner, and with it he was able to observe a multiple rainbow around the apperture during the observation in the *camera obscura*. This observation may be interpreted as one of the interference of light of higher orders. [6]

This thesis was considered to have been lost. But recently one copy of it was found in the National Library in Prague. It is the only copy known thus far. [7]

We have not copies of other theses defended under the supervision of Conrad. But we know that there were other students who defended their theses under Conrad's supervision. We know it from the disputations of Marci against Conrad.

We know Marci's book *De angulo, quo iris continetur* [8]. It is a cri-

[2] C. Sommervogel, *Bibliothèque de la Compagnie de Jésus*, vol. 2, 1891.
[3] Ch. Huygens, *Oeuvres complètes... publiées par la Société hollandaise des Sciences*, vol. 2, p. 193.
[4] *Ibid., p. 356.*
[5] Ch. Scheiner, *Rosa Ursina sive Sol...*, Bracciano, 1626–30.
[6] J. Marek, *Nature* (London), 201 (1964), p. 110.
[7] National Library in Prague, sign. Rg 108(49G8).

tique of Conrad's book of the same title. But we do not know the text of this book; we only know that it was again a thesis, but the candidate's name for the degree of doctor is not known either.

Recently, still another book of Marci was discovered in Prague, called *Appendix* [19]. From the foreword to this book it appears that Conrad had accepted neither Marci's ideas about the properties of the rainbow nor his previous criticism of his work. From what Marci says it follows that Conrad had in the meantime presented several theorems concerning the qualities of the rainbow to same foreign Academies. At present no copy of these theorems is available.

It seems that optics was cultivated in Prague also in the second half of the 17th century. At present we have but a very superficial knowledge of the development of optics in this period. Professor Pagel is working on the life of Joh. Fer. Franc. L. B. de Pisnitz. This member of a noble family in Bohemia defended his thesis entitled *Catoptica illustrata ... de speculorum essentia et proprietatibus* in Prague in 1668. [8] Of this not a single copy is available in Prague and thus we do not know if there was anything important for the development of optics in it. But the existence of this thesis shows that optics was cultivated in Bohemia to some so far unknown extent also in the second half of the 17th century.

Although much attention has been paid to the development of science in the 17th century in the literature until now, further searches after documents on the history of science and a critical study of them are still necessary. These efforts will be successful, as we hope. On the example of the work of Marci we see that we must study the mutual influence of scientists and their ideas in more detaily.

But we have not only to study the works of the important scientists; we must also consider the background on which they had grown as well as their different kinships as far as it is possible. There may exist scientific papers or books which were forgotten in the course of time (as, e. a. g., the work of Theodoricus of Freiberg on the rainbow [9]). This may be sometimes unfortunate as they may have contained important descriptions of observations and thus could have constituted a source and stimulus to other synthetic works that are known nowadays.

One of the scientists whose work is hardly known at present is Ioannes Marcus Marci de Crondland. His fate is an example of the lot of a scientist who once had stood on the peak of world science, one whose work had been known abroad during his life but which sank into oblivion with the lapse of time.

---

[8] Private communication.

[9] J. Würschmidt, *Beiträge zur Geschichte der Philosophie des Mittelalters*, Band 12, Heff 5–6, Münster, 1914; A. C. Crombie, *Robert Grosseteste and the Origins of Experimental Science, A. D. 1100–1700*, Oxford, 1953.

We hope that this aniversary of Marci's death will mark the revival of interest of the historians of science in his work. [10] We are sure that the reedition of his books *De proportione motus* and *Thaumantias* [11] will contribute to this purpose. In the future the reedition of Marci's other books could be desirable in order to facilitate the study of his work. We think it is worth considering and we may expect that a study of it will bring new information on his activities.

MECHANICS AND OPTICS IN THE 17TH CENTURY

We know that Galilei was much interested in mechanics. In 1638 he published his fundamental work in this field, the *Discorsi,* which contained his ideas on kinetics. [12] Galilei dealt with the impact of bodies which Marci was also studying that time. Later on this problem was more extensively studied by R. Descartes, J. Wallis, Ch. Wren and Ch. Huygens. [13]

The development of geometrical optics was hardly caused by the invention of the telescope and by its use for the astronomical observations by Galilei. [14] After Kepler had got familiar with Galilei's book *Sidereus Nuntius* 1610 he published the theory on projection by means of lenses and their systems in his book *Dioptrice.* [15] Seven years before Kepler wrote another book on optics, especially on optics applied in astronomy, the *Paralipomena* ..., where he published his new theory on vision. [16]

The optical study was continued by Ch. Scheiner, who discovered the existence of sunspots independently of Galilei. Like Kepler, Scheiner applied for his astronomical observations both the telescope and the *camera obscura.* For his purpose he also constructed different instruments. He described his work in the voluminous book *Rosa Ursina sive Sol* ... (cf. note 5).

In the first half of the 17th century, the problem of the origin of the rainbow was studied by M. A. de Dominis, Descartes and B. Conrad.

We know from the foreword to the book *De radiis visus et lucis* ... by de Dominis that he had studied the qualities of the rainbow long before the publication of his book. It seems that he decided to write the book from his own records after Galilei's book had appeard. De Dominis stud-

---

[10] J. Marek, V. Ronchi, *loc. cit.*; J. Smolka, *Acta historiae rerum nat. necnon tech.*, 3(1967), p. 5; Z. Servit, *ibid.*, p. 27 (also: *Vesmir*, 46 (1967), p. 274, in Czech).

[11] In *Acta historiae rerum nat. necnon tech.*, 3(1967), p. 131, and in the collection *Cimelia Bohemica,* respectively.

[12] G. Galilei, *Discorsi dimonstrazioni matematiche...*, Leyden, 1638.

[13] E. Mach, *Die Mechanik in ihrer Entwicklung historisch dargestellt,* Leipzig, 1883.

[14] V. Ronchi, *L'optique, science de la vision,* Paris 1966.

[15] J. Kepler, *Dioptrice,* Augsburg, 1611.

[16] J. Kepler, *Ad Vitellionem paralipomena, quibus astronomiae pars optica traditur,* Frankfurt, 1604.

ied the conditions of the origin of the rainbow on the isolated water-drop.[17] Descartes described correctly the passage of the sunrays through raindrops in the origin of the rainbow in his important *Discours de la méthode*. It is interesting that this problem had also been dealt with by Arab scientists and by Theodoricus of Freiberg in the Middle Ages.[18]

Balthasar Conrad was also interested in the study of the rainbow, and his students defended their theses on this subject. But at present we know only one thesis, that of M. B. Haněl mentioned above. It is important from this point of view, that it involved the description of the interference of light of higher orders. This is the first description of this kind.[19]

In the second half of the 17th century the study of mechanics and optics continued. In mechanics we know the famous work of Newton, who published the fundamental laws of kinematics and dynamics in his *Principia*.[20] Also the important work of Ch. Huygens with a new construction of clocks is known.[21] As mentioned above, Huygens studied the impact of bodies, as did Wallis and Wren. In optics Huygens published the important *Traité de la lumière*, where he explained the propagation of light and described the passage of light through a crystal of Iceland limestone.[22] Huygens is considered to be the founder of the wave theory of light.

But long before Huygens Grimaldi had written about the ideas of the wave theory of light in his work *De lumine, coloribus et iride* published posthumously, where he also described the discovery of diffraction as a new type of propagation of light.[23]

In Bohemia, the birthplace of Marci, other scientists must also have worked in optics to a certain extent in the second half of the 17th century. But at present we do not know much about it. The thesis of J. F. F. de Pisnitz has been mentioned. It was defended by another professor, as at that time, i.e. in 1668, Marci was dead. Besides, Marci was suffering from an eye disease before his death and we do not know for how long. Nor do we know if it is probable that Pisnitz worked with Marci on his thesis, i.e. if Marci could have been Pisnitz's teacher.

This is a brief survey of the work of the more important scientists who studied mechanics and optics in the 17th century, and have a direct or indirect connection with Marci's work.

---

[17] M. A. de Dominis, *De radiis visus et lucis in vitris perspectivis et iride*, Venice, 1611; V. Ronchi, *Bollettino dell'Associazione Ottica Italiana*, 17, No. 4 (1943).

[18] J. Würschmidt, *op. cit.*

[19] J. Marek, *loc. cit.*

[20] I. Newton, *Philosophiae naturalis principia mathematica*, 1687.

[21] Ch. Huygens, *Horologium oscillatorium*, Paris, 1674.

[22] Ch. Huygens, *Traité de la lumière*, Leyde, 1690.

[23] F. M. Grimaldi, *Physico-mathesis de lumine, coloribus et iride*, Bononiae, 1665.

Out of the more ancient scientists, known in the history of optics, Marci quoted in his books Aristotle, Vitello, Maurolyco, J. Scaliger. It is interesting that in 1648, the year of publication of Marci's fundamental book on optics *Thaumantias,* Marci did not know the work of Descartes, and quoted him only in the *Appendix,* which was published later [19].

MARCI'S LIFE

A considerable part of Marci's life coincided with of the Thirty-Years--War. This war affected the cultural, political and social situation of Bohemia. As a result of the battle Bila Hora (1620), Bohemia became a part of the Habsburg Empire, and Prague lost its position of the Emperor's residence. The recatholicization afflicted also the University of Prague. After long negotiations between the political and cultural officials, the University was united with the Jesuit College into the Charles-Ferdinand University. And Marci's life was fully tied up to the life of the University of Prague during this difficult period.

We know little about Marci's work and life. Marci was born at Lanškroun, a small town in north-eastern Bohemia, on the 13th of June 1595, to a family of a nobleman's higher official. He studied at the Jesuit College at Jindřichův Hradec in southern Bohemia and then he continued his study of philosophy and theology at the famous university of Olomouc in Moravia. He wished to become a priest, but because of his health he did not join the Society of Jesus. In 1618 he came to Prague and continued his studies at the Faculty of medicine. In 1625 Marci defended his Thesis there and the degree of Doctor of Medicine was conferred upon him. In the following year he became associate professor at the Faculty of medicine and Physician of the Kingdom of Bohemia. In 1630 he was appointed Professor, and he lectured at the University of Prague the rest of his life. Thus he was both a teacher and a scientist in mathematics, astronomy, physics, medicine, philosophy. Owing to his important activity he was granted different honours on different occasions. He had academic functions: he was Dean of the Faculty of Medicine several times, and in 1662 he became Rector of the University. When a part of Prague was occupied by the Swedish army in 1648, Marci took part in the defense of the unoccupied part of the City. He organised a student unit and commanded it; owing to these and other merits he was raised to knightship with the title "de Cronland". At the end of his life, Marci was suffering from an eye disease. Shortly before his death in Prague in 1667 he joined the Society of Jesus. [24]

---

[24] For Marci's life story cf. note 1 and the items cited in note 10.

MARCI'S WORK IN MEDICINE, ASTRONOMY, MATHEMATICS

Marci's medical studies are now in the centre of interest. Z. Servit is studying Marci's ideas on epilepsy and points out the progressive character of his ideas: he shows Marci's interest in the relation to mechanics and medicine in the book *De proportione motus,* where he deals with the effect of mechanical trauma upon the living organisms and explains the mechanism by which the fracture of the skull blocks reactin in the opposite side of the impact. The same author speaks also about a probable relation between John Locke's (1632–1704) opinions concerning brain mechanisms and Marci's ideas. [25] Also W. Pagel has been much interested in Marci's work in medicine. [26] Now he edited a voluminous book about the biological ideas of the English physician W. Harvey (1578-1657), where he deals with the relation between the ideas of Harvey and Marci. [27]

It has been supposed that Harvey and Marci met personally in Prague in 1636. [28] Harvey was then member of a mission sent by Charles I to negotiate with the Emperor Ferdinand III. The mission was headed by Thomas Howard, Earl of Arundel and besides Harvey, the important Bohemian graphist V. Holar was member of the mission too.

Having travelled through Germany and after the meetings with the Emperor at Linz the mission arrived at Prague on July 6th 1636. It was a good will mission and a negotiating body, and was entertained by meetings with notable men as well as by visits to the best known colections, buildings and institutions.

W. Pagel has shown that Harvey met really Marci personally in Prague: "Harvey stayed at Prague for at least a week. ... The proof that the meeting between Harvey and Marcus Marci really took place is provided by Marci himself and embedded in a critical discussion of Harvey's *De Generatione Animalium* (1651). This is found in Marci's work, *Philosophia Vetus Restituta* (1662) [12]. Here Marci expresses regret and disappointment at the omission on Harvey's part of any reference to his, Marci's books of 1635 on generation. As Marci says, Harvey could not have remained ignorant about it. 'For I gave the book into his hands, here at Prague talking to him familiarly'. [29]

It is well known that Harvey was the discoverer of the circulation of blood, which has been described in his book *De motu cordis et sanguinis in animalibus anatomica exercitatio* of 1628; and Marci was one of the few supporters of Harvey's discovery in this time. It is interesting that Jacobus Forberger, a pupil of Marci, defended a thesis entitled *De pulsu*

---

[25] Z. Servit, *loc. cit.*
[26] W. Pagel, P. Rattansi, *Medical History,* 8 (1964), p. 78.
[27] W. Pagel, *William Harvey's a Biological Ideas,* Basle, 1967.
[28] V. Kruta, *Physiologia Bohemoslovenica,* 6 (1957), p. 433.
[29] W. Pagel, *op. cit.*, p. 287.

et eius usu in Prague in 1642. [30] The thesis was defended under the chairmanship of Marci. It contained a good précis of Harvey's book, although Harvey's name was not quoted even once. [31] In many pages W. Pagel has shown the contacts and parallels between Harvey's views on generation in *De generatione animalium* of 1651 and Marci's theory of embryology in *Idearum operatricium idea* of 1635 [2].

As to Marci's interest in astronomy we have one book, *De longitudine* [9]. Here Marci published two methods for determination of longitude based on observation of the motion of the Moon. Such effort to determine exactly the position on the Globe was important for sailing in that time, before the construction of the chronometer. This book has been dedicated to the king of Spain.

One book of Marci deals with mathematics. It is the *Labyrinthus* of 1654 [11]. There were many scientists at that time, also from the environment of Marci, who focused their attention on the problem of quadrature. [32] Marci has presented twenty different attempts of the solution of the quadrature by means of a deep knowledge of geometry. [33]

MARCI'S WORK IN OPTICS

Marci's results in optics are presented in a number of his observations of the fundamental phenomena of physical optics.

Marci studied the origin of spectral colours in different conditions. On the one hand, he experimented with the passage of light through a prism. He knew that each colour of the spectrum originated by an angle of refraction of a definite magnitude, and that the angle of this magnitude could produce the same colour only. [34]

Marci performed an important experiment with monochromatic rays, the *experimentum crucis* of I. Newton: Marci isolated monochromatic rays after the passage of light through a prism, and then he transmitted these isolated rays through a second prism. He found that the colour of the transmitted rays did not change. [35]

These were his most important experiments with the passage of light through a prism. On the other hand, Marci knew all cases of appearing

[30] V. Kruta, *loc. cit.*

[31] W. Pagel, *op. cit.*, p. 287.

[32] J. Smolka, *loc. cit.*

[33] J. Smolík, *Živa*, 7(1871), p. 1 (in Czech).

[34] „Neque idem color a diversa refractione, neque ab eadem plures colores esse possunt." — *Thaumantias*, Theorema XVIII. „Refractio enim lucem condensando in colores mutat; ab eadem ergo refracione eadem condensatio, ac proinde idem color." — *Thaumantias*, Theorema XXI. „Refractio superveniens radio colorato non mutat speciem coloris." — *Thaumantias*, p. 100.

[35] J. Marek, *Sborník pro dějiny přír. věd a tech.*, 8(1963), p. 5 (summary in German); E. Hoppe, *Archiv für Geschichte der Mathematik, der Naturwiss. und der Technik*, 10(1928), p. 282; J. Marek, *Nature*, 190(1961), p. 1092.

of spectral colours in all the conditions presented in our handbooks of physical optics nowadays: he knew the origin of spectral colours by diffraction of light on a wire, on an edge and on an aperture. And he also experimented with a system of apertures which he called a lattice (*reticulum*) [1].

In Marci we find the first known description of the observation of the colour of thin plates, which we may read in scientific literature nowadays. Marci observed this phenomenon on soap bubbles. [36]

Marci's principal interest was the explanation of the origin of the rainbow, as he expressed it in the title of his fundamental book, *Thaumantias, liber de arcu coelesti ...* [7]. He described correctly the passage of sunrays through the raindrops at the origin as the principal rainbow as the second one.

Thaumantias is not his only book on optics. He published also *De natura iridis* [10], *De angulo, quo iris continetur* [8]. But there were discussions with his colleague in Prague, B. Conrad. Recently, another book by Marci was found, the *Appendix* [19]. It is also a discussion with the ideas of a thesis defended by a pupil of Conrad, whose name is unknown at present.

We may speak about a tradition in optical studies in Prague. Kepler was writing his book *Paralipomena ad Vitellionem* during his stay in Prague at the court of Emperor Rudolphus II. The object of this book was to give a survey of physiological and geometrical optics, written for astronomical applications.

But Marci's interest was different from that of Kepler: Marci was interested in the problem of spectral colours. In the preceding centrury, the *camera obscura* had become one of the important instruments used in astronomical observations. Moreover it was an arrangement useful for the observation of diffraction of light. [37] The first observations of diffraction were made using the *camera obscura* in the observations of celestial bodies and measurements of their apparent diameters. [38]

But Marci did not mention the possibility of observation of spectral colours in the *camera obscura*. He wrote about the origin of spectral colours in a passage of light directly through the aperture.

Marci used this observation for an other experiment. At that time scientists commonly thought that the colours originated from the mixture of white and black colours (or light and darkness). Marci disagreed with this opinion and tried to contradict it with the following experiment: he cut apertures in paper of different colours and let white light pass through the apertures. He observed that the spectral colours originated

[36] J. Marek, *Arch. Int. d'Histoire des Sciences*, 13(1960), p. 79.
[37] J. Kepler, *Gesammelte Werke*, vol. 2, (ed. F. Hammer), München, 1939, p. 300.
[38] J. Marek, *Sbornik*, 8, p. 5; E. Hoppe, *loc. cit.*

on the apertures in the papers of different colours were the same in all cases. Marci thought it impossible to assume that spectral colours originated by the mixture of the white light with the colour of the paper at the aperture in these experiments. Marci thought that he refuted this theory in this manner. [39]

Another experiment described by Marci had not been known in scientific literature up to his days: it was the observation of the colour of thin plates. Marci observed this phenomenon on soap bubbles and it seemed strange to him. He thought it necessary to excuse his interest in this observation: someone could say that such interest would suit a little boy rather than a scientist which sought a way to truth. But Marci did not want to pass over any possibility to obtain new information, especially if it was so evident a possibility.

Thus Marci described the observation of colours on the soap bubbles, where he admired the variability of colours. He observed also dark spots on the surface of the soap bubbles appearing immediately before the bubble dissolved. [40]

Marci's explanation of this observation is interesting: he uses the analogy to the explanation of the origin of a rainbow. He presumed a difference between the air outside and inside the bubble: the latter contained little waterdrops, which condensed on the wall of a bubble and flowed down. In these waterdrops originated the spectral colours analogously to the origin of the rainbow in the raindrops. The colours were then projected on the wall of the bubble, where the observer was able to see the change of spectral colours. [41]

Marci was interested in the study of the propagation of light. He mentions propagation both along straight lines and in spheres. It is interesting how Marci dealt with the change of direction in the propagation of light. We can say that Marci presumed here Huygens' ideas: if the light ray reached the point on the boundary plane of two media with different densities, this point became the centre of a new sphere of the light. Marci spoke about his idea in several places of his book: he explained the reflection and the refraction of light in this manner. Thus Marci presumed Huygens' ideas but Huygens formulated his principle more generally and used also the ideas of the wave theory of light. [42]

In the title of *Thaumantias, liber de arcu coelesti...*, Marci spoke at first about the rainbow. He studied the problem of the origin and of the properties of the rainbow, but his results in his matter were not so important as the ones in the general study of spectral colours.

Marci correctly described the passage of sunrays through a raindrop

---

[39] J. Marek, *Sbornik*, 7(1962), p. 61 (summary in German).
[40] J. Marek, *Sbornik*, 9(1964), p. 71 (summary in German).
[41] J. Marek, *Arch.*
[42] J. Marek, *Sbornik*, 9(1964).

in the cases of the origin of the primary rainbow and of the secondary one. But this result had been known, e.g. to Theodoricus of Freiberg and to Descartes before Marci. It is probable that Marci did not know these authors. In connection with his study of rainbow, Marci quoted only Vitello, F. Maurolycus and J. Scaliger. About Descartes, he spoke in his last book dealing with the rainbow, the *Appendix,* only.

But Marci was not sure if this explanation of the origin of the rainbow by the refraction-reflection-refraction in the raindrop was correct. It seems that Marci was here dependent on Aristotle's explanation of the origin of the rainbow by the reflection of light on a cloud. In the paragraph *De atmosphera* in the *Thaumantias,* he presents a different explanation, based on his study of the passage of the light through the *trigonum armillare*—the prism in the form of a bracelet.

Marci presumed that a part of the atmosphere was formed accidentally in the shape of curved prism. The sunrays passed this prism and the originated colours were projected on a dark cloud, where the observer saw the rainbow. This was another possible explanation of the origin of the rainbow given by Marci. [43]

Marci was convinced that all phenomena of the occurrence of spectral colours had a unique cause. Therefore he drew the section of the raindrop in the section of the prism as a circle into a triangle and pointed out that the conditions for the passage of light through the raindrop and through the prism are the same.

Marci did not know until then the rule of refraction of light. But he was near to a discovery of the composition of white light. He knew of some fundamental properties of the spectral colours (cf. note 34), he experimented with monochromatic rays, e.g., he mixed the rays of separated spectral colours. [44] We think that it was the influence of ancient science that impeded the further progress by Marci in his way to a discovery of the composition of white light. Marci accepted the ideas of Aristotle on the four elements in nature, and was of the opinion that white light is an Element too, yet more delicate and noble than the four common elements of Aristotle. He even alleged that these four common elements had their very origin in that of white light. [45] He rejected the old idea that spectral colours are a product obtained when mixing white light with darkness. Yet his belief in the superiority of white light over all other elements made him think that white light is undergoing some kind of contamination (*degeneratio*) while spectral colours are being for-

[43] J. Marek, *The Origin of Physical Optics in Bohemia,* Charles University, Prague, 1961, (in Czech).

[44] *Thaumantias,* pp. 124, 136.

[45] „Priusquam enim quidquid esse creatum, dixit Deus: Fiat lux, et facta est lux. Essentia, inquam, illa simplex et ex se lucens, radix vero omnium elementorum. Necesse enim, quod in omnia mutari et ex quo omnia constitui oportebat, omni illorum forma carere." — *ibid.,* p. 59.

med, this contamination being caused not only by the peculiarities of white light but also by the properties of matter.[46] In this way white light remained for Marci a singular substance and Marci failed to discover that light is a composition of the spectral colours.[47]

In general, we can say that Marci presented some observations on the fundamental phenomena of physical optics. Marci's approach was different from that of the previous scientists: Marci was more a physicist—as we understand this word at present. The conditions of Marci's experiments were progressive: he studied not only the spectrum of sunlight but also that of other sources;[48] through the aperture he transmitted not only white light but also monochromatic rays;[49] he studied the spectral colours projected on the screen placed in a shadow;[50] he observed the colours of the transmitted light through metal foils;[51] he experimented systematically with the prism;[52] by means of a prism he examined not only the direct light but also the reflected one.[53]

MARCI'S WORK IN MECHANICS

Marci's results in the field of mechanics are very important; they are quoted in the literature dealing with the history of this branch of physics.[54] As we know, Marci started his stay at university with the study of philosophy and later he took up medicine. But his first book on physics was published rather late, in 1639, i.e. in the 44th year of his age. This book was entitled *De proportione motus seu regula sphygmica* [3]. It seems that Marci was visiting the lectures in mathematics of Professor Grégoire de Saint-Vincent, given at the University of Prague in 1626–31.[55]

This is the first book in the literature that deals with the impact of bodies to such an extent. Marci studied the elastic impact of balls, first in the case when one ball is at rest, then the case with both balls in motion. Almost all the Theorems obtained by Marci were correct.

The different cases of impact of bodies were restricted by Marci to the case of the central impact only; he pointed out the influence of dif-

---

[46] „... color sit quaedam imperfectio et veluti opacitas luci adveniens." — *ibid.*, p. 101.
[47] J. Marek, *Organon*, 4(1967), p. 133.
[48] *Thaumantias*, p. 101.
[49] *Ibid.*, p. 171.
[50] *Ibid.*, pp. 103, 108, 135.
[51] *Ibid.*, p. 128.
[52] *Ibid.*, pp. 94, 137.
[53] *Ibid.*, p. 177.
[54] E. Mach, *op. cit.*
[55] J. Smolka, *loc. cit.*

ferent properties of the material of bodies and also the influence of the proportion of their masses. Marci studied the problem of the recoil of a falling body and the recoil of pebbles on the water surface as special cases of impact. [56]

He was trying to define some terms of mechanics, e.g., velocity and momentum (*impulsus*). Thus, we may consider Marci as a predecessor of Newton in his idea of the second law of motion. [57] Marci studied different cases of motions, not only rectilinear ones but also the circular motion [58] and the motion of the pendulum. Here he formulated isochronism, and he knew of the proportion between the length of a pendulum and the corresponding period of oscillation. [59]

The results of the study of the motion of a pendulum were used by Marci in the construction of an instrument for measuring the frequency of heart-beats. It was a small pendulum with suspension of variable length. [60] Marci suggested this arrangement for measuring very short time intervals (shorter than one third of a second) for the purpose of astronomical observations. [61]

Marci studied the free fall of bodies with different mass and concluded that the free fall is independent on their volume, shape or weight. All bodies fall with the same speed and the difference in the motion of bodies with different weights is caused by the medium in which the motion occurs. [62]

We may consider Marci's work in mechanics as very important. Galilei and Descartes also dealt with the impact of bodies in the first half of the 17th century, but not to such an extent. We may point out some of Marci's merits. First of all Marci did not study the impact of bodies

---

[56] *De motu reflexo lapillorum ex aqua* in [3].

[57] For details cf. J. Smolka, *op. cit.*, p. 10.

[58] *De reflexione motus circularis* in [3].

[59] See in [3]:

„Propositio XXIV. Perpendiculum ex quolibet puncto eiusdem circuli aequali tempore recurrit in suam stationem.

Propositio XXV. Excursus perpendiculi in eodem circulo a linea stationis sunt inter se aequales.

...

Propositio XXVIII. Motus circulorum sunt in ratione suorum temporum, quam habent diametri ad se duplicatam."

See also Propositio XXXXI.

[60] See in [3]: „Propositio XXXXI. Problema II. Regulam construere ad celeritatem et tarditatem pulsuum absque errore metiendam."

[61] „Problema. Horologium construere, quod suo motu tempus numerat divisum in partes minores, quam tertias unius secundi." [3], p. Q2.

[62] „De inaequalium ponderum lapsu. ... His suppositis dico 1: motum quatenus a gravitate procedit eiusdem speciei seu gradus, eadem celeritate fieri in omnibus, quantumvis mole, figura, pondere a se differant ... Dico secundo: illam inaequalitatem motus, quo inaequalia pondera moventur, esse a medio, in quo fit motus. Atque illa corpora, quorum gravitas seu impulsus maiorem rationem habet ad suam plagam, velocius moveri. Quia enim aer resistit divisioni ac notabili 3. erit plaga ad mensuram huius resistentiae; dificiet ergo impulsus, ac proinde velocitas motus in ea ratione, in qua magnitudo, plagae..." [3], p. P.

in general, but he restricted his research to one case only: the central impact of elastic bodies.

He had a good approach as a physicist to the studied problem, when he was observing the difference in the qualities of bodies and its influence on the course of the impact. He distinguished between soft, hard and fragile bodies and defined the absolutely hard body. [63] He experimented with wooden balls which were a good approximation to his definition of an absolutely hard body. In this way Marci exactly defined the case of impact with which he was able to experiment: he changed the speeds of both bodies and their weights and studied the influence of this change on the motion of both bodies after their impact. [64]

Marci knew the law of momentum conservation. He studied the case of the direct impact of two balls with equal weights. One of the two balls was in motion and the other was in rest. Marci knew that the result of the impact of those balls would be the change of the conditions of both balls: the ball, which had been in motion would be at rest after the impact, and would transmit its velocity to the ball, which had been at rest before. This case was illustrated with a ball fired by means of a cannon against a ball lying on a table. [65]

Marci studied the motion of the pendulum as had done Galilei. Galilei had been interested in this question much earlier, in 1583, but he published his result in 1638 only. Marci edited his book one year later, in 1639. We can say, hovever, that Marci worked most probably independently of Galilei. There was a too short interval between the editions of the two books for preparing Marci's book to the printing.

At this time Marci also travelled; in 1638 (or 1639) he went to Rome as a member of a Czech embassy. During this trip he made acquaintance with P. Guldin at Graz. Staying with him, Marci got familiar with Galilei's *Discorsi*, as he reported in his letter to Galilei. [66]

The approach of Galilei and Marci to the relation between the motion of a pendulum and the frequency of heart-beats is very interesting: Galilei measured the period of oscillation by means of his own heart-beats, whereas Marci constructed an instrument with a pendulum in order to measure the frequency of heart-beats. It seems, therefore, that we may consider Marci as a pioneer of medical physics.

---

[63] „Corpora percussa alia esse molia, quorum partes percussioni cedunt, inter se vero unitae manent... Alia dura; et siquidem percussioni nullo modo cedunt, absolute dura... Corpora autem dura absolute quia neque perforantur, neque partes habent percussioni cedentes, aequalem recipiunt atque inferunt plagam, motum vero ex illa plaga reflectunt, atque eo magis, quo duritiae magis praestant" [3], p. L3. (For more details see note 25 in J. Smolka, *loc. cit.*)

[64] In [3], pp. M1, M2.

[65] Z. Horák, J. Machalický, *Vesmir*, 46(1967), p. 271 (in Czech).

[66] Z. Pokorný, *Sbornik pro dějiny přir. věd. a tech.*, 9(1964), p. 12 (summary in French).

MARCI'S RELATION TO THE DEVELOPMENT OF SCIENCE IN THE WORLD

After Marci many other authors continued in research of mechanics and optics. Now it is a question, if Marci had had some influence on the development of science in the world?

We may say that Marci's book was known among the scientists abroad during his life. We can introduce some examples about it and illustrate them by means of documents.

Marci's work was known and appreciated by the Royal Society in London. W. Pagel and P. Rattansi (*loc. cit.*) found the correspondence between Oldenburg, the Secretary of the Royal Society, and the English physician Edward Browne (1644–1708) in the Archives of the Society. E. Browne, the oldest son of Sir Thomas Browne (1605–82), travelled to eastern Europe and at this occasion Oldenburg asked him to enter into correspondence with Marci. But when Browne came to Prague, Marci had been dead for two years. Pagel points out that the proposed correspondence between Oldenburg and Marci would probably have led to a Fellowship as it did with Leeuwenhoek and Malpighi. [67]

S. I. Vavilov points out that I. Barrow, the teacher of I. Newton, published in his *Optical Lectures* some opinions reminding one of Marci, whose name was not explicitly mentioned in this book. Newton was able to make himself familiar with these opinions because Barrow's book was reviewed by Newton. [68]

In England, more authors knew the name of Marci. Pagel says that Marci was a well-known figure in the Puritan English Literature, as an empirical naturalist and physicist. He mentions Thomas Vaughan (1622–1665/6), the mystical philosopher, alchemist and naturalist; John Webster, a sectarian author who wished to introduce revolutionary changes in the teaching of the natural sciences at Oxford and Cambridge.

But Marci's name was quoted in other scientific works. It is interesting that Robert Boyle mentioned Marci together with such naturalists as Galilei, Descartes, and Fabri (Boyle studied also the colour of thin layers).

It is interesting that Marci's astronomical book *De longitudine* [9] was also quoted, namely by Sir Edward Sherburne, who listed Marci among the "most eminent astronomers ancient and modern."

One of Marci's book on mechanics was mentioned in Samuel Harlib's *Ephemerides* (1658). [69]

Huygens was also familiar with Marci's books. In the fifties, A. G.

---

[67] W. Pagel, *op. cit.*, p. 289.
[68] S. I. Vavilov, *Isaak Niuton*, Moskva, 1945, p. 31, (in Russian).
[69] W. Pagel, *op. cit.*, p. 287.

Kinner von Löwenthurn, the educator at the court of the Emperor in Vienna, came to Prague. He was a friend of the Huygens family and wrote news concerning scientific life in Prague to Ch. Huygens.[70] In this way, Huygens knew Marci's work on mechanics and optics, and received seven of his books from Antwerp, as he wrote in a letter.[71] In his letters, Huygens was more interested in Marci's mechanics than in his optics.

Huygens also wrote about the work of Conrad, Marci's near colleague in Prague. Conrad dealt with the improvement of the telescope and Huygens had great interest in his work. Conrad's open letter to all European mathematicians was answered by Huygens with a personal letter, in which he expressed his interest in Conrad's work in connection with his own work in optics.[72]

CONCLUSION

The origin of the development of physical optics is usually located in the second half of the 17th century. We associate it with the names of such scientists as F. M. Grimaldi, R. Hooke, R. Boyle, I. Newton, Ch. Huygens. In the person of Ioannes Marcus Marci de Cronland we have a naturalist who dealt with the problems of physical optics to a great extent and described the observations of some fundamental phenomena in this field of science already in the first half of the 17th century.

The most important thing is that Marci presented new methods in his study. He used new methods in the experiments with the prism and also for his observations of the diffraction of light. He used his study of the motion of a pendulum for the construction of his instrument for the measurement of the frequency of heart-beates, and also for a proposal of an arrangement for the measurement of short intervals of time.

But some of these important results were not described in clear Theorems. Marci did not know the importance of his all discoveries and discussed fundamental problems together with subsidiary ones, occasionally also concerning other fields of science from our point of view. Therefore it is sometimes difficult to study Marci's books and this seems to be one of the reasons why the work of Marci fell into oblivion after his death.[73]

---

[70] Ch. Huygens, *op. cit.*, vol. 1 (e.g., p. 192) and vol. 2.

[71] „... Opera Marci Marci nunc demum Antwerpia mihi missa sunt septem numero tractatus ..." Letter No. 194 (p. 289); see *ibid.*, vol. 1.

[72] *Ibid.*, vol. 2, p. 356.

[73] J. W. Goethe, *Geschichte der Farbenlehre*, Stuttgart, 1858, p. 166.

ACKNOWLEDGEMENT

I should like to express my thanks to Professor Vasco Ronchi for many fruitful discussions and for constant interest in my work.

LIST OF MARCI'S WORKS

[1] *Disputatio medica de temperamento in genere et gravissimorum morborum tetrade: epilepsia, vertigine, appoplexia et paralysi, quam... praeside Domino Franco Roia de Aquista, Pace Veronensi etc. publice examinandam proponit Ioannes Marcus, A. et Philos. Mag., U.M. candidatus anno* 1625.

[2] *Idearum operatricium idea sive hypothyposis et detectio illius occultae virtutis, quae semina faecundat et ex iisdem corpora organica producit. Authore Ioanne Marco Marci, philosophiae et medicinae doctore et ordinario professore eiusdem medicinae facultatis in universitate Pragensi, physico regni Boemiae. Anno* 1635.

