

Early observations of and knowledge on air electricity and magnetism at Hohenpeißenberg during the Palatina era.

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After the first important steps to the understanding of the atmospheric electricity in 1752 (Franklin and European researchers) observations on electrical field strength were implemented in the observing programme of the Societas Meteorologica Palatina in 1781 at few selected stations, one of which was Hohenpeißenberg. The most important installation was a lightning rod on the roof of the building, situated on top of a mountain and thus frequently attracting lightning strokes into the tip of the tower of the pilgrimage church. Several times fire was generated and once even the bells melted during burning of the woodwork of the bell-tower.

Thus it is not astonishing that Hohenpeißenberg was selected for air electrical measurements. The instrumentation consisted of an antenna on the roof and a conductor to the meteorological observatory. During thunderstorms the distance between the end of the wire and a grounded tip needed to produce a spark was measured to characterise the electrical field strength.

Besides air electricity observations on the magnetic field were made at Hohenpeißenberg by a Declinometer and an Inclinator. The scientists recognised the influence of polar lights which were sometimes visible at Hohenpeißenberg on the Inclinator and concluded on the magnetic nature of these phenomena. The early magnetic measurements are presently of high interest since they allow the reconstruction of the secular trend of the northern direction and the reconstruction of the solar wind, when daily measurements are available.

Instrumentation to measure the electrical field strength and the magnetic direction are presented as well as scientific conclusions. Physicists at that time had recognised the electrical activity during thunderstorms but they still distinguished between the flash as a pure light (spark) phenomenon and the “Wetterstrahl” (“weather stroke”) which was a cloud to ground flash. First observation on the fair weather field were also made at that time.

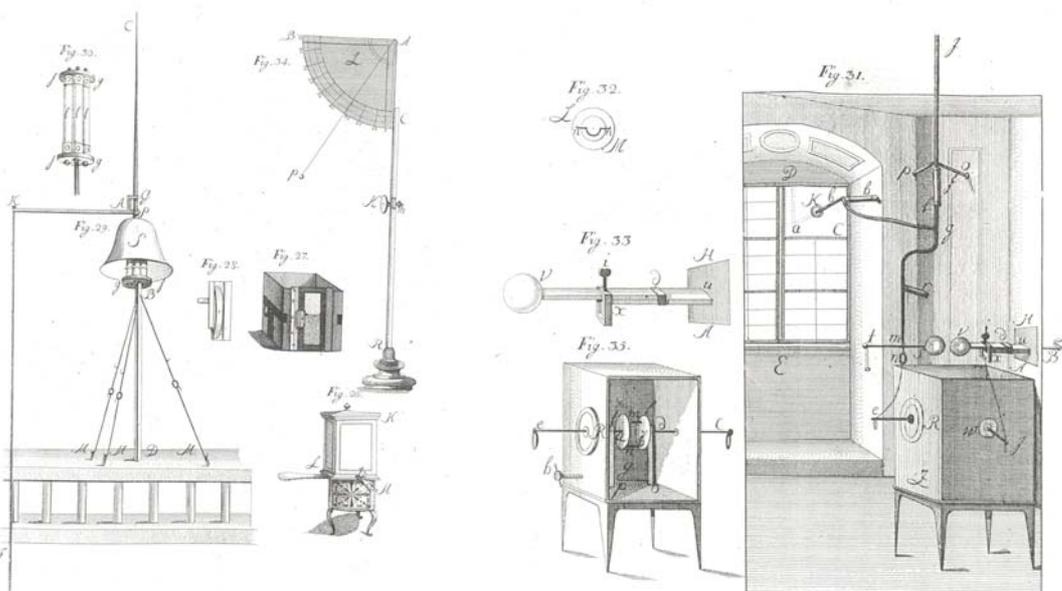


Fig 1: Device for the investigation of the electrical field strength of the air.

State of knowledge on air electricity at 1781

Knowledge on air electricity was incomplete and scientists thus only made presumptions. Nevertheless numerous and sophisticated experiments were performed to explore the nature of electricity and to collect experience. Some of the facts were:

- 1746: Prof. Winkler (Leipzig) was one of the first who concluded on the similarity between the electrical matter and the “lightning substance”! He was convinced that the difference between electricity in the laboratory and the air was only a matter of the order of magnitude.
- 1752: Franklin made his famous experiment with a paper kite by which the electrical nature of thunderclouds was confirmed. Without knowledge of this experiment H. de Romas independently performed a similar experiment in Europe in 1753 with a kite at a 170 m long wire and came to the same conclusion.
- The permanent air electrical field was discovered by le Monnier in St. Germain, France. His experiments were repeated at many places.
- To produce air charging friction should be included. The wind was thought to be the origin of friction. Friction of air parcels and of those with clouds or friction between clouds were believed to create electricity. Induction of the opposite polarity were also known.
- It was known that tourmaline developed electrical tension when warmed. Thus it was believed that temperature differences were included in creating air electricity. In analogy mountain peaks were compared to huge tourmalines the electrical charge of which would be enhanced by heat and taken up from clouds.
- The electrical matter was believed to penetrate upwards into a region where no conducting hazