Aurorae Borealis Studia Classica

Vol. XIX

[Om Nordlyset] (ms, 1748) /
Richtig angestellte und aufrichtig mitgetheilte Observationes von dem [...] Nord-Licht
(1751)

by Lars (Laurids) Barhow

digitized, with a biographical introduction and summary
of contents by Per Pippin Aspaas

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The nineteenth volume in the series presents a treatise on the aurora borealis by Lars (or Laurids) Barhow (1707–1754), a parish priest at Ørlandet, some 50-odd kilometres west of Trondheim in Norway. His theory of the aurora may not be correct from the vantage point of present-day physics, but his consistent methodological approach and independent line of reasoning certainly met the standards of the Age of Enlightenment. Unlike many other investigators, Barhow argued (correctly) that the aurora borealis never descended below the height of the clouds. He also attempted to make a classification system on various types of aurora to ensure that discussions of the phenomenon could follow a common epistemology.

Barhow's text is extant in two versions, a Danish manuscript and a German printed book. Per Pippin Aspaas has written an introduction that takes both versions of the text into account. The original manuscript, written during the 1740s, has been edited in a diplomatic transcription by Aspaas; it is presented here both in the form of a TXT file and a PDF with searchable fulltext. The first and seemingly only printed version, the German edition from 1751, is also available for download, in the form of an image-only PDF and a TXT transcript file prepared by Kristin Vieweger during an internship at UiT's university library. I would like to thank Kira Moss in Copenhagen and the "Creating the New North" research group at UiT in Tromsø.

- The editor

Items digitized for this volume:

**An untitled manuscript *[Om Nordlyset]* written by L. Barhow and submitted to the The Royal Danish Academy of Sciences and Letters in 1748. Digitized and transcribed by Per Pippin Aspaas, see searchable PDF e-book. Also available as a separate file, see TXT e-book.

**The book *Richtig angestellte und aufrichtig mitgetheilte Observationes von dem seit eines halben Seculi in den meisten europäischen Ländern sehr merklich zeigenden und bekannt gewordenen Phaenomeno, unter dem Namen von Nord-Licht* by L. Barhow (Frankfurt & Leipzig, 1751). Digitized by the National Library of Norway, see image-only PDF e-book. Transcription by Kristin Vieweger available as a separate file, see TXT e-book.

LARS BARHOW (1707–1754)

Biographical introduction
by Per Pippin Aspaas

Lars (often referred to as Laurids)[1] Barhow was born in February 1707 in his father's rectory at Qvernæs (or Kvernes in modern spelling, not far from Kristiansund in Norway). After examinations at gymnasium level in Trondheim and studies at Copenhagen University he was appointed resident chaplain (*Kapellan*) at Vedøen (Veøy, near Molde) in 1731. Nine years later, he became parish priest (*Sognepræst*) at Ørlandet, a peninsula located at roughly the same latitude as Trondheim, only farther out towards the open sea. He kept his position at Ørlandet from 1740 until his death in September 1754. During the 1740s, Lars Barhow wrote the treatise on the aurora borealis presented here. He based his theory to a large extent on observations that he had himself made at Ørlandet. The Danish[2] original is published here for the first time.

Barhow tried first to submit the manuscript to the fellows of the Royal Danish Society of Sciences in the autumn of 1748 to have it published with them.[3] When this attempt failed, he turned to his older brother residing in Copenhagen, Hans Barhow (1704–1754), who apparently helped make sure that the treatise eventually got published in a German translation, with imprint in both Frankfurt and Leipzig, in 1751. Franz Christian Mumme, keeper of a flourishing book shop in Copenhagen from 1728 till his death in 1759, was the publisher.

Little is known about Lars Barhow, beyond the biographical anecdotes that can be gleaned from his treatise on the aurora as well as a manuscript on Moskstraumen, a maelstrom phenomenon in Lofoten.[4] He was evidently well versed in the natural philosophy of his time. This shows in

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[1] Lars is the Danish (and Norwegian) equivalent of Lauritius or Laurids. Some literature refers to the form Laurids instead of Lars.
[2] No written form of Norwegian was in use at the time; Danish was the standard written language in both Norwegian and Danish parts of the Kingdom of Denmark and Norway until the nineteenth century.
[3] The official protocol of the society records that the manuscript was brought to the attention of the fellows of the society on 4 November 1748 and then read alound over a series of six sessions, from 19 January till 23 November 1750. At the last-mentioned date, the manuscript was deemed worthy of being printed. For unknown reasons, however, this never took place: see Asger Lomholt, *Det Kongelige Danske Videnskabernes Selskab 1742–1942: Samlinger til Selskabets Historie* Bind V: *Manuskripter og tegninger i selskabets arkiv* (Copenhagen, 1973), p. 26.
[4] For more on this manuscript, which comprises a set of brief, critical remarks on earlier theories on the properties and origins of the maelstrom, see Sigri Skjegstad Lockert, "De Charybdi Septentrionali: Kontinuitet og endring i forestillinger om Moskstraumen fra 1539 til omkring 1900" (MA thesis, University of Tromsø, 2010), pp. 77–78. Fulltext: https://hdl.handle.net/10037/2506. Also available as a slightly revised hard-cover book, *Havsvelget i nord: Moskstraumen gjennom årtusener* (Stamsund 2011), pp. 121–123. On

his references, which include the likes of René Descartes, Christian Wolff, and Edmund Halley alongside less prominent figures such as the Uppsala professor Erik Johan Burman (see *Aurorae Borealis Studia Classica*, vol. XIII), the Saint Petersburg professor Friedrich Christoph Mayer (vol. XI), and the Swedish rural dean Johan Ödman. While he is respectful in tone, Barhow does state his views earnestly whenever he disagrees with previous investigators. He uses his own observations extensively, obviously having witnessed the phenomenon on numerous occasions.

Another auroral observer, Erich Johan Jessen-Schardebøll (1705–1783), informs that Barhow was "known for his bewildering and extraordinarily sharp sense of hearing".[5] An anonymous reviewer in the periodical *Kiøbenhavnske Nye Tidender om lærde og curieuse Sager* ended his summary of Barhow's book by concluding that "this little piece is filled with observations that have been largely unexplained until now, and which merit further reflection".[6] Like his contemporaries, the ecclesiasts Jens Spidberg in Kristiansand (see *Aurorae Borealis Studia Classica*, vol. V) and Erich Pontoppidan in Bergen (vol. VII), Barhow lacked a local circle of savants with whom to engage in meaningful discussions on natural philosophy. Such a society was formed in Trondheim only six years after Barhow's death, by a group of intellectuals spearheaded by the polymath bishop Johan Ernst Gunnerus (1718–1773), the historian and gymnasium rector Gerhard Schøning (1722–1780), and the historian and littérateur, nobleman Peter Frederik Suhm (1728–1798). Suhm devoted the following paragraph to the late Ørlandet priest in an article "On the merits of the Norwegians with regard to the sciences and learning" from 1762:[7]

> Lars Barhow, vicar at Ørlandet, a man of great perspicuity, and with a keen insight into physics. He knew how to grind glass and polish stones; he had constructed an artificial grotto of mussels and had read – probably not much, but with deep reflection – particularly on the subject of physics. From him the only things that are available are the *Observationes vom Nord-Licht*, Frankfurt & Leipzig 1751, in octavo – a work that had to be issued in German, because no printer wanted to take on the task of publishing it in Danish, due to the woeful demand for good books amongst us – and also a very beautiful obituary of Mr. Albert Topp, Trondheim 1747, in quarto. This fine gentleman [i.e. Barhow] died in 1754.

Barhow's intellectual background, see further Oddvar Vasstveit, "Tidlige spor av europeiske opplysningsideer blant geistligheten på Nordvestlandet", *Heimen*, vol. 53:1 (2016), 23–41. Fulltext: https://doi.org/10.18261/issn.1894-3195-2016-01-03.

[5] Erich Johan Jessen-S., *Det Kongerige Norge fremstillet efter dets naturlige og borgerlige Tilstand*, Tom. I (1763), p. 408: "bemældte Hr. Barhov var bekiendt for at have en forunderlig og usædvanlig sterk Hørelse".

[6] *Kiøbenhavnske Nye Tidender om lærde og curieuse Sager* Num. XL (7 Octobr. 1751), 319–320 (on p. 320): "Dette lidet Skrift er fuldt af Observationer, som man har hidindtil kuns lidet vidst af at sige, og de fortiene at eftertænkes".

[7] [Peter Frederik Suhm], "Om de Norskes Fortienester i Henseende til Videnskaber", in *Tronhiemske Samlinger*, Udgivne af Philaletho, 3 Stykke (Tronhiem 1762), [171]–225 (on pp. 214–215): "Lars Barhov Præst paa Ørlandet, en Mand af stor Skiønsomhed, og god Jndsigt i det Physiske, som forstod at slibe Glas, polere Stene, og havde indrettet en konstig Grotte af Skiæl, og læst, vel ei meget, men med stor Eftertanke, særdeles i Physiquen. Af ham haves kon Observationes vom Nord-Licht, Franckfurt und Leipzig 8vo 1751, som maatte gives ud paa Tydsk, fordi ingen Bogtrøkker vilde befatte sig med at forlegge den paa Dansk, for den slette Aftræk paa gode Bøgger, som er hos os; og en meget smuk Liigprædiken over Hr: Albert Topp, Tronhiem 4to 1747. Denne brave Mand døde 1754."

Barhow's treatise on the northern lights is the product of an inquisitive and independent spirit that never got fazed by the interpretational authority of other, more famous investigators. It engages with several hypotheses that may appear strange from the vantage point of present-day physics. The constant attention to wind directions and other meteorological phenomena was surely a dead end. In the eighteenth century, however, the majority of theorists linked the phenomenon to meteorology. Deliberating on the kind of weather preceding, accompanying, and following auroral outbreaks was therefore commonplace. Another recurring point of discussion was the height of the phenomenon, with reports arguing that the aurora could sometimes descend down to the very surface of the earth proving hard to discard. In this respect, Barhow fared better than many contemporary invesitgators.[8] Furthermore, the geographical situatedness of the aurora was hotly debated. Most investigators from the Nordic regions, like Barhow, recognised it as a phenomenon occurring with a much higher frequency in the far north than on the European continent.

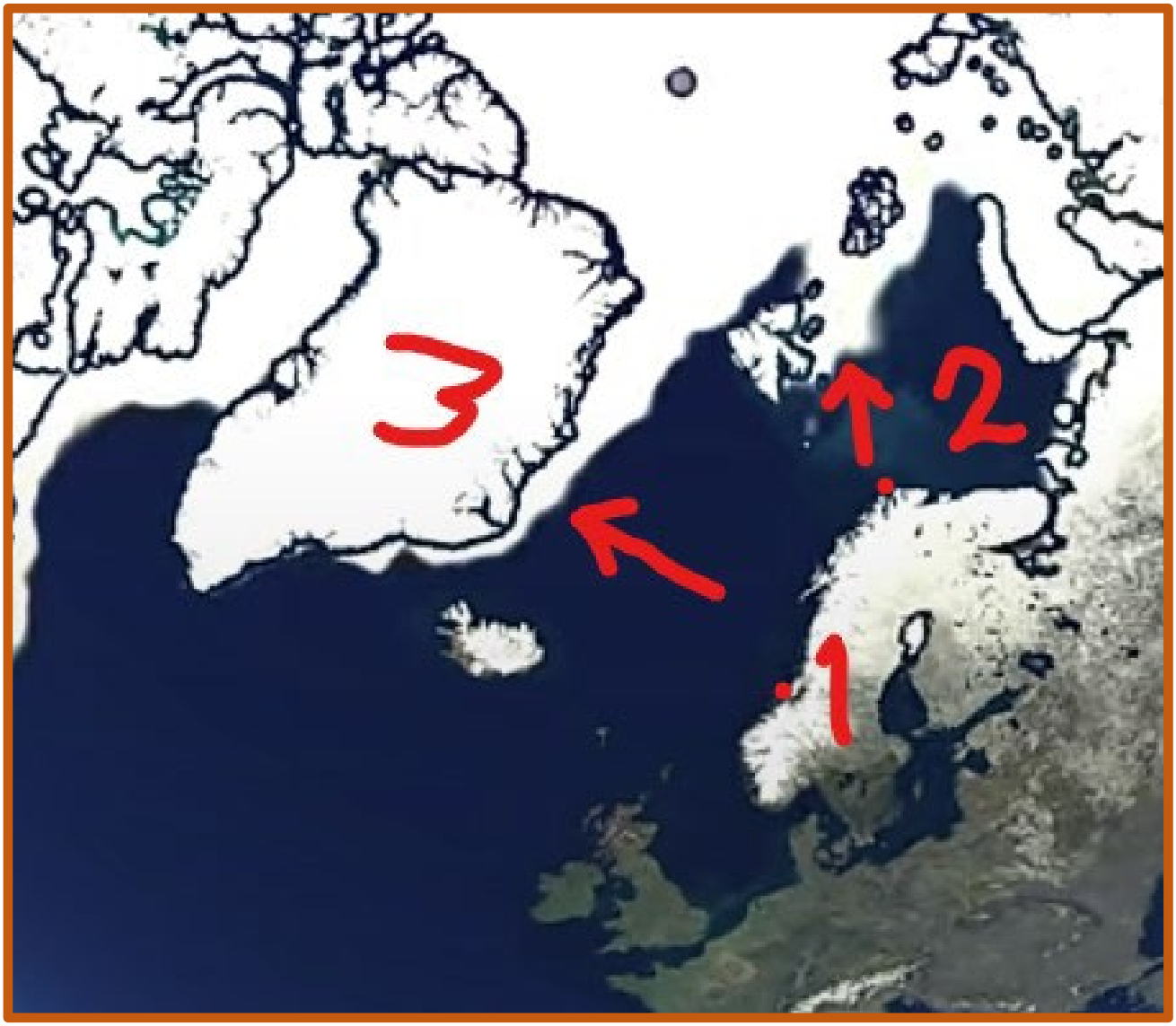
Reports on a corresponding phenomenon, *aurora australis* (Southern Lights), in the Southern Hemisphere did not enter mainstream learned discourse until after Barhow's time of writing and therefore has no place in his theory, except for a speculative marginal note on page 48 of the Danish original.[9] On a purely linguistic note, it may be mentioned that the Danish word "Nordlys" (*Nordlicht* in German) is a singular noun corresponding to the English plural, Northern Lights. Barhow usually sticks to this term, although he also mentions other synonyms, including "Væirlys" (*Wetterlicht*, i.e. Weather Lights), a term linking the phenomenon even closer to the domain of geophysics, and meteorology in particular.

With the benefit of hindsight, we can safely conclude that Barhow arrived at a incorrect theory. His theory – that the aurora originates from fine particles of ice floating around in the sky at high altitudes and illuminated from below by rays of light reflected from the massive amounts of ice found in the Arctic – is speculative at best. Barhow's carefully structured line of reasoning does, however, merit attention as a fine example of enlightenment scholarship conducted by an

[8] The physicists Asgeir Brekke and Alv Egeland credit Barhow with a correct deliberation on the height of the aurora, see their book *The Northern Lights: Their Heritage and Science* (Oslo, 1994), p. 68. A comprehensive study of Barhow's impact on the development of auroral science is however missing.

[9] Possibly the earliest printed record of an *aurora australis* was published in the (poorly distributed) *Miscellanea Physico-Medico-Mathematica* ed. by Andreas Elias Büchner, for the year 1730 (printed in Erfurt, 1734), Erstes und Zweites Quartal, pp. 1326–1327, in the form of a brief mention of a "Lumen australe, oder Süd-Schein, so zu Ende des vorigen Monats in der Gegend Siam observiret worden" (a *lumen australe*, or Southern Lights, as observed at the end of the preceding month in the region of Siam): digitised, see further W. Boller, "Das Südlicht", in *Beiträge zur Geophysik: Zeitschrift für physikalische Erdkunde* ed. by Georg Gerland, III. Band (Leipzig, 1898), pp. 56–130 (esp. pp. 88–90). In the 1745 issue of the (widely read) *Histoire de l'Académie royale des sciences* (printed 1749), pp. 23–24, there is a report of an exceptional aurora seen in Quito (modern Ecuador), as communicated by Ignacio Chiribogra y Daza to Charles-Marie de la Condamine in Paris (digitised). Further printed reports of sightings of the aurora australis – along with claims of it actually being a common phenomenon in certain parts of the Southern Hemisphere – followed from the 1770s onwards, much too late to influence Barhow's treatise.

investigator situated on the periphery of the world of learning, but in a privileged location when considering the frequency of the phenomenon that he placed under scrutiny.



Barhow's theory explained

An observer at the North Cape (2) will see the a blueish, unmoving light close to the horizon when looking north. The same kind of light is seen by sailors approaching the drift ice around Greenland (3). The glow from the ice extends up into the atmosphere, where it illuminates dusty particles of ice floating high above an observer situated further south, for example at Ørlandet (1).

Image credits: © EUMETSAT 2017, still image from the video "A year of polar ice – 2016" (https://youtu.be/IcrCUAKZw-8). Numbers, dots, and arrow added by Per Pippin Aspaas.

[OM NORDLYSET] (c. 1748) / *OBSERVATIONES VON DEM NORD-LICHT (1751)*

Summary of contents by Per Pippin Aspaas

[Title page]

The Danish manuscript lacks a title page.[10] It seems probable that "Om Nordlyset" (On the Northern Lights) formed at least part of the original title as envisaged by Barhow. The title page of the German edition can be translated as follows (all translations in this issue of *Aurorae Borealis Studia Classica* are by Per Pippin Aspaas):

> Properly conducted and earnestly communicated Observations of the Phenomenon that over the last half century has diplayed itself in a most remarkable manner in most European countries and has become commonly known under the name of the Northern Lights, wherein its history, its movements and forms of appearance, the temporalities, localities, and hindrances of its taking place, as well as such conclusions as can be safely drawn from those experiences, along with a hypothesis of its origin and cause, to the amusement of all amateurs of natural science, but especially to the service of experts of physics, who have hitherto lacked access to adequate observations made in the northernmost countries that would help them discover the true cause of the northern lights, are presented and edited by L. Barhow, parish priest at Ørlandet, not far from Trondheim in Norway.

In the following, the contents of the treatise will be summarized according to the structure emerging from the Danish section headings. The corresponding section headings and page numbers from the German edition will be given in *italics*. No comprehensive comparison between the Danish and German texts has been undertaken. Examination of random selections of the two versions does, however, suggest a German translator faithful to Barhow's original.

Apart from the missing title page, the Danish text is also conspicuous in that is refers to, yet does not include, an illustration. An illustration is, however, printed in the German edition. In the copy used for this issue of *Aurorae Borealis Studia Classica*, it is bound immediately after the title page, before the preface.

[10] In the archives of the Royal Danish Society of Sciences the manuscript is catalogued as "Fra hvor lang tid, og paa hvad stæder Nordlyset i forrige tider har ladet sig tilsyne". This is hardly the title; it is only the heading of the first of numerous sections in the text, beginning on p. 3 of the manuscript, directly after the Preface (see below).

[Illustration]

As mentioned, the illustration is missing from the Danish manuscript. In the body of the text, the illustration is referred to in §. 22 (p. 11 / *p. 14*) as well as in a discussion of rainbows on page *84* of the German edition. The figure legends can be translated thus:

> *A.* The appearance of Northern Lights of the first type
> *B.* The Northern Lights of the second type, and
> *C.* The Northern Lights of the third type, as they display themselves in different figures.
> *D.* A rainbow, about which is reported in the explanation of the hypothesis.

[Fortale] (pp. [1]–[2]) / *Vorbericht (pp. [iii]–[x])*

The preface of the Danish manuscript is signed "Lars Barhow", in the German version abbreviated as *"L. Barhow"*. The author stresses that he was born and raised in an area where this meteorological phenomenon ("Meteoron" / *"Lufterscheinung"*) is quite frequent. His current position at Ørlandet, as far north as 66 degrees and out in the open sea where the skies are generally clear and therefore more suited for observations than further inland, is quite convenient for investigations of the northern lights. He deems that his own hypothesis offers the only viable alternative to explain all the different appearances of the aurora.

Observ: Fra hvor lang tid, og paa hvad stæder Nordlyset i forrige tider har ladet sig tilsyne (pp. [3]–[5]) / *Observationes Von wie langer Zeit und an was für Orten sich das Nordlicht in den vorigen Zeiten hat sehen lassen (pp. [1]–4)*

A section with "Remarks about how long and in what places the Northern Lights have displayed themselves in previous times", divided into §§. 1–5. The phenomenon is attested in learned literature since Greco-Roman Antiquity; the oldest written records from Greenland mention it some 700 years before Barhow's time of writing; the phenomenon was frequently seen also in Iceland and Finnmark but was, however, more rarely seen from the latitude of Trondheim until it emerged around the year 1680; since the early 1700s, it has been more commonly seen even in the south of Norway, as well as in "Denmark, Germany, France, and Italy" (§. 5, p. [4] / *p. 4*). Based on information from inhabitants in the region of the North Cape and eastern Finnmark, Barhow supposes that there might be two different types of aurora: the first type being "a blue glimmer or light by the horizon in the northwest, which is standing still and not moving, which they call the true 'Nordlys' / *'Nordlicht'* [Northern Lights], but the other, which is seen higher up in the sky – and which is the topic here – they call 'væirlys' / *'Wetterlicht'*

[Weather Lights]" (§. 3, pp. [3–4] / *pp. 2–3*; the phrase "and which is the topic here" is missing in the German edition).[11]

Hvad bevægelser Nordlyset har (pp. [5]–[6]) / *Was vor Bewegungen das Nordlicht hat (pp. 4–7)*

The next section, comprising §§. 6–12, covers "What movements the Northern Lights possess". Barhow differentiates between an external ("udvortes" / *"äusserliche"*) and an internal ("indvortes" / *"innerliche"*) form of movement. The external movement implies that the entire mass of the aurora moves from one part of the sky to another; the internal is when it seemingly erupts and explodes, dissipates to near invisibility before reassembling to form new shapes, etc. The aurora is capable of moving across the entire sky, and in all directions, but the most common is a movement from the northeast towards the southwest.

Hvorledes Nordlyset representerer sig, hvilchet kand henföres til tre slags maader (pp. [7]–[12]) / *Wie sich das Nordlicht praesentiret, welches zu dreyerley Arten kann gebracht werden (pp. 7–16)*

"How the Northern Lights display themselves, which can be divided into three different categories" fills §§. 13–25. Barhow here differentiates between three types of appearances.

The first, §§. 13–17, is the most spectular. It takes the form of an arc diplaying all the colours of the rainbow, only in reverse order: red at the bottom, followed by orange, yellow, green, blue, indigo, and finally violet at the top. It is the red hue that appears first and is the last colour to disappear. Several circumstances must be in place for this type of aurora to appear: 1) clear skies and low temperatures; 2) the arc must be between 30 and 45 degrees from the northern horizon; 3) the auroral matter must not be too dispersed, nor too dense; 4) the external movement of the aurora must be from north to south. Such a multicoloured aurora is rare: "although only a few weeks or days go by with no sighting of the aurora in these places, sometimes two or three years can pass without the chance to see it in such an orderly way" (§. 17, p. 9 / *p. 11*).

The second appearance of the aurora, §§. 18–19, does not take the form of an arc, but is more irregular, diffuse, and patchy. It can be compared to sunlight slipping through a rainy cloud. Such an aurora is not colourful, but its interior movement is as energetic as the above type. Externally, its movement is hard to detect, for when it does move, its matter tends to be so

[11] The differentiation between Weather Lights and Nothern Lights is not mentioned by Barhow again, despite the fact that he does return to the blue light seen by inhabitants close to the North Cape later in the treatise. In §. 34 and §. 48, however, "Væirlys" is used simply as a synonym of "Nordlys".

dissipated that the human eye cannot discern it. Only here and there will it be visible, in patches of the sky. "Sometimes", however, "the entire northern part of the sky appears to be lit up by such thinly distributed – but nevertheless shining – particles from zenith and down to 10–12 degrees above the horizon in the north, so that no certain location or empty spaces are visible" (§. 19, p. 10 / *p. 12*).

The third appearance is described in §§. 20–22. It "manifests itself in all forms and shapes, and is seen everywhere in the sky except for the south" (§. 20, p. 10 / *p. 12*). This appearance is the most common one and is also the hardest one to differentiate from the others, with its forms consisting in "bows, stripes, columns, rays, and whirls" that are "at times vertical, at other times horizontal" (§. 21, p. 11 / *p. 13*). Barhow argues that it is this elusive form of aurora that has been most commonly seen and described in other places (than Ørlandet), but attempting to arrive at a comprehensive characterisation of it would be futile (§. 21). Under certain circumstances, this third form of appearance will exhibit some of the colours of the rainbow, but usually it is colourless, he remarks (§. 22).

Summing up the three appearances in §. 23, Barhow deconstructs the entire classification system: "[...] nobody should think that I reckon these appearances to constitute different kinds, for as everybody can easily notice and realise, it is actually one and the same [phenomenon], which only lends itself to differentiation based on where it is situated in the sky and how densely or diffusely the matter is assembled" (§. 23, p. 11 / *p. 14*).[12] Moreover, sometimes two, or even all three, appearances are observed on the same night. This is explained by the ever-changing nature of the auroral matter.

§. 24 deals with the glow of the aurora. At times, it outshines a full moon, at others it is far fainter and "so obscure that it can be characterized as nothing but a white fog or smoke, without any glow at all" (p. 12 / *p. 15*).

In a brief §. 25, Barhow concludes that the height of the aurora can vary, adding that it occasionally happens that one aurora is situated higher up in the sky than another. In such cases, the upper aurora is more diffuse than its lower counterpart.

Hvad tid paa aaret Nordlyset helst viiser sig (p. [13]) / *Um welche Jahrzeit sich das Nordlicht am meisten zeiget (pp. 16–17)*

"At which time of the year the Northern Lights usually displays themselves" consists of two brief paragraphs, §§. 26–27. Barhow affirms that the aurora can be seen throughout the year, "for as

[12] The adjective and adverb "hyppig" is used by Barhow in the sense 'thick, densely packed, compact' as opposed to "tynd" ('thin, loosely packed, diffuse'). This contrasts to modern, standard Danish, where "hyppig" means 'frequent, common'. The German translator has interpreted it in the latter sense. However, the German "häufig" hardly makes sense in the given context.

soon as the night is dark enough for the sun not to take away its glow, it will immediately appear" (§. 26, p. 13 / *p. 16*). Although he admits that the strongest visual impressions that he can recall have usually taken place in September or October, Barhow explains this by pointing out that the Nordic night has by then returned to its darkest while the snow has not yet arrived. A snowclad landscape robs even the darkest nights of a little of their darkness, making the aurora appear fainter and less colourful. During spring, snow will cover the entire landscape while the nights become gradually brighter, so that in the end the aurora is hardly visible at all. Moonlight has the same effect, making the aurora appear fainter (§. 27).

Hvad tid om natten Nordlyset viiser sig (pp. [13]–[14]) / *Um welche Zeit der Nacht sich das Nordlicht zeiget (pp. 17–19)*

"At which time of the night the Northern Lights display themselves" fills §§. 28–31. Again, no fixed pattern is to be found. The aurora can appear, grow stronger, disappear, and reappear several times from the arrival of dark in the afternoon till the brightness of dawn arrives the next morning. Barhow discusses the aurora in conjunction with changes of the weather, the position or movement of the moon, and the ebb and flow of tides. While he does point out certain circumstances that appear conducive to making the aurora appear more often, no strict rules apply. For example, "when there between two types of weather exists in the air such a balance as is likely to occur here [at Ørlandet] in-between eastern and western winds, the aurora tends to be seen most regularly and densely packed" (§. 31, p. 14 / *p. 19*).[13]

Paa hvad stæd paa himmelen Nordlyset helst viiser sig (pp. [14]–[17]) / *An was für einem Orte des Himmels sich das Nordlicht besonders zeiget (pp. 19–24)*

"At what place in the sky the Northern Lights usually display themselves" entails a rather elaborate discussion distributed over ten paragraphs, §§. 32–41. The most common place is in the northern part of the sky, close to zenith (§. 32). It is rarely seen in the southern part of the sky, and in such cases only the third appearance of aurora is on display. The maximum distance from zenith to the south that Barhow has observed is 40 degrees, but such instances are very rare (§. 33). The Weather Lights / Northern Lights of the first kind ("værirlyset af det förste slags" / *"das Nordlicht von der ersten Art"*) are most conspicuous between 30 and 45 degrees above the horizon in the north, as described in §. 17 (§. 34, p. 15 / *p. 20*). In fact, all kinds of aurora are most common in this region of the sky. It is here the phenomenon usually starts becoming visible, it is here it tends to be at its brightest, and here it lasts the longest (§. 34). A

[13] Again, the German translator uses "häufig" (*am beständigsten und häufigsten*). I have translated according to "hyppig" in the sense of 'densely packed'.

discussion of whether or not colours are on display when the aurora passes directly through zenith fills §§. 35–36. The next paragraph can be translated thus (§. 37, p. 16 / *pp. 21–22*):

> When two persons at different places that are no more than three or four miles distant from each other, try to observe and record the situation, site, brightness, and colours of the Northern Lights at exactly the same time of the clock insofar as this is possible, they will rarely agree on anything at all. This goes to show that it – like the rainbow – manifests itself differently depending on the change of place of the observer. Therefore, an effort to determine the parallax and height above the earth by means of observation from two different places is bound to be in vain. For it is hardly the same Northern Lights that are seen in two different places situated at any substantial distance from each other, as previously observed by both Halley and Maraldi.

§. 38 emphasises that clouds will always block the aurora from sight. This demonstrates that the aurora is always situated above the clouds, in contrast to lightning and "other fiery meteorological phenomena", which can be seen below the clouds (p. 16 / *p. 22*). The aurora always emerges in the Northeast and disappears in the Northwest. This is because of the movement of the sun below the horizon (§. 39). New arcs and rays can appear at a place from which the aurora has recently disappeared. This is because of the external movement of the phenomenon already described in §. 16 (§. 40). The aurora is regularly seen in the northern part of the sky at all places except Greenland, where it is exactly the opposite. Barhow here refers to Andreas Bing (1702–1760), "a man well versed in mathematics and with a keen interest in physics" (p. [17] / *p. 23*). During the several years that Bing spent on Greenland as a missionary at Christianshaab (Qasigiannguit), he never observed the Northern Lights in the northern, but always in the southern part of the sky and no more than 23 degrees above the horizon. At the slightly more southerly latitude of Godthaab (Nuuk), he recalled seeing them higher in the sky, but never to the north of zenith (§. 41).

Ved hvad slags veirlig Nordlyset helst viiser sig (pp. [17]–[27]) / *Bey was für einer Witterung sich das Nordlicht am meisten zeiget (pp. 24–39)*

"In what kind of weather conditions the Northern Lights tend to display themselves". The length of this section, §§. 42–63, reflects both the importance commonly attributed to the weather by eighteenth-century auroral investigators and the meteorological nature of Barhow's own theory.

In §. 42, Barhow remarks that the aurora can be on display even in heavily overcast weather, provided there are openings in the layer of clouds. In §. 43, he dismisses any ideas that a particular kind of weather can be used to forecast the aurora, nor can the aurora be used to forecast any particular kind of weather. Despite the lack of strict rules, he does point to some tendencies, "which I have arrived at, upon thorough observation over a long period of time" (p. 18 / *p. 25*). Barhow discusses the general wind directions and the different kinds of weather

associated with these, as seen from the vantage point of Ørlandet. The aurora is frequently seen during clear and cold weather with winds blowing from North or East, yet at times you can experience these conditions without any aurora whatsoever (§§. 44–45). The cause of this might be local circumstances characteristic of the coastal region of Ørlandet (§. 46). When the northwestern wind dominates out at sea, there will be no aurora in sight. However, "when northwest winds have raged for a long time" one can be sure that the aurora will display itself afterwards (§. 47, p. 21 / *p. 29*). The only type of weather that excludes the possibility of witnessing an aurora at Ørlandet, is "thick air in the northwest" (§§. 48–49, p. 21 / *p. 30*). "Although the Northern Lights per se do not indicate any particular kind of weather, it is still more or less possible to judge by their external movement from what direction the wind will blow in the coming days, since the aurora always moves towards the weather that is about to arrive" (§. 50, p. 21 / *p. 30*). This external movement is, however, often difficult to observe. According to local wisdom, a kind of thin clouds or vapours that emanate a dim brightness ("Bleege" / *"Bleiche"*, or *pallor* in Latin) and move slowly across the sky are certain harbingers of the weather. This phenomenon is interpreted by Barhow as a form of Northern Lights. Barhow has observed that these clouds or vapours are barely visible during daytime, only to flare up in the form of a shining aurora at night, a circumstance that "to a large extent makes it clear what the Northern Lights actually are", he argues (§§. 51–52, esp. p. 22 / *pp. 31–32*). When this dim brightness lies in the north, the first appearance of the aurora is often witnessed there (§. 53). The clouds or vapours causing this dim brightness do not in themselves constitute Northern Lights, yet they have several properties in common (§. 54, p. 23 / *p. 33–34*):

1) They lie as separate layers, arcs, stripes, and whirles across the sky.

2) They are covered by any kind of cloud, but are in return incapable of covering clouds of any kind and block these from our sight, meaning that they are always higher up than the clouds.

3) They always move towards the lowermost clouds or towards the approaching weather.

4) While they change their place, they also change their shapes and forms in a variety of ways.

5) They can disappear in one place and reappear at another place where nothing was previously seen.

However, the vapours apparently differ from the Northern Lights in at least two senses: 1) "In these vapours, no internal movement is discernible, unlike in Northern Lights". This is because the sun shines too brightly for such movement to be observed during daytime, when the dim brightness is at display, Barhow explains. 2) Unlike the Northern Lights, which are never seen in the southern part of the sky, the vapours can be seen all across the sky (§. 55, p. 24 / *p. 34*). The reasons are given in §§. 56–58, where Barhow discusses the relationship between day-time vapours and night-time aurorae. Under given circumstances, "these vapours, which are in the

sky during the day, can turn into Northern Lights in the evening" (§. 58, p. 25 / *p. 36*). It may also come to pass that the vapours dissipate and become too thinly spread out, or they drift downwards and occupy too low altitudes for them to manifest themselves in the form of Northern Lights.

An exceptional observation, where an aurora borealis became so dense that it stopped shining for a long time, is described in §. 59. In §§. 59–61, also mock suns ("bie-Sole" / *"Nebensonnen"*, or *parhelia* in Latin) are introduced. Similar to halos ("ring om Solen" / *"Hof um die Sonne"*, *halones*), these optical phenomena depend on the degree of density of moist particles in the atmosphere, Barhow explains.

§. 62 refers to literature reporting a gentle sizzling sound in the air ("een sagte suusen i luften", p. 27 / *"ein sachtes Sausen in der Luft", p. 38*). Barhow cannot deny that observers have heard something, yet he himself has never been able to hear any sound at all from the aurora (p. 27 / *pp. 38–39*):

> I have, however, found that when one stares at it for quite some time during its most intense flapping and moving, it is easy to imagine that this kind of sizzling accompanies the strong movement, especially if someone else has told you about such a sound beforehand. Yet, I confess that at other times, even during daytime under a completely serene sky with no wind at all, I have heard this gentle sizzling sound in the air, without being able to find any cause for this, for no wind has followed.

In §. 63, Barhow rounds off the first half of his treatise. It remains to try to demonstrate "what can be deduced, with some degree of certainty, from these observations and other sufficient evidence regarding the Northern Lights and their properties" (p. 27 / *p. 39*).

Nordlyset har sit stæd i vor Atmosphæra og ingenlunde der ovenfor (pp. [28]–[30]) / *Das Nordlicht hat seinen Ort in unserer Athmosphaera, und nicht über dieselbe (pp. 39–43)*

"The Northern Lights reside in our atmosphere and not above it" is the first of altogether twelve sections that form the second part of the treatise. In terms of paragraph numbers, the latter part of the treatise does not build upon the former part. The system of numbered paragraphs (§. 1, §. 2, etc.) is replaced by numerals beginning anew with the start of each new section. These numerals will hereafter be referred to as (1), (2), etc. The current section comprises seven numerals, (1)–(7). These take the form of corollaries (logical deductions) from the observations presented in the preceding part of the treatise, and can be summarized as follows.

In case the aurora had in fact been placed above our atmosphere, it would by necessity have been observed as frequently near the equator as in the north (1). In case the aurora had been located in the "celestial ether" (Barhow here resorts to Latin, *in æthere Cælesti*), it would either

have a certain fixed spot or be ubiquitously present. However, observations exclude both alternatives (2). In case the aurora was above our atmosphere, it would invariably move from the East towards the West due to the rotation of the Earth, which is not the case (3, referring to §. 9 above). The variable shape, position, and colours of the aurora, as seen by two observers situated only a short distance between each other, also suggest that the aurora is not placed above our atmosphere (4, referring to §. 37). The rapid movement of the aurora across the sky is also hard to explain when assuming that it is placed above the atmosphere (5). The movement of the aurora towards the approaching weather also shows that it is always connected to our atmosphere (6, referring to §. 8). In a mixture of Danish (or German) and Latin, the seventh corollary of this section claims that (7, p. 29 / *p. 41*):[14]

> Wherever it is, regardless if the aurora is a *materia ardens* [burning matter], a *phosphorica* [phosphorous matter], or a *pellucida* [transparent matter], it must surely be a *corpus grave* [body with weight], and by necessity belong to another *corpus mundi totale qvod motu vertiginis gaudet* [celestial body endowed with a whirling movement].

By this, Barhow apparently tries to point out that such behaviour (rapid movement across the sky, varying colours and shapes, etc.) as has been described in detail in the previous part of the treatise, is hard to imagine to origin from objects or processes above the atmosphere of the Earth. He continues by concluding that the *lumen Zodiacale* that Cassini and de Mairan have described, is not related to the aurora borealis. Efforts at measuring its height have also been entirely in vain, he claims, with reference to observations made on the European continent and his own §. 37 above.

Nordlyset har sit stæd iche i dend nederste, men stedse i dend överste part af Atmosphæra (pp. [30]–[31]) / *Das Nordlicht hat seinen Ort nicht in dem niedrigsten, sondern stets in dem obersten Theile von der Athmosphaera (pp. 43–44)*

"The Northern Lights reside not in the lowermost, but always in the uppermost part of the atmosphere", (1)–(3). The reasons can be summarized as follows: all clouds, no matter how high up, will always hide the aurora from our sight (1); you can never see any trace of clouds above the aurora, nor can you see a mountain peak towering in the air behind an aurora (2); the tendency of the aurora to move in the opposite direction of the winds in the lowest part of the atmosphere, as described by Barhow in §. 8, proves that the aurora must be located at a considerable height (3).

[14] The opening modification, "overalt" (wherever it is), is missing in the German version.

Nordlyset er ingen selvbrændende materie (pp. [31]–[35]) / *Das Nordlicht ist keine selbstbrennende Materie (pp. 44–50)*

"The Northern Lights are not a substance that burns by itself", (1)–(7). In this section, Barhow argues against a widespread hypothesis of the aurora borealis as an igneous or fiery phenomenon.

(1) The aurora displays the colours of the rainbow in their usual order, something a burning substance would never do. As Barhow sees it, the wisdom of current optics leads to the conclusion that the rays of the sun are refracted in the auroral substance, in a way similar to the rainbow. Wolff in his report on the 1716 aurora argued for the thesis of 'imperfect lightning', but later changed his mind and hypothesized that the appearance of colours suggested that at least some aurorae were caused by refractions of solar rays. At the end of a rather intricate line of argument, Barhow concludes by stating that any suggestion of igneous aurorae is surely mistaken. In the next numeral (2), he considers frequency at different latitudes, spatial distribution in the sky, and visual observations of colours to argue against the igneous aurora hypothesis. Numeral (3) highlights the capability of an aurora to rest motionless in the same part of the sky, something a burning substance would hardly do. The brief numerals (4), (5), and (6) take contemporary knowledge of lightning and particles of sulphur floating in the air as a point of departure – with dismissal of igneous aurorae the result. Finally, numeral (7) is less concerned with proving what the aurora is not, but rather points to what it probably is (p. 35 / *p. 49*):

> In the aurora borealis, regardless whether it is simply shining brightly or displaying colours as well, you can distinguish its particles clearly from one another, how they are driven and thrown about, just as if you had been throwing dusty particles of ice or fine glass towards the sun [...]. It would have been possible to put forth further pieces of evidence, except that I find that meaningless. I am convinced that those who have, up until now, nurtured the idea that the northern lights are a substance burning by itself, would surely have rejected this conjecture if only they had had the opportunity to observe the shapes and forms of the aurora as often as we do, in this region where we live. Indeed, all the properties of the northern lights resemble nothing less than an igneous substance.

At the very end of the section, the Northern Lights – especially those of the first type (see §. 13) – are compared to a rainbow.

Nordlyset bestaar iche af nogen Phosphorisk materie, som selv har lys (p. [36]) / *Das Nordlicht bestehet von keiner phosphorischen oder electrischen Materie, die selbsten Licht hat (pp. 50–51)*

"The Northern Lights are not a phosporous substance that shines by itself", one paragraph. Similar to the above section, Barhow uses contemporary physics to argue that the properties of the aurora are incompatible with a hypothesis claiming that its light originates in phosphor.

Nordlyset er vandagtige Damper i luften som faar lys andenstæds fra (pp. [36]–[37]) / *Das Nordlicht ist wässerichte Dünste in der Luft, die ihr Licht anderswoher bekommen (pp. 51–53)*

"The Northern Lights are watery vapours in the air that receive their light from outside", (1)–(2). Having established what the aurora is not, Barhow proceeds to explain in detail what he deduces it to be. The auroral matter consists of "exceedingly light and fine particles" floating around at high altitudes that ordinary clouds and mist cannot reach due to their density and weight (1, pp. 36–37 / *p. 51*). At such heights the air is always cold, enabling "frozen particles of water, or fine ice dust" to "refract rays of light and emit both light and colours" (1, p. 37 / *p. 52*). These particles must by necessity receive their light from outside, based on the laws of optics.

Nordlyset kand iche vel have sit skin ifra Solen (pp. [38]–[40]) / *Das Nordlicht kann nicht wohl seinen Schein von der Sonne haben (pp. 53–56)*

"The Northern Lights can hardly receive their light from the Sun", (1)–(5). Eclipses demonstrate that the shadow of a planet or the moon will extend beyond the extent of the atmosphere, and – by analogy – no doubt far beyond the height of the northern lights. The rays of the sun simply cannot reach the auroral substance as it floats above our heads, any time of the night (1). The northern lights as a phenomenon are likely to have been always present throughout history, just like the sun (2). When the northern lights display all the colours of the rainbow, they might be lit up by the sun around midnight, but according to the laws of optics they could not possibly exhibit themselves in the way that they do during the evening and early morning hours (3). For example, when the aurora is seen in the northeast just after sunset, it can remain in the same position all through the night, despite the movement of the sun, which would logically have caused the phenomenon to shift its position in the sky, had it been the source of the light. Optical experiments corroborate this assumption (4). Furthermore, in case

the sun was the true cause of the northern lights, they would logically occur just as often further south, close to the Equator,[15] "as they do here around the North Pole" (5, p. 39 / *p. 56*).

Nordlyset har iche sit skin af Maanen (p. [40]) / *Das Nordlicht hat nicht seinen Schein vom Mond (p. 57)*

"The Northern Lights do not receive their light from the Moon", (1)–(4). Neither the phases of the moon (1–2) nor its position in relation to the earth (3) has any effect on the aurora. Also, the geographical distribution of the phenomenon (most frequently seen in the north) would be hard to explain in case the moon was involved (3–4).

Nordlyset har iche sit skin fra stiernene (p. [41]) / *Das Nordlicht hat seinen Schein nicht von den Sternen (pp. 57–58)*

"The Northern Lights do no receive their light from the stars", (1)–(3). The stars shine equally bright everywhere, which makes it impossible to use the light of stars in order to explain why the phenomenon occurs most frequently near the North Pole.

Nordlyset har sit skin fra Norden, og unden fra Jorden (p. [41]–[43]) / *Das Nordlicht hat seinen Schein von Norden und unten von der Erde her (pp. 58–61)*

"The Northern Lights receive their light from the North, and from below, from the Earth", (1)–(6). Barhow is convinced that he has by now proved that the aurora does not receive its light from any celestial body (1). The circumstance that the aurora is most frequently seen in the north, less frequently in more southern countries, and not at all south of the Equator,[16] points to rays of light emanating from a fixed spot or region in the far north (2). Inhabitants close to the North Cape tend to see an unmoving light close to the horizon in the north (compare §. 3); this very same light is probably shining on frozen particles further up in the sky, thereby producing the aurora borealis (3). When assessed against the laws of optics, the distribution of colours seen during certain auroral outbreaks prove that the light reaches the auroral matter from the north – and from below, not from above (4). Thick clouds from the northwest can block the northern lights from sight (compare §. 46), proving that the light comes from that direction (5). Against the magnetic-matter theory of Halley and the sulphureous-matter theory promoted by others, Barhow argues that the matter cannot possibly be luminous in and by itself.

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[15] For the Equator, Barhow invariably uses the noun 'linien' / *'die Linie'* (literally, the line).
[16] See above, page 5 with footnote 9.

Observations of the placement and properties of northern lights in the sky (compare §. 9) suggest that the source of this light lies somewhere below the North Pole (6).

[section without heading] (p. [43]–[44]) / ** * * (pp. 61–63)*

This part of the treatise functions as an intermezzo where Barhow reflects on his reasoning so far, which he considers to be anchored "in well-known and established physical laws, or in irrefutable optical and mathematical ones" (p. 43 / *p. 61*). He then prepares the reader for a more speculative and hypothesis-driven line of reasoning, which he intends to follow over the next part of the treatise. As an analogy, Barhow refers to hypotheses that have been put forward to explain the maelstrom phenomenon (Moskstraumen) in Lofoten: in that regard, certain authors have departed from Cartesian or Newtonian physics and invented their own physical laws. Barhow, by contrast, is adamant to speculate in line with established laws only; he will resist any temptation to move beyond these.

De damper hvoraf Nordlyset bestaar, synes at kunde faae sit skin af dend mengde Jis som findes omkring Nordpolen (p. [45]–[48]) / *Es scheint, daß diejenigen Dünste, woraus das Nordlicht bestehet, ihren Schein, Glanz und Licht bekommen können von der Menge Eiß, das um den Nordpol befindlich ist (pp. 64–69)*

"It appears that the vapours that the aurora consists of, may receive their light from the masses of ice that are found around the North Pole", (1)–(9). Barhow argues for his hypothesis by pointing to several circumstances that he deems important.

As everybody knows, that there is no shortage of ice in the farthest north, including on and around Greenland, which is the best explored area (1). The amount of ice has increased dramatically over the last two centuries (i.e. the period from the mid sixteenth till the mid eighteenth century); this is evident when comparing old and new descriptions of Greenland and when one takes into account the Norse colonies that are now abandoned (2). Drift ice is created in a fjord at the western side of Greenland. From there, it is brought by the current of the sea around Cape Farewell and over to the eastern side, where huge icebergs are drifting along the coast (3). There is not much snow falling on Greenland, and the little that comes, will soon melt or blow away from the slippery ice surface (4). When approaching Greenland, sailors will see a glow in the air that they call "iisblinch" (p. 46) / *"Jisblink, oder Eißschimmer" (p. 66)*. This glow is the same that the inhabitants around the North Cape see on the northern part of the horizon (5). Ice is, exactly like glass, capable of reflecting even the faintest rays of light (6). When great fires erupt, be it in cities or forests, the light from the flames may lit up clouds in the sky and thus be visible over large distances (7). The herring, which at times swims in enormous schools,

can cause the sky to lit up at night. This happens when these schools swim close to the surface, according to local inhabitants. Barhow himself has seen this only once, but judges the reports of others to be credible, not least during autumn, "when the salty sea around here is filled with a kind of slimy phosphor called *morild*" (8, p. 48 / *p. 68*).[17] Experience shows that a very even surface of ice, when viewed from a high point at night, reflects all kinds of light, even that of small stars. The amount of ice on and around Greenland and other places in the farthest north, is therefore highly relevant to consider when the northern lights are concerned (9).

In a marginal note that is not included in the German translation, Barhow speculates on the possible existence of an analogous phenomenon on the Southern Hemisphere (p. 48):[18]

> Based on Halley's experience it is established that there is even more ice around the South Pole than around the North Pole, and there is an astronomical cause for this. It would be desirable to be able to penetrate sufficiently far to the south, to see if the ice down there produces the same phenomenon. It is likely that this will be the case, sometime in the future.

[section without heading] (pp. [49]–[71]) / ** * * (pp. 69–101)*

In a section of 22 (Danish manuscript) or 33 pages (German book), Barhow further explains and corroborates his theory. Two important questions in auroral research are *first*, why the phenomenon is most frequently seen in the north and *second*, why it is more commonly seen nowadays than in the past.

Pages [49]–[50] / *69–71.* The first question is answered by Barhow by pointing to the ice around the North Pole. Regarding the occasional sightings of aurorae further south, he explains this by reminding his readers that one translucent object (i.e. ice dust floating high in the sky above Scandinavia) is fully capable of reflecting light in a new direction, so that it reaches another object farther away (i.e. ice dust floating high in the sky above France or Italy). The light may in such cases lose some of its strength and colour, which explains well why the aurora on the continent generally exhibits other properties than in the north.

Page [50] / *71.* The second question relates to whether the aurora is something new in nature. Barhow argues that the climate in the north has changed in recent decades, resulting in a wider ice cape, extending all the way down towards 70 degrees north. This has caused the aurora to be more frequently seen above Scandinavia than before, including above the continent in some cases.

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[17] Nightly luminescence of the seas puzzled many eighteenth-century investigators. In Norway, the phenomenon known as *morild* is caused by zooplankton in the dinoflagellate group. This cause of *morild* was not established at Barhow's time of writing, however.
[18] With this remark, Barhow actually predicts the existence of the aurora australis.

[missing in Danish version] / *71–74.* Note that the Danish manuscript has a lacuna, causing the flow of the text to be broken.[19] This summary of pages *72–74* follows the German version only.

"Two things are important to consider here", Barhow argues (at the very bottom of p. *50* / *71*). *First,* the lack of ice on the eastern side of Greenland in former times was the main reason why the aurora was not seen on the European continent, Barhow argues. The many high mountains on Greenland have probably prevented the glow of the ice to extend beyond its western part. *Second*, the form of the earth, which recently has been established as spheroid and compressed towards the pole, has also prevented the light to penetrate further south.

Certain investigators see the widening ice cape as a sign that the climate is growing colder. Barhow, however, argues that it is a cyclic phenomenon. The reason why the pack ice around Greenland has grown in extension in recent years is likely to be found in the mysterious Jisfiord / *Sinus glacialis* (i.e. Ilulissat), where new icebergs constantly calve and drift towards the open sea. However, the shallow waters at the mouth of this fiord tend to prevent the icebergs from moving further, until the sheer weight of amassed icebergs join forces with the waves of the sea.

Pages [51]–[52] / *74–76.* It is this that must have happened recently, resulting in numerous icebergs being driven by the current around the southern tip of Greenland and getting packed along the eastern coast. Drift ice will occasionaly break loose and drift as far as Iceland, sometimes bringing white polar bears with them.

Page [52] / *76–77.* Historical records attest that not only has large parts of the Baltic Sea (Östersöen, *Ostsee*) been frozen, but also the North Sea along the coasts of southern and western Norway. The Byzantine chronicler Glycas records that the shores of the Mediterranean Sea have been covered with ice. Given such circumstances, the observations of Aristotle and Pliny are easy to explain.[20]

Pages [53]–[56] / *77–82.* The rapid movement of the northern lights are explained by analogy with waves in the water. Often, when two currents meet, or when the current of the sea goes in one direction and the wind in the opposite, waves will go in both directions. Similar clashes between wind currents in the thin air high up in the atmosphere will cause fine particles of ice to move around rapidly in different directions. The air is thin and the particles so light that the movement can become both energetic and swift, as well as chaotic. The aurora is frequently seen when two conflicting types of weather meet, and its undulating movement will often occur

[19] "Two things are important to consider here", Barhow states near the bottom of p. [50] in the Danish manuscript, but only the first of the two is introduced. The page ends in the middle of a sentence, while the next page [51] picks up in the middle of another sentence on something else. The missing part is supplied by the German edition. The sentence where p. [50] breaks off represents the beginning of p. *72* in the German edition; the place where p. [51] picks up, can be found in German in the lower half of p. *74*. From there, the two versions again follow each other closely.

[20] The German edition here includes a mention of observations from Persia, as recorded by Jean Chardin. Barhow thinks these are fiery phenomena, not related to the aurora at all (*p. 77*). No trace of this is found in the extant part of the Danish manuscript.

in the opposite direction of the wind that moves close to the surface of the earth. Winds moving in different direction at different heights are also analogous to currents of water in the sea.

Pages [56]–[58] / *82–85.* The position of the aurora in the sky, especially when it displays a variety of colours, is explained by analogy to the rainbow. The slightly shifting position of the aurora from time to time results from the large extent of the ice in the Arctic; at the 66th latitude, where Barhow is situated, the aurora is statistically seen most frequently in the north-north-west, which dovetails nicely with his theory. The two first types of aurora (introduced in §§. 13–17 and 18–19 respectively) are caused by refraction of light, whereas reflection comes into play when the third type is produced (see §§. 20–22).

Pages [59]–[62] / *85–90.* Barhow foresees criticism (p. [61] / *pp. 85–86*):

> When such vapours are in the air, capable of refracting the light and emit both light and colours, why cannot the light of the Sun, Moon, or stars cause the same phenomenon as the ice in the vicinity of Greenland? The light of these celestial objects will likewise be transported through the same vapours in its way to us, so why do they not produce the same light?

The objection is answered by analogy to a *camera obscura* experiment. When allowing rays of light to enter a darkened room through a small hole, it is easy to produce all the colours of the rainbow by allowing the light to pass through a glass of water on its way to a white sheet of paper behind it. Similarly, the ice particles will be translucent and fully capable of producing different colours in the dark as the rays of light hit the particles from an area that is totally obscure to us due to the shape of the earth. By pointing to an "irrefutable truth" in the optical theory of Newton, Barhow explains why the aurora so often manifests itself in a red hue: since this is the strongest of the colours in sunlight, red is the colour most likely to be seen when the conditions of the sky are not ideal.

Pages [63]–[64] / *91–93.* When winter arrives before the ground is frozen, vapours will sift though the snow from the moisty soil of marshlands. As soon as these vapours meet the freezing temperature above the layer of snow, they turn into heavy, frozen particles that form a thick fog covering the lowest parts of the landscape; the local population refers to this as "frostgov" or "frostdamp" (p. [63]) / *"Frostgov, oder Frostrauch"* (*p. 91*). When the sun shines on this fog, it can appear red when observing from a dark place. Sometimes even other colours will appear, but all colours, including red, vanish as soon as the observer steps out from the dark. As for the different colours of the aurora, Barhow is puzzled by certain continental reports, e.g. those by Pieter van Musschenbroek, that do not match his own observations described in §. 14 above.

Pages [64]–[67] / *93–96.* Reports state that in contrast to the Norwegian mainland, from Greenland the aurora is regularly seen in the southern part of the horizon (see also §. 41 above). Barhow tackles this by hypothesizing that periods of rain followed by freezing temperatures

scarcely occur north of the Danish colonies at Greenland. Such climate is however needed for ice to be formed, and without ice, there can be no northern lights according to Barhow's theory. Nevertheless, reliable reports on the weather north of these colonies are missing, save for what can be deduced from wind directions observed by Andreas Bing and others that have lived in the southern part of Greenland. Barhow therefore confesses that his explanation can only be tentative.

Pages [68]–[69] / *97–99.* Barhow next discusses certain kinds of weather that according to his own observations made in §. 46 prevent northern lights to be observed. In keeping with his hypothesis of the ice around Greenland as the true cause of northern lights as seen at Ørlandet, northwestern wind directions are given particular attention. Simultaneous observations made of the weather (and the aurora) at Greenland, Iceland, and Ørlandet would likely contribute massively to clarify this topic, if such an observational scheme could be organized.

Pages [69]–[70] / *99.* As for the moon, which apparently can have some degree of influence on the aurora borealis (as see §. 31 above), Barhow has no explanation.

Pages [70]–[71] / *100–101.* In a topographical treatise on Bohuslän by the Swede Johan Ödman, there is reference to a coversation on the aurora that Ödman has had with Barhow some years earlier. The latter is not happy with Ödman's summary of this discussion and feels that he is misquoted. The final sentences of the treatise (before the appendix) can be translated thus (pp. [70]–[71] / *pp. 100–101*):

> I could continue presenting various pieces of evidence that would seem to lend more probability to this hypothesis. However, since I am already guilty of having transgressed my own limitations by being far more elaborate than intended, I will let the matter rest for now. With what has been said, I do expect that, despite having been unable to settle the question of what the aurora borealis is, I have nevertheless (to a certain extent) been capable of demonstrating what is is not. Anyone that wishes to do so, can easily proceed by assessing my conclusions in light of the observations described by myself or by others, and thereby investigate the matter further on their own accord, to see whether all phenomena lend themselves to be explained in this way. To those that immediately find this hypothesis to be fully improbable, and agree with the majority of investigators that the northern lights are some kind of exhalations – be they sulphurous, magnetic, phosphoric, or some other figment of imagination – and believe that this kind of exhalations either enter the atmosphere around the North Pole or (for whatever reason) are prone to be present in this region, I have the following message. At the end of the day, they should consider one circumstance only, as described in §§. 1 and 4 above, namely that the northern lights have been observed many hundred years ago in Greenland, but not at all here in Norway, where it was reported as something highly unusual. As everybody realizes when consulting a geographical map, the southernmost part of Greenland, which at that time was inhabited by Norwegians, is on the same latitude as Bergen in Norway, where the aurora borealis was not recorded until the year 1709. Furthermore, this part of Greenland is far more southerly than Trondheim, where no aurora was observed during that period either. This circumstance leaves an unsolvable puzzle, no matter what other conclusion on the nature of the aurora is picked. I may grant that the northern lights might consist of some peculiar kind of vapours, which due to some particular reasons are prone to encircle the North Pole at a certain distance.

> However, I cannot bring myself to imagine that these vapours have, even in earlier periods, been (so to speak) determined by fate to occupy a certain longitude and latitude – that is, a certain distance from the Pole – and at the same time to imagine that the aurora borealis was continually seen in Greenland, but not at all here in this region or other places that are just as far north, or even closer to the Pole. This, I must say, would be far too much to ask from a meteorological phenomenon.[21] Here at the very end, I express my hopes that in case nobody is satisfied with the hypothesis that I have presented, I have nonetheless been able to serve the interests of at least some devoted investigators with my meticulously reported observations.

Anhang (pp. [72]–[75]) / ** * * Anhang (pp. 101–104)*

In a brief appendix, Barhow mentions the phenomenon of bloodred night skies that has occasionally been described. The first time it was observed "here" (at Ørlandet) was in 1734. Thereafter, Barhow himself has witnessed a bloodred night sky twice – in November of an unmentioned year and finally in December of 1747. On both occasions, ordinary northern lights were observed simultaneously. Barhow believes that the cause of the bloodred night sky might be found in the rather mild weather, which, combined with a lack of wind, may have caused extraordinarily small snowflakes to melt in the air without dropping to the ground immediately. He has witnessed an analogous phenomenon on frost-covered window glass. When the room inside is heated, the windows will appear glowing red for a short moment, just as the temperature inside rises above zero degrees. Another analogy is when a large bonfire is witnessed from a distance, with precipitation in the form sleet or quite wet snow taking place simultaneously. The fire will then appear bloodred. However, during clear skies or after an ordinary snowfall, the light from such a fire will appear utterly white.

[21] The German version has two verbs, which can be translated as "[…] far too much to demand from a meteorological phenomenon, or for a meteorological phenomenon to lay claim to".

APPENDIX

Barhow's references explained

p. [3]; cf. pp. [4], [13] / *p. 1; cf. pp. 3, 17* Eet gammelt skrift skreven paa Grönland [...] hvilket af Hr Peder Clausen Præst i Undal er indfört i hands Norriges beskrivelse / *eine alte Schrift, geschrieben in Grönland [...] welche Schrift der Hr. Peder Claussön, Pastor in Undal, in seine Beschreibung von Norwegen eingerückt hat* = Speculum Regale, printed in Peder Claussen [i.e. **PEDER CLAUSSØN FRIIS, 1545–1614**], *Norriges og omliggende Øers sandfærdige Beskrivelse: Indholdendis Hvis værd er at vide, Baade om Landets og Indbyggernis Leylighed og Vilkor* (Kjøbenhavn, 1727), pp. 167–173 (172–173 on the aurora borealis). Digitized

p. [3] / *p. 2* Hollændernis reise beskrivelser af seenere tider / *Die Reisebeschreibungen der Holländer von späteren Zeiten* = (without specifying, Barhow refers to "the travel accounts of the Dutch from recent times").

p. [3]; cf. p. [52] / *p. 2; cf. p. 77* Arist: Meteorol. Lib 1. c. 4.5. / *Aristot. Meteorol. Libr. 1. cap. 4.5.* = **ARISTOTLE, 4th cent. BCE**, *Μετεωρολογικά* (Meteorology).

p. [3]; cf. p. [52] / *p. 2; cf. p. 77* hos plinium Hist: Nat: lib: 2 c. 26 / *beym Plinium Hist. Nat. lib. 2. c. 26.* = **PLINY THE ELDER, 1st cent. CE**, *Naturalis Historia* (Natural History).

p. [3] / *p. 2* hos Senec: qvæst: Natur: lib. 1. c. 15 / *bey Senecam quaest. Natur. lib. 1. cap. 15.* = **SENECA THE YOUNGER, 1st cent. CE**, *Naturales Quaestiones* (Natural Questions).

p. [4]; cf. pp. [46], [71] / *p. 3; cf. pp. 66, 98* Wolf i sin Vernunft: ged: Von Wirchung der Natur § 735. / *der weltberühmte Philosophus, B. Wolff, in seinen vernünfft. Gedank. von den Würk. der Natur* = Christian Wolffen (i.e. **CHRISTIAN WOLFF, 1679–1754**), *Vernünfftige Gedancken von den Würckungen der Natur, den Liebhabern der Wahrheit mitgetheilet* (Halle in Magdeburg, 1723), pp. 467–482. Digitized

p. [5] / *p. 4* in Act: Erud: / *in Actis Erudit.* = **Acta Eruditorum**, a journal ed. by the Mencke family (Lipsiae [Leipzig], 1682–).

p. [5] / *p. 4* Memoir: de l'Acad. Royal. des scienc: / *Memoires de l'Academ. Royal* = the official journal of the French Academy of Sciences, **Mémoires de l'Académie Royale des Sciences, avec les mémoires de mathématique & de physique [...] tirez des registres de cette Académie** (Paris, 1699–).

p. [5] / *p. 4* Transact: Angl: / *Transact. Angl.* = the official journal of the Royal Society of London, **Philosophical Transactions giving some Accompt of the present**

Undertaking, Studies, and Labours of the Ingenious in many considerable Parts of the World (London, 1666–).

p. [5] / *p. 4* foruden i andre particulaire tractater / *als auch in andern particulairen Tractaten* = (journal articles aside, Barhow refers to "other separate treatises").

p. [6]; cf. p. [47] / *p. 6; cf. p. 67* Christian Mejer Videnskabernes Academies Medlem til Petersburg har observeret in Comment: Acad: Petrop: 1728. p. 357 / *Christian Meier, Mitglied der Academie der Wissenschaften zu Petersburg, observiret hat in Comment. Acad. Petrop. 1728. p. 357* = **FRIEDRICH CHRISTOPH MAYER (1697–1729)**, "De Luce Boreali" in *Commentarii Academiae Scientiarum Imperialis Petropolitanae* Tomus I ad annum 1726 (Petropoli, 1728), pp. 351–367. Digitized

p. [6] / *p. 6* Wagn: in tract: de phæn: boreal: p. 33 / *Wagner in Tract. de Phoenom. boreal. p. 33* = **RUDOLPH CHRISTIAN WAGNER (1671–1741)**, *Erzehlung derer zu Helmstädt am Abgewichenen 17ten Martii von 7. biß nach 12. Uhren zu Nachts gesehenen Meteororum Igneorum welche bestanden Jn einer starcken Helle und Luffi Erleuchtung, Breiten lichten Strahlen, und einem dem Wetterleuchten ähnlich gewesenen Blitzen, benebst einer Deduction, daß diese Erscheinungen aus natürlichen Uhrsachen entstanden* (Helmstedt, 1716). Digitized

pp. [6], [13], [23], [64] / *pp. 6, 16, 33, 92* Muscenbrooch / *Mussenbroek* = **PIETER (PETRUS) VAN MUSSCHENBROEK (1692–1761)**, probably the *Elementa physicae, conscripta in usus academicos*, where the aurora borealis is discussed in "Cap. XL. De Meteoris Igneis". The work was issued in several editions from 1726 onwards. See e.g. the 1734 ed. (Lugduni Batavorum, 1734), §§. 968–982, pp. 457–466. Digitized; the 1741 ed. (Lugduni Batavorum, 1741), §§. 1310–1326, pp. 557–567. Digitized; the two-volume 1745 ed. (Neapoli, 1745), Tomus Secundus, §§. 1310–1326, pp. 250–261. Digitized

p. [6] / *p. 6* og fleere / *und mehrere* = (Barhow says that certain properties of the aurora have been observed by the above-mentioned "and more" authors).

pp. [16], [42], [48] / *pp. 22, 60, 92* Halley / *Halley* = **EDMOND HALLEY (1656–1742)**, "An account of the late surprizing appearance of the lights seen in the air, on the sixth of March last, with an attempt to explain the principal phænomena thereof" in *Philosophical Transactions* Vol. 29, No. 347 (London, 1717), pp. 406–428 (on pp. 424–425). Digitized

pp. [16] / *p. 22* Maraldus / *Maraldus* = **JEAN-PHILIPPE (Giacomo Filippo) MARALDI (1665–1729)**, "Observations d'une Lumière Septemtrionale" in *Histoire de l'Académie Royale des Sciences [...]* Année 1716 (Paris, 1718), *Mémoires* section, pp. 96–107 (on p. 99). Digitized

p. [17]; cf. p. [68] / *p. 23; cf. p. 95* Een in mathematicis sær erfaren og in physicis meget curieux Mand Hr Andreas Bing, som i nogle aar har været Missionair i Grönland / *von einem in Mathematicis sehr wohl versirten und in Physicis sehr curieusen Manne, Herrn Andrea Bing, welcher etliche Jahre als Missionarius in Grönland gewesen* = **ANDREAS BING (1702–1760)**, whom Barhow appears to have met in person and had conversations with.

p. [27] / *p. 38* Burman in Act: Lit: Svec: p: 568: / *Burmann. in Act. Lit. Svec. p. 565.* = **ERIK JOHAN BURMAN (1692–1729)**, "Observatio circa Lumen Boreale d. 20. Sept. Ao. 1717 prope Upsal." in *Acta Literaria Sveciæ* Volumen Primum, Anni MDCCXXIV, Trimestre Tertium (Upsaliæ & Stockholmiæ, [1724]), pp. 566–570. Digitized

p. [27] / *p. 38* Heuson tract: germ: de aur: bor: / *Hausson. Tract. Germ. de auror. boreal.* = **JOHANN CHRISTIAN HEUSON [or Heusson] (1676–1741)**, *Kurtze Betrachtung über zwey Phaenomena oder Luffi-Geschichte, welche sonsten Lumen Boreale seu Aurora Borealis genennet werden deren das erste zwischen dem 17. u. 18. Febr. von 7 biß 12 Uhr, das andere zwischen dem 1. un 2. Mertz [...] über der Stadt Franckfurth am Mayn [...] gesehen worden* (Franckfurth am Mayn, [1721]). Digitized

p. [29] / *p. 41* Det lumen Zodiacale som af Cassino [...] er observeret / *das Lumen zodiacale, welches von Cassini [...] vorgegeben wird* = **[JEAN-DOMINIQUE] CASSINI (or Giovanni Domenico C., 1625–1712)**, *Découverte de la Lumière Céleste qui paroist dans le Zodiaque* (Paris, 1685). Digitized

p. [29]; cf. p. [30] / *p. 41; cf. p. 42* Det lumen Zodiacale som af [...] de Mairan er observeret / *das Lumen zodiacale, welches von [...] de Mairan vorgegeben wird* = **[JEAN-JACQUES D'ORTOUS] DE MAIRAN (1678–1771)**, *Traité physique et historique de l'Aurore Boréale* (Paris, 1733). Digitized

p. [29] / *p. 42* antegnet i L'Hist: de l'Acad. Roy. for aar 1731. / *in Mem. de l'Acad. Royal von ao. 1731. angezeichnet* = **JACQUES CASSINI (1677–1756)**, "Observations météorologiques faites à Aix par M. de Montualon [...], comparées avec celles qui ont été faites à Paris en 1730." In *Histoire de l'Académie royale des sciences [...]* Tome IV (Paris, 1731), *Mémoires* section, pp. 1–9 (on pp. 5–6). Digitized

p. [32]; cf. pp. [46], [69] / *p. 45; cf. pp. 66, 98* Dend Berömmelige Wolf, Hvilchen efterat hand havde observeret Nordlyset 1716. udgav Hand sine tancher derom i een liden tractat / *Der Herr Baron Wolff, nachdem er das Nordlicht 1716. observirt hatte, gab seine Gedanken davon in einer Dissertation heraus* = **CHRISTIAN WOLFF (1679–1754)**, *Gedancken über das ungewöhnliche Phoenomenon, welches den 17. Martii 1716. des Abends nach 7. Uhren zu Halle und an vielen andern Orten in und ausserhalb*

Deutschland gesehen worden, wie er sie den 24. Martii in einer Lectione Publica auf der Universität zu Halle eröffnet (Halle, 1716). Digitized

p. [44] / *p. 62* Een vis Scribent for kort tid siden har vildet explicere havets Ebbe og flod, og iche vilde nöyes med Cartesii eller Neutons meening herom / *ein gewisser Schriftsteller, vor nicht so gar langer Zeit, hat expliciren wollen die Ebbe und Fluth des Meeres, und wollte mit Cartesii, oder Newtons, Erklärung sich nicht begnügen lassen* = ("A certain author has not long ago tried to explain the ebb and flow of the tides, and in doing so was neither content with the opinion of Descartes, nor that of Newton"). Probably referring to senior district stipendiary (*amtmann*) **OVE SCHIELDERUP (1674–1756)**, towards whose manuscript on the Moskstraumen maelstrom Barhow was very critical, see footnote 4 above.

p. [45] / *p. 65* naar mand Conferer de gamle og nye Grönlands beskrivelser / *wenn man die alten und neuen Beschreibungen von Grönland mit einander conferirt* = (without specifying, Barhow refers to "the old and the recent descriptions of Greenland").

p. [52] / *p. 76* Vi finde i de gamle Norske Historier / *Wir finden in den alten norwegischen Historien* = (without specifying, Barhow refers to "old Norwegian historical accounts").

p. [52] / *p. 76* Glycas forteller / *und erzehlet der alte Historienschreiber, Glycas* = **MICHAEL GLYKAS, 12th cent. CE**, Βιβλος χρονικη, first printed in a Latin edition by Johannes Löwenklau (Iohannes Leuvenclavius), *Annales Michaeli Glycae Siculi, qui lectori praeter alia cognitu iucunda & utilia, Byzantinam historiam uniuersam exhibent: nunc primum Latinam in linguam transscripti & editi* (Basileae, 1572). Digitized

- - / *p. 77* *wie Chardin erzehlet* = **JEAN (John) CHARDIN (1643–1713)**, probably the *Journal du Voyage du Chevalier Chardin en Perse et autres lieux de l'Orient [...]*, 10 vols (Amsterdam, 1711).

p. [58] / *p. 85* Denne regnbue skal være omtrent af samme slags som Halley siger sig een eeneste gang at have seet, Philos: Trans: No 420. / *ohngefehr von der Art [...], wie der Herr Halley sagt Phil. Traus. No. 420* = **EDMOND HALLEY (1656–1742)**, "An Account of the Appearance of an Extraordinary Iris Seen at Chester, in August Last", in *Philosophical Transactions* Vol. 20, No. 240 [*not* 420!] (London, 1698), pp. 193–196. Digitized

p. [67] / *p. 96* een gammel reise beskrivelse / *in einer alten Reisebeschreibung* = ? (without specifying, Barhow refers to "an old travel account").

p. [70] / *p. 100* Mag: Ödmans, Provst udi Vigerne, og SognePræst til Tanum i Sverrig, hands Chorographia Bahusiensis / *M. Oedmanns, Probst in Vigen und Hauptprediger in Tanum in Schweden, seine Chorographia Bahusiensis* = **JOHAN ÖDMAN (1682–1749)**,

Chorographia Bahusiensis thet är: Bahus-läns beskrifning, så til thesz natur, art och beskaffenhet under fred och feigd i gamla urminnes tider under danska regeringen, som til thesz nu warande tilstånd sedan thet kom, genom freds-fördrag under Sweriges crono, både hwad inbyggarenas wäsende, handel ock näring i alla stånd widkommer, som ock alla the märckwärdigheter, man kunnat på alla orter i hwart giäl utur dystra mörckret upleta ock nu i dagsliuset bringa, efter mångas åstundan (Stockholm, 1746). Digitized