[3] *De proportione motus seu regula sphygmica ad celeritatem et traditatem pulsuum ex illius motu ponderibus geometricis liberato absque errore mentiendam. Authore Ioanne Marco Marci, phil^ae^ et medic^ae^ doctore et ordinario professore eiusdem medic. facultatis in universitate Pragensi, physico reg. Boh.*
Pragae, typis Ioannis Bilinae, 1639.

[4] *De causis naturalibus pluviae purpureae Bruxellensis, ad reverendissimum et eximium D. D. Ioannem Caramuelem Lobkowitz, Monsseratensem et Disenbergensem abbatem, denominatum missiae episcopum et Moguntium suffrageneum. Ioannes Marcus Marci, in universitate Pragensi medicinae professor primarius, S.C.M. medicus cubicularius et in regno Bohemiae physicus senior.*
Pragae, typis academicis, 1647.

[5] *Observationes exotico-philosophicae, Pragae* 1647.

[6] *De proportione motus figurarum rectilinearum et circuli quadratura ex motu. Authore Ioanne Marco Marci, medicinae doctore et professore primario, S.C.M.^tis^ medico cubiculario et in reg. Boh. physico seniore.*
Pragae, ex topographia academia, 1648.

[7] *Thaumantias. Liber de arcu coelesti deque colorum apparentium natura, ortu et causis, in quo pellucidi opticae fontes a sua scaturigine, ab his vero colorigeni rivi derivantur. Ducibus geometria et physica hermetoperipatetica. Authore Marco Marci, philosophiae et medicinae doctore, et eiusdem medicinae primario professore in universitate Pragensi, S.C.M medico cubiculario et in Bohemia physico seniore.*
Pragae, typis academicis, 1648.

[8] *Anatomia demonstrationis habitae in promotione academia die* 30. *Maii per R.P. Conradum, Soc. Jesu, matheseos professorem: De angulo, quo iris continetur. Authore Ioanne Marco Marci.*
Pragae, typis Georgii Schyparz, 1650.

[9] *De longitudine seu differentia inter duos meridianos una cum motu vero Lunae inveniendo ad tempus datae observationis. Authore Ioanne Marco Marci, S.C.M. conciliario et medico cubiculario, nec non medicinae primario professore in universitate Pragensi et in regno Bohemiae physico seniore.*
Pragae, typis Georgii Schyparz, 1650.

[10] *Dissertatio in propositiones physicomathematicas De natura iridos R.P. Balthasaris Conradi, Soc. Jesu, Aa.Ll. et philos, magistri ordinariique matheseos professoris. Authore Ioanne Marco Marci, S.C.M. consiliario et medico cubiculario, nec non medicinae primario professore in universitate Pragensi et in regno Bohemiae physico seniore.*
Pragae, ex typographia Georgii Schyparz, 1650.

[11] *Labyrinthus, in quo via ad circuli quadraturam pluribus modis exhibetur authore Ioanne Marco Marci. ...*
Pragae, typis Urbani Goliasch, 1654.

[12] Περὶ πάντον-*Sophia seu philosophia vetus restituta. Authore Ioanne Marco Marci a Kronlandt, primario medicinae professore, consiliario et medico caesareo.*
Pragae, typis academicis, 1662
(2 ed. Lipsiae 1676 ? 1677).

[13] *Liturgia mentis seu disceptatio medico-philosophica et optica de natura epilepsiae, illius ortu et causis deque symptomatis, quae circa imaginationem et motum eveniunt, in qua multa scitu digna, difficilia et recondita deteguntur.*
Opus posthumum, cui accessit tractatus medicus De natura urinae et Consilia tria medica.
Leopoldo Caes. dedicavit Jac. Ioan. Dobrzensky praemisso auctoris elegio et praefatione de scriptis eius.
Ratisbonae, sumptibus Joh. Conr. Emmrich, 1678.

[14] *Otho-Sophia seu Philosophia impulsus universalis Ioannis Marci Marci a Kronland, Boemi Landskronensis, philosophiae et medicinae doctoris, in caesarea regiaque universitate Carolo-Ferdinandea Pragensi quondam professoris primarii et senioris, Sacrae Caesareae Majestatis consiliarii, comitis palatini nec non regni Boemiae physici iurati, philosophi, mathematici et medici, huius saeculi eximii opus posthumum nuperrime in eiusdem authoris Liturgia mentis promissum, in quo admiranda genesis, natura, progressus, vires, impulsus, cum in animalibus, tum liquidis et solidis corporibus explicantur, opus curiosioribus medicis, mathematicis, philosophis utile ac periucundum, nunc primum cum aeneis figuris in lucem editum a Jacobo Ioanne Wenceslao Dobrzensky de Nigro Ponte, phil. et medicinae doctore, nec non eiusdem facultatis in alma universitate Carolo-Ferdinandea publico professore.*
Vetero-Pragae, typis Danielis Michalek, 1683.
(2 ed. Prague ? 1730).
Cui accessit tractatus: Monita quadeam ad dieteticam spectantia.

[15] *De imaginatione.* (Lost)

[16] *De vita et calido innato.* (Lost)

[17] *De vita et morte.* (Lost)

[18] *Praxis medica.* (Lost)

[19] *Appendix.* (It is a discussion with B. Conrad, published probably after 1650.)