Aurorae Borealis Studia Classica

Vol. III

L'Aurore Boréale (1886)
Om polarljuset eller norrskenet (1886)

by Selim Lemström

digitized by UiT, with a biographical introduction
and summary of contents by Päivi Maria Pihlaja

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SELIM LEMSTRÖM (1838–1904)

Biographical introduction
by Päivi Maria Pihlaja

(Karl) Selim Lemström was a Finnish physicist. Born in 1838 in Ingå (Inkoo) in present-day Finland, at that time the Grand Duchy of Finland within the Russian empire, he died in Helsingfors (Helsinki) in 1904. In 1853, Lemström began studies at Borgå (Porvoo) Lyceum. Four years later, he matriculated at the Imperial Alexander University (later, the University of Helsinki), where he became a *Filosofie kandidat* in 1862, *magister* in 1864, *docent* in 1869, and received a doctoral degree in physics in 1872. Lemström was a professor of physics at the same university during 1878–1903.

In 1867, Selim Lemström received a stipend for a study visit in Sweden, where he assisted physicist Erik Edlund. The year after, he participated as a physicist in a Swedish polar expedition to Svalbard. During this expedition, he became interested in the aurora borealis. In 1869–70, Lemström continued his study tour to Paris, where he later became elected as a member of the *Société Géographique*.

Back in Finland, Lemström chose as his focus of interest the scientific investigation of the aurora borealis. He promoted Finnish participation in the first International Polar Year in 1882/83, and used this opportunity to perform further experiments and demonstrations in Finnish Lapland. The book *L'Aurore Boréale / Om polarljuset eller norrskenet* was published with the aim of promoting Lemström's theory concerning atmospheric electricity as the cause of the aurora borealis. The theory builds upon earlier experimentation with electric currents in rarefied air by August de la Rive, the notion of electric discharges and currents circulating in the atmosphere, and the concept of unipolar induction as formulated by Erik Edlund. The theory was later refuted.

L'Aurore Boréale, with the subtitle *Étude générale des phénomènes produits par les courants électriques de l'atmosphère* ('The Aurora Borealis: General Study of Phenomena Caused by the Electric Currents of the Atmosphere') was published in Paris in 1886 by Gauthier-Villairs. Its publication was promoted by Lemström's personal contacts in Paris. A grant allocated by the Imperial Alexander University in Helsinki facilitated the production and inclusion of a set of fourteen illustrations. Some of these were original chromolithographs

executed on the basis of croquis by the author (incorporated within the text), whereas nine gravures were based on drawings provided by the director of the *Bureau central météorologique*, Alfred Angot (1848–1924), depicting spectacles and forms of aurorae observed on various locations (appended to the end of the book).

Another version of the book (in Swedish), bearing the title *Om polarljuset eller norrskenet* ('On the Polar Light, or Northern Light'), was published in Stockholm in the same year (1886) by the publishing house Bonnier. This version was also facilitated through a grant from the Imperial Alexander University in Helsinki. The types are smaller, rendering the book somewhat shorter with regard to the number of pages. Moreover, the nine gravures appended to the end of the French edition are not included in the Swedish version. No detailed comparison of the actual text of the two versions has been made. It is striking, however, that in the French version the alleged electric origin of the phenomenon is stated in the subtitle and has even been allotted a separate chapter. The Swedish version has no subtitle and its corresponding text on the electric theory has been integrated into a more general chapter on atmospheric electricity (compare the French edition, Chapters VIII and IX with the Swedish edition, Chapter VIII).

Overall, *L'Aurore Boréale / Om polarljuset eller norrskenet* provides a popularized account of late nineteenth-century knowledge of the aurora borealis and phenomena related to it. At the same time, it is intended to function as a collection of evidence in support of Lemström's own theory, according to which the aurora borealis originates from atmospheric electricity circulating towards the arctic regions in the upper layers of the atmosphere.

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Holmberg, Peter: *The History of Physics in Finland* (The History of Learning and Science in Finland 1828–1918). Vaasa: Societas Scientiarum Fennica, 1993, pp. 76–87.

Seppinen, Ilkka: *Selim Lemström: Aleksanterin yliopiston fysiikan professorina 1878–1904 toimineen geofyysikon elämä ja työ.* Ed. Heikki Nevanlinna. Helsinki: Ilmatieteen laitos, 2006.

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L'AURORE BORÉALE

Summary of Contents (French edition)
by Päivi Maria Pihlaja

Apart from a list of works cited, a foreword, introduction, endnotes, and list of errata, the book as a whole is divided into two parts. Below, the corresponding page numbers in the Swedish edition are referred to within [brackets].

The first part, chapters I–VI (pp. 7–98 [=SWE, 5–76]), provides a general description of the study topic. The author explores general contemporary knowledge and lists observations concerning the aurora borealis and other phenomena having a close relationship with it (in particular, geomagnetism) .

The second part, chapters VII–XII (pp. 99–165 [=SWE, 77–135]), introduces the new theory. Atmospheric electricity is proposed as the cause of the aurora borealis. The narrative takes the form of series of questions and answers, concentrating on three problems: 1) the possible electric origin of the aurora borealis; 2) the cause behind negative electric charge of the Earth and positive charge in the air; 3) the reason why the aurora borealis is observed mostly in regions surrounding the poles of the Earth.

Auteurs et ouvrages cites (pp. xi–xii) [=SWE, 171–172]

Authors and works cited.

Avant-propos (p. xiii) [=SWE, no page]

Foreword.

Introduction (pp. 1–5) [=SWE, 1–4]

underlines the significance of the topic by giving an account of the most significant steps of scientific progress in questions concerning electricity. The author stipulates the need for more experimental knowledge on the subject. On the basis on his personal experiments and expeditions, the author promises to demonstrate the links between different phenomena of

light observed in the atmosphere (thunder, sheet lightning and the aurora borealis) and gives the overall motivations for adopting a new theory of their origin.

PREMIÈRE PARTIE

Chapitre I. Apparence de l'aurore boréale (pp. 7–17) [=SWE, 5–15]

The first chapter begins with a systematic depiction of the different visual appearances or forms of the aurora borealis. The author describes the splendours of the sights he has witnessed himself in high latitudes. Besides the most characteristic appearances, he draws parallels to other glows or glimmers of light observed not only in arctic regions, but in different parts of the world, as well as in varying altitudes, including near to the ground.

Chapitre II. Periodicité de l'aurore boréale (pp. 18–27) [=SWE, 16–21]

discusses recent investigations concerning the periodicity of the phenomenon by citing, among others, the compilation of observations by Fritz. It explains how those cycles appear to be connected with variation in Earth's magnetic fields, magnetic storms and sunspots. The author also analyses the periodicity of sunspots in relation to the years of famine experienced in Finland.

Chapitre III. Étendue géographique de l'aurore boréale (pp. 28–44) [=SWE, 22–23]

explores the geographical scope of the phenomenon, its maximum zone and variations, with a particular reference to recent observations by A. E. Nordenskiöld, Samuel Kleinsmidt and Sophus Tromholt. The author praises the significance of the systematic observations by Kleinsmith in Bossekop as calculated by Tromholt, but slightly disagrees with the conclusions Nordenskiöld has made. The author also draws attention to the rarity of storms or lightning in regions situated close to the poles of the Earth.

Chapitre IV. Hauteur de l'aurore boréale au-dessus de la surface de la Terre (pp. 45–59) [=SWE, 33–45]

discusses the methods and difficulties involved in determining the altitude in which the phenomenon takes place, based on measurements by a great number of scholars, in particular in Godthaab [Nuuk], Sodankylä and Bossekop. It is concluded that the upper limit appears to be between 35 and 70 kilometres. On the other hand, the author suggests that particular forms of the aurora borealis can take place significantly lower than has been believed, even close to the Earth's surface.

Chapitre V. Aperçu général sur le magnétisme terrestre (pp. 60–89) [=SWE, 33–45]

explores the theories and principles of geomagnetism and telluric currents, as well as the methods of measurement of their constants and variations. The author cites the work performed by the Magnetic Union of Göttingen and global observation networks, which have facilitated examination of the scope of magnetic storms, and refers to observations made by Hansteen, Sabine, Ross, von Humboldt, Lamont, Tromholt, Wild, Wijkander and others. With regard to methods of measurement, work by Gauss and Weber is cited. Based on his own measurements in Lapland, the author proposes that there exists a zone of telluric currents, which is analogous to the maximum zone of the aurora.

Chapitre VI. Effets et nature de l'aurore polaire (pp. 90–98) [=SWE, 70–76]

To complete his account of the facts that a scientific explanation of the phenomenon must cover, the author describes the effects of the aurora borealis on telegraphic lines, the nature of the light of the aurora in spectroscopic analysis, as well as its fluorescent properties. The difficulties in capturing the phenomenon into a photographic image are also discussed. The end of the chapter is devoted to describing how the phenomenon is experienced by the inhabitants of northern regions in terms of utility and perception.

DEUXIÈME PARTIE

Chapitre VII. Explication scientifique des aurores boréales (pp. 99–107) [=SWE, 77–85]

begins by refuting old superstitious beliefs concerning the aurora borealis, and then paves the ground for a scientific explanation. Alternative theories given earlier to the phenomenon are briefly described (i.e. reflections of light from ice, cosmic dust, magnetic theory). The author refutes all of these and finishes the chapter by justifying why the electric theory maintained by late August de La Rive should be considered as the most plausible one.

Chapitre VIII. Origine électrique de l'aurore boréale (pp. 108–110) [=SWE, 85–87]

displays a short overview of different types of evidence, which demonstrate the electric nature of the phenomenon. These include experiences with light produced by an electric current in rarefied gases; effects of magnetic storms; and spectral analysis. According to the author, the phenomenon belongs entirely to the atmosphere.

Chapitre IX. Électricité atmosphérique (pp. 111–123) [=SWE, 87–93]

analyses the measurements of atmospheric electricity as well as its daily and seasonal variations by citing different scholars, and explores varying scholarly opinions of its origin. Although observations have not showed any significant increase in electricity of the air during outbreaks of aurora borealis, the author claims that the absolute state of atmospheric electricity is not a necessity for the aurora borealis to take place, as this would more depend from the variation of its potential in a vertical direction. The author describes Erik Edlund's laboratory experiments concerning 'unipolar induction' and discusses the principles of vaporisation as a cause of atmospheric electricity. Combined, these phenomena lend support to the idea that the cause of the aurora borealis can be found in the circulation of atmospheric electricity towards arctic regions in the upper layers of the atmosphere.

Chapitre X. Fréquence des aurores polaires autour des poles de la terre (pp. 124–136) [=SWE, 93–106]

refutes the theory presented by August de la Rive concerning the role of winds as carriers of the atmospheric electricity towards the polar regions. The author presents an enhanced version of a laboratory device for reproducing a phenomenon resembling the aurora borealis by conducting an electric current through Geissler tubes containing rarefied air.

Chapitre XI. Les courants électriques de l'air (pp. 137–149) [=SWE, 106–119]

discusses closer the existence of electric currents in the atmosphere. The author challenges the idea of air being an isolator that could only allow momentary discharges of electricity in the form of lightning. The chapter concentrates on the results of measurements of air electricity and demonstrations producing a light resembling the aurora as performed in open air on mountains of Finnish Lapland, first in 1871/72 and later during the First International Polar Year (1882/83, 1883/84), by using a large influx machine *(appareil d'écoulement)* developed by the author for the purpose.

Chapitre XII. Théorie actuelle de l'aurore boréale (pp. 150–165) [=SWE, 119–135]

articulates the conclusions of the author by formulating a new theory on the origin of the aurora borealis. The author discusses again different types of discharges of atmospheric electricity; he explains why the aurora borealis should be considered as one, yet slower, form of discharge of atmospheric electricity in the manner of lightning. The discussion includes a physical explanation of the vertical electric currents, which are supposed to be the cause of the phenomenon, as well as factors affecting them. The author extends the significance of his new theory with regard to explanations given of other phenomena in a close relationship to it

(i.e. geomagnetism; influence of the Sun; geographical and temporal scope as well as the spectre of the aurora; and its alleged sound). Finally, suggestions for future research are given.

Notes (pp. 166–179) [=SWE, 137–170]
Endnotes.

Errata (p. 180) [=SWE, 170]

Planches VI–XIV (pp. 181–198) [*missing in* SWE]
Illustrations provided by A. Angot.

OM POLARLJUSET ELLER NORRSKENET

Summary of Contents (Swedish edition) by Päivi Maria Pihlaja

Apart from a list of works cited, a foreword, introduction, endnotes, and list of errata, the book as a whole is divided into two parts. Below, the corresponding page numbers in the French edition are referred to within [brackets].

The first part, chapters I–VI (pp. 5–76 [=FRE, 7–98]), provides a general description of the study topic. The author explores general contemporary knowledge and lists observations concerning the aurora borealis and other phenomena having a close relationship with it (in particular, geomagnetism) .

The second part, chapters VII–XI (pp. 77–135 [=FRE, 99–165]), introduces the new theory. Atmospheric electricity is proposed as the cause of the aurora borealis. The narrative takes the form of series of questions and answers, concentrating on three problems: 1) the possible electric origin of the aurora borealis; 2) the cause behind negative electric charge of the Earth and positive charge in the air; 3) the reason why the aurora borealis is observed mostly in regions surrounding the poles of the Earth.

Förord (no page) [=FRE, p. xiii]

Foreword.

Inledning (pp. 1–4) [=FRE, 1–5]

underlines the significance of the topic by giving an account of the most significant steps of scientific progress in questions concerning electricity. The author stipulates the need for more experimental knowledge on the subject. On the basis on his personal experiments and expeditions, the author promises to demonstrate the links between different phenomena of light observed in the atmosphere (thunder, sheet lightning and the aurora borealis) and gives the overall motivations for adopting a new theory of their origin.

FÖRSTA AFDELNINGEN

I. Om polarljusets allmänna uppträdande (pp. 5–15) [=FRE, 7–17]

The first chapter begins with a systematic depiction of the different visual appearances or forms of the aurora borealis. The author describes the splendours of the sights he has witnessed himself in high latitudes. Besides the most characteristic appearances, he draws parallels to other glows or glimmers of light observed not only in arctic regions, but in different parts of the world, as well as in varying altitudes, including near to the ground.

II. Om polarljusets periodicitet (pp. 16–21) [=FRE, 18–27]

discusses recent investigations concerning the periodicity of the phenomenon by citing, among others, the compilation of observations by Fritz. It explains how those cycles appear to be connected with variation in Earth's magnetic fields, magnetic storms and sunspots. The author also analyses the periodicity of sunspots in relation to the years of famine experienced in Finland.

III. Polarljusets geografiska utbredning (pp. 22–33) [=FRE, 28–44]

explores the geographical scope of the phenomenon, its maximum zone and variations, with a particular reference to recent observations by A. E. Nordenskiöld, Samuel Kleinsmidt and Sophus Tromholt. The author praises the significance of the systematic observations by Kleinsmith in Bossekop as calculated by Tromholt, but slightly disagrees with the conclusions Nordenskiöld has made. The author also draws attention to the rarity of storms or lightning in regions situated close to the poles of the Earth.

IV. Polarljusets höjd öfver jordytan (pp. 33–45) [=FRE, 45–59]

discusses the methods and difficulties involved in determining the altitude in which the phenomenon takes place, based on measurements by a great number of scholars, in particular in Godthaab [Nuuk], Sodankylä and Bossekop. It is concluded that the upper limit appears to be between 35 and 70 kilometres. On the other hand, the author suggests that particular forms of the aurora borealis can take place significantly lower than has been believed, even close to the Earth's surface.

V. Allmän öfversigt af jordmagnetismen (pp. 45–69) [=FRE, 60–89]

explores the theories and principles of geomagnetism and telluric currents, as well as the methods of measurement of their constants and variations. The author cites the work performed by the Magnetic Union of Göttingen and global observation networks, which have

facilitated examination of the scope of magnetic storms, and refers to observations made by Hansteen, Sabine, Ross, von Humboldt, Lamont, Tromholt, Wild, Wijkander and others. With regard to methods of measurement, work by Gauss and Weber is cited. Based on his own measurements in Lapland, the author proposes that there exists a zone of telluric currents, which is analogous to the maximum zone of the aurora.

VI. Om polarljusets verkningar och dess natur (pp. 70–76) [=FRE, 90–98]

To complete his account of the facts that a scientific explanation of the phenomenon must cover, the author describes the effects of the aurora borealis on telegraphic lines, the nature of the light of the aurora in spectroscopic analysis, as well as its fluorescent properties. The difficulties in capturing the phenomenon into a photographic image are also discussed. The end of the chapter is devoted to describing how the phenomenon is experienced by the inhabitants of northern regions in terms of utility and perception.

ANDRA AFDELNINGEN

VII. Polarljusets vetenskapliga förklaring (pp. 77–85) [=FRE, 99–107]

begins by refuting old superstitious beliefs concerning the aurora borealis, and then paves the ground for a scientific explanation. Alternative theories given earlier to the phenomenon are briefly described (i.e. reflections of light from ice, cosmic dust, magnetic theory). The author refutes all of these and finishes the chapter by justifying why the electric theory maintained by late August de La Rive should be considered as the most plausible one.

VIII. Om polarljusets elektriska ursprung och källan till den atmosferiska elektriciteten (pp. 85–93) [=FRE, 108–123]

displays a short overview of different types of evidence, which demonstrate the electric nature of the phenomenon. These include experiences with light produced by an electric current in rarefied gases; effects of magnetic storms; and spectral analysis. According to the author, the phenomenon belongs entirely to the atmosphere. Furthermore, it analyses the measurements of atmospheric electricity as well as its daily and seasonal variations by citing different scholars, and explores varying scholarly opinions of its origin. Although observations have not showed any significant increase in electricity of the air during outbreaks of aurora borealis, the author claims that the absolute state of atmospheric electricity is not a necessity for the aurora borealis to take place, as this would more depend from the variation of its potential in a vertical direction. The author describes Erik Edlund's laboratory experiments concerning 'unipolar induction' and discusses the principles of vaporisation as a cause of atmospheric electricity. Combined, these phenomena lend support to the idea that the cause of the aurora

borealis can be found in the circulation of atmospheric electricity towards arctic regions in the upper layers of the atmosphere.

IX. Polarljusens uppträdande omkring jordens polar (pp. 93–106) [=FRE, 124–136]

refutes the theory presented by August de la Rive concerning the role of winds as carriers of the atmospheric electricity towards the polar regions. The author presents an enhanced version of a laboratory device for reproducing a phenomenon resembling the aurora borealis by conducting an electric current through Geissler tubes containing rarefied air.

X. De elektriska strömmarna i luften och experimentel framställning af polarljuset i naturen (pp. 106–119) [=FRE, 137–149]

discusses closer the existence of electric currents in the atmosphere. The author challenges the idea of air being an isolator that could only allow momentary discharges of electricity in the form of lightning. The chapter concentrates on the results of measurements of air electricity and demonstrations producing a light resembling the aurora as performed in open air on mountains of Finnish Lapland, first in 1871/72 and later during the First International Polar Year (1882/83, 1883/84), by using a large influx machine (*utströmningsapparat*) developed by the author for the purpose.

XI. Den närvarande teorien för polarljuset (pp. 119–135) [=FRE, 150–165]

articulates the conclusions of the author by formulating a new theory on the origin of the aurora borealis. The author discusses again different types of discharges of atmospheric electricity; he explains why the aurora borealis should be considered as one, yet slower, form of discharge of atmospheric electricity in the manner of lightning. The discussion includes a physical explanation of the vertical electric currents, which are supposed to be the cause of the phenomenon, as well as factors affecting them. The author extends the significance of his new theory with regard to explanations given of other phenomena in a close relationship to it (i.e. geomagnetism; influence of the Sun; geographical and temporal scope as well as the spectre of the aurora; and its alleged sound). Finally, suggestions for future research are given.

Noter (pp. 137–170) [=FRE, 166–179]

Endnotes.

Citerade arbeten (pp. 171–172) [=FRE, xi–xii]

Works cited.

Anmärkta tryckfel (p. 170) [=FRE, 180]

Errata.