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The development of the aurora of 18 January 1770

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Abstract. The development of the great aurora of 18 January 1770 has been discussed in fundamental papers by Silberschlag, Behn and other authors. The aurora was observed in middle and low latitudes and in Northern latitude. In Central Europe it displayed all typical auroral forms, including the corona.

1 Introduction

In the past some extraordinary auroras have been observed in middle and low latitudes. Reports are known from ancient times up to now. A most interesting aurora was observed on 18 January 1770 and has been described in detail by Silberschlag (1770) and Behn (1770). Johann Esaias Silberschlag (1716–1791) was a universal educated scholar. He studied theology and natural sciences at the University of Halle and was later Director of the Realschule in Berlin and preacher at the Trinity Church. King Friedrich Wilhelm II of Prussia appointed him as Councillor for Building and Hydraulic Engineering in Prussia because of his scientific reputation. Friedrich Daniel Behn (1734–1804) was an important representative of Enlightenment and Director of the – at that time – famous gymnasium "Katharineum" in Lübeck. Silberschlag's account is written as a letter to his brother (George Christoph, priest in Stendal), whereas Behn's observations of the above aurora are embedded in a complete book (144 pages) about current knowledge (and speculations) of auroras and written as a dialogue between teacher and student, a literary form which was quite popular at that time. The book contains a list of auroral observations from the years between 502 and 1731 AD as well. Silberschlag observed from Berlin (geographic latitude and longitude: 52.52° N, 13.38° E; geomagnetic latitude and longitude of year 2010: 48.5° N, 89.4° E), Behn from Lübeck (geographic latitude and longitude: 53.87° N, 10.69° E, geomagnetic latitude and longitude of year 2010: 50.1° N, 87.6° E). From both accounts and other sources (e.g. Fritz, 1873), the development of the aurora in the Northern Hemisphere, can be traced.

2 The observations

2.1 Geographic distribution

The aurora was observed over the whole Northern Hemisphere from East Asia to North America. The southern limit included Northern Africa, Spain, Italy and Greece. Observations were made in Middle Europe (France, Germany, Switzerland, Austria, Hungary). In Denmark and Scandinavia intense auroral forms were detected. Some observations were also received from northern America (Fritz, 1873).

2.2 Forms

The aurora showed all typical forms (Figs. 1 and 2): the arc, rays (including rapid rays), patches, and the corona. The corona is very seldom seen in middle latitudes, and is better known from more northern observations. This was apparently already known by Behn (1770). He specifically mentioned that the corona is only observed during *größerer* (=larger) auroras and gives as examples an aurora with corona of the year 585 AD described by Gregor of Tours and another one observed 1716 by Halley.

2.3 Colours

The colours for Middle Europe were reported mostly as intense red, but also yellow, green, violet, and changing from white to red. Rapid changes, well-known in auroras, were also noted.

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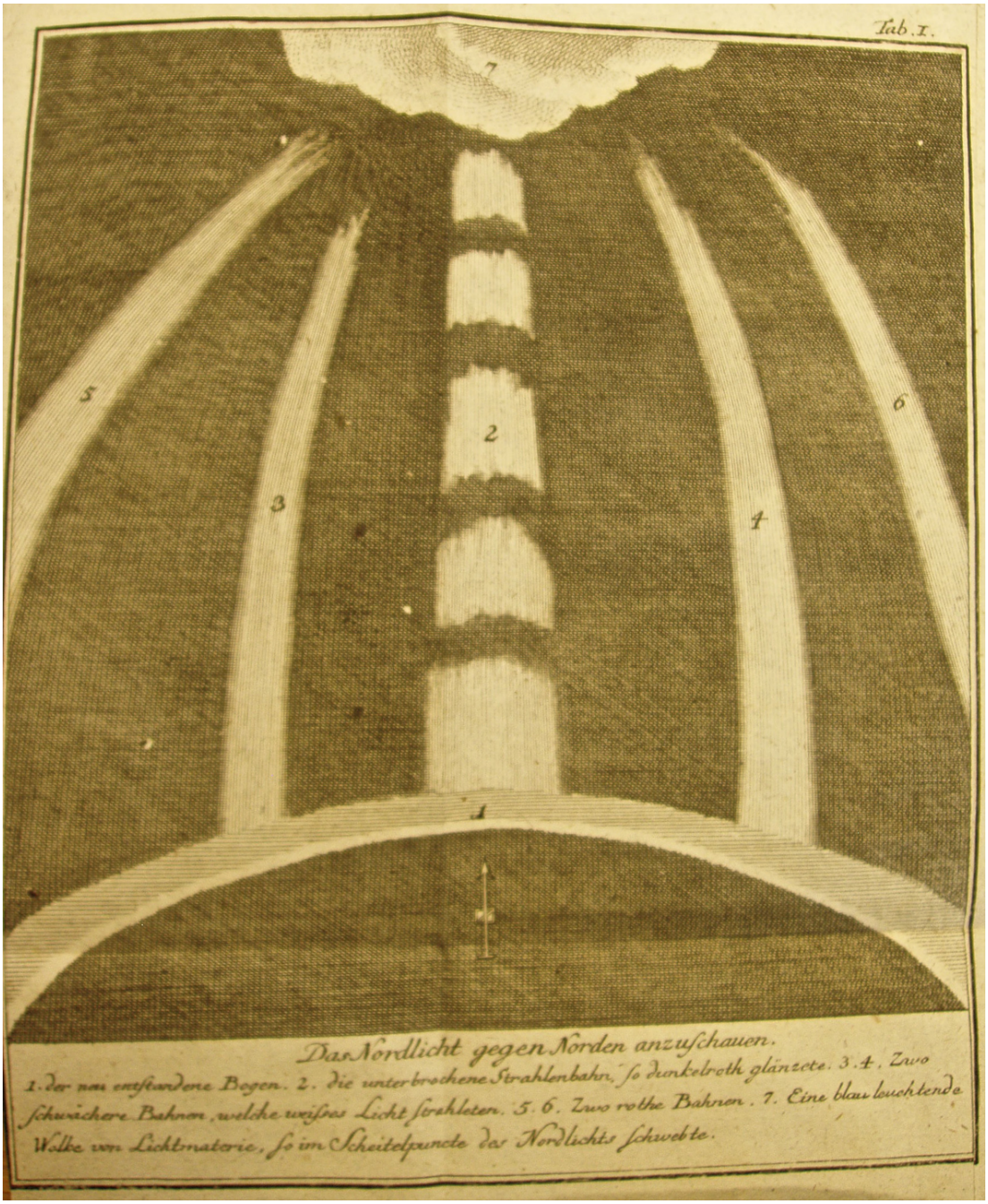

Figure 1. Copperplate of the aurora, seen by Silberschlag. The German figure caption translates as: The aurora seen towards North. 1. The newly appeared arc. 2. The broken ray shining dark red. 3.4. Two weaker paths shining in white light. 5.6. Two red paths. 7. A blue shining cloud of lighted matter which floated in the vertex of the aurora.

According to Silberschlag's description the auroral display started around 18:00 LT with the arc (1) stretching over about 80 degrees, its axis was about 15 degrees westwards of the meridian, roughly the pointing direction of the magnetic needle. From this arc several rays shot upwards towards the vertex, at both ends and in the middle, the latter (2) was interrupted by several dark sections. All rays displayed intense red colours. In the following hours the arc moved upwards and reached the zenith at about 20:00 LT. After midnight it moved further south and in the north a new arc had formed. Form it, again brilliant red rays shot upwards, the light was so bright that a text with enlarged letters could easily be read and the snow on the ground and the roofs of nearby houses glowed in red. The ray in the NW (3) changed colours frequently, from red to yellow to green, blue and white. At the top of the rays, but disconnected from them, a blueish cloud (7) floated at the vertex. Silberschlag already used the word *Crone* (= crown = corona) here. After 04:00 LT in the morning the southern as well as the northern display faded away.

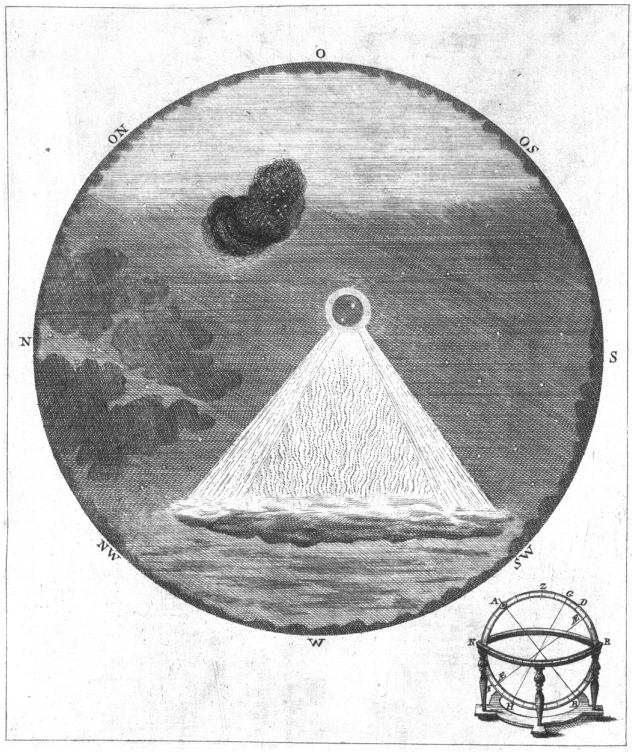

Figure 2. A copperplate showing Behn's observation. He did not provide a figure caption. The celestial sphere on the lower right is used to explain celestial positions. The rim of the large circle is the horizon, its center the zenith.
According to Behn the aurora started after 18:00 LT with a dark red cloud in ENE elevating about 30° above the horizon and stretching over 90°. From its edges yellow rays moved upwards towards the zenith. About 15° from the zenith towards SE a circle formed with a dark red ring. Its diameter was about 8°, the width of the ring 2°. Stars were shining through the circle (later Behn also used the term *Krone*). The upwards shooting rays changed their width frequently and seemed to be separated sometimes by dark lines. All rays together formed something like a pyramid with the aforementioned cloud (he did not use the word arc, but sometimes *Streifen* = strip) as base. The colour of the rays were red and white and so bright that a letter could be read. Around 19:00 LT the red ring close to the zenith vanished and the red cloud moved towards North and towards the zenith and was later observed also in southerly direction. Behn states that he observed the auroral display until 23:00 LT.

3 Solar data

The great event of 18 January 1770 was observed near the solar maximum of Schwabe's solar cycle No. 2. This solar cycle (1766–1775) was not so strong in terms of the sunspot number index W (the monthly W at maximum attained only about 116). Nevertheless, another extremely powerful and famous event was observed in 1770 (Willis et al., 1996). The September 1770 storm was the first documented evidence of an extremely powerful conjugate aurora and strongly perturbed magnetosphere at that time. These two observations of extreme events in 1770 confirm once again the well known fact, that sunspot numbers per se are not always a good proxy of solar activity manifestations, especially regarding largest solar flares, coronal mass ejections and geomagnetic storms. A similar situation with extreme events was observed during the most recent period of time in the past 23rd solar cycle (1996–2009).

4 Other observations

During the night before, 17 January, a great aurora was observed in Germany as well (Behn, 1770; Fritz, 1873). Similarly, an aurora of 21 January was also very prominent, and showed intense red colours, typically of auroras observed from middle latitudes.

5 Magnetism and auroras

Silberschlag's remarks on the relationship between magnetism and the appearance of auroras are important. Before the 18th century, auroras and other mysterious sky phenomena were interpreted as ominous Signs of God. A change in this thinking began with the great aurora of 1716 after which Christian Wolff (1679–1754), at that time Professor at the University of Halle/Prussia, delivered a public lecture declaring that all such phenomena can be explained as natural physical processes in the Earth's atmosphere (Schröder, 1984).

Silberschlag referred to various sources in which a connection between geo-magnetism, as exhibited by variation in the magnetic needle, and occurrence of aurora were demonstrated. He emphasised that auroras were natural phenomena subject to the influence of the geomagnetic field, and were not Signs of God.

Behn was convinced of a natural cause of auroras as well, and mentioned several corresponding ideas in his book. However he tried to defy a relationship with magnetism with strange and not convincing arguments. Instead he favoured a relationship with electricity and developed over 20 pages a hypothesis about an "electric ether" causing the aurora.

A clear relationship to solar activity was not recognized in the 18th century. This came later with the auroras of the 19th century as interpreted by Alexander von Humboldt, Hermann Fritz, Rudolf Wolf, Johann K. F. Zöllner, Eugen Goldstein, Emil Wiechert and others (for details see: Schröder, 1984).

We can conclude that in the 18th century a new insight began into the nature of auroras as fundamentally natural physical phenomena in the Earth's atmosphere.

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