Friedrich Christoph Mayer and his theory of the aurora borealis

Eric Chassefiere

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The articles *De Luce Boreali*
(1728 & 1735)

by Friedrich Christoph Mayer

with an introduction
by Eric Chassefière

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The eleventh volume in the series presents two articles on the aurora borealis by Friedrich Christoph Mayer (1697–1729), a mathematician at the Imperial Academy of Sciences in Saint Petersburg. The first paper, titled "De Luce Boreali" (On the Northern Light), was presented during a session at the newly founded Academy in October 1726. It was printed two years later (1728) in the very first volume of its official periodical, the *Commentarii Academiae Scientiarum Imperialis Petropolitanae*. The second paper, also bearing the title "De Luce Boreali", constitutes the author's 'second thoughts' on the matter. It was presented during a session in October 1728 but was not printed until after Mayer's death, in the fifth volume of the *Commentarii* (1735).

Eric Chassefière, member of the *Histoire des sciences astronomiques* team of the SYRTE laboratory at the Observatoire de Paris, has written an introduction to Mayer's life and works with a special emphasis on his theory of the aurora borealis. In his introduction, Chassefière also recounts how Mayer's theory was received by other eighteenth-century savants.

- The editor

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**Mayer's first article "De Luce Boreali" as published in the *Commentarii Academiae Scientiarum Imperialis Petropolitanae* Tomus I ad annum 1726 (Petropoli: Typis Academiae, 1728). Copy held by the Natural History Museum Library, London. Digitized by the Biodiversity Heritage Library. Optical character recognition by Hana Kekić, University Library, UiT. See digitized article

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FRIEDRICH CHRISTOPH MAYER AND HIS THEORY OF THE AURORA BOREALIS *

by Eric Chassefière

Friedrich Christoph Mayer, born in 1697, came to Saint Petersburg from Tübingen, where he was Georg Bernhard Bilfinger's student in the disciplines of mathematics, theology and philosophy, and served three years as a curate after his doctorate. Bilfinger was a disciple of Christian Wolff, the main successor of Gottfried Wilhelm Leibniz. Very little biographical information is available about Mayer. He probably stayed in Saint Petersburg in 1725 as a visitor to the newly established Imperial Russian Academy of Sciences, before being appointed *Professor extraordinarius*, i.e. without an explicitly defined discipline, the following year. He is recognized in the new academy as a specialist in "mathesis", i.e. "the foundation of knowledge", a rationalist project inherited from Descartes and Leibniz based on the fact that it should be possible to understand the universe on the basis of a small number of simple laws, the universal order thus proving to be accessible to reason.

During the four years he spent at the Academy, up until his premature death in 1729, Mayer worked with the French astronomer Joseph-Nicolas Delisle, who was in charge of the Imperial Observatory. Among other things, he composed a calendar, the first and only for a long time not to include astrological elements. It is also known that from the time of Leonhard Euler's arrival in 1727, Mayer helped the Basel mathematician with various problems of celestial mechanics applied to the determination of the sun's orbit, the movement of the planets and the calculation of lunar eclipses. In addition, he worked with two other Basel mathematicians, Jakob Hermann and Daniel Bernoulli, on a theory of the moon based on Delisle's extensive programme of astronomical observation, which

* This introduction is a summary of the article Eric Chassefière: Aurora borealis systems in the German-Russian world in the first half of the eighteenth century: the cases of Friedrich Christoph Mayer and Leonhard Euler, *Annals of Science* 78,2 (2021): 162–196. https://doi.org/10.1080/00033790.2021.1891284

included the occultations of stars and planets by the moon, as well as lunar and solar eclipses. This work gave rise to several publications by Mayer in the first volumes of the *Commentarii Academiae Scientiarum Imperialis Petropolitanae*, the official journal of the Academy.

One of Mayer's most outstanding subjects of study was the observation of and theory regarding the aurora borealis. Delisle states that Mayer observed many auroras during the first year of his stay in Russia as part of his meteorological observation work, and that he published in the first volume of the *Commentarii* a collection of his observations, accompanied by "his thoughts on the cause of this phenomenon, & the first foundations of his system, which he strove to perfect until his death three years later". Delisle is rather negative about Mayer's observational skills, judging that the latter did not take the trouble to write down the details of his auroral observations, often indicating only the day.[1]

In his article "De Luce Boreali" (On the Northern Light) in volume 1 of the *Commentarii* published in 1728, Mayer analyses the different observed types of aurora borealis and concludes that "it is obvious that this matter [the auroral matter] has all the characteristics of the clouds and thus occupies the same position as them and is the same distance from the Earth" (p. 358).[2] He suggests that auroral jets "are issued from the reflection of the light that is present in the small luminous clouds [that form the auroral matter], […] while these small clouds project beams upwards onto the flat surface of the very tenuous vapours that overlook them, through which light is subsequently reflected in the form of beams" (p. 362). Regarding the physical cause of the auroral light, he attributes it to "flammable exhalations [sulphur, nitre, salts]", which, "with the aid of heat, mingle and merge with the watery vapours and are then separated from them when the cold arrives, at the moment when the watery vapours gather faster than the flammable exhalations" (p. 364). He proposes a cycle of ignition-extinction where the heat generated by the ignition causes the exhalations to mix with the vapours, which then separate again when the air cools down, re-concentrating the exhalations and provoking a new ignition, explicitly referring to Wolff's theory of the 'imperfect thunderstorm' (p. 364). For Mayer, the auroral light is similar to that of a small flash of lightning, as Wolff advocated.

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[1] Joseph-Nicolas Delisle, *Mémoires pour servir à l'histoire et au progrès de l'astronomie, de la géographie et de la physique* (St. Petersbourg: l'Imprimérie de l'Académie des Sciences, 1738), pp. 77–78 (translated by E. Chassefière).

[2] All translations from Mayer's Latin original are by François Mottais, member of the THEMAM/ARSCAN team at Université Paris Ouest Nanterre la Défense.

On the strength of his knowledge of mathematics, at the end of his first article Mayer proposes a trigonometric method for estimating the height of the auroral arc from a single point of observation. This method met with great success in the community of astronomers and mathematicians of the time. Mayer further elaborated the theory in his second article titled "De Aurora Boreali", presented during a session at the Academy in 1728 and ultimately published in volume 5 of the *Commentarii* in 1735, five years after his death. In this article, Mayer modifies some of the claims in his first article on the subject, revisiting his method for estimating the height of the aurora on pp. 127–130.

Pierre Louis Moreau de Maupertuis gave a demonstration of Mayer's method in the *Mémoires de l'Académie Royale des Sciences* in 1731. Several scholars proposed their own demonstration of Mayer's problem, and used it for estimating the heights of various auroral arcs. Interestingly, Mayer himself did not apply his method to his own aurora observations, and soon lost interest in observing the aurora. The hypothesis Jean-Jacques Dortous de Mairan forwarded in the second edition of his *Traité physique et historique de l'aurore boréale* (1754) to explain Mayer's lack of conviction in using his own method is the following:[3]

> He believed along with an *illustrious Philosopher* [i.e., most probably Wolff], that the matter of the Aurora Borealis was little more than an indigestible heap of that which produces Thunder-bolts & Lightning [...] & consequently he did not make the Arc of Lightning rise above the region of the clouds [...]. What could he think of such a principle, when his rule yielded a hundred times that distance, & sometimes even more! However, his rule was good, it was proven, he was a skillful calculator; it was therefore necessary to question the observations which he could not fail to find faulty, & infinitely more faulty than they were, since they resulted in such a huge alleged error.

Mayer, although not believing in his observations, seems to have had a great level of confidence in his aurora borealis system, inherited from Wolff, at least enough to publish it in the *Commentarii*. Is his abandonment of the observation of the aurora a consequence of his philosophical conceptions, which would have given pre-eminence to reason over experience, or is it simply the result of a mind naturally more turned towards the imagination than towards the real world? We lack the evidence to answer this question.[4]

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[3] Jean-Jacques Dortous de Mairan, *Traité physique et historique de l'aurore boréale*, Seconde Édition (Paris, Imprimerie Royale, 1754), p. 411 (translated by E. Chassefière).

[4] For a more comprehensive discussion of Mayer's theory, see Chassefière 2021 (with an appendix including François Mottais' complete translation of Mayer's first paper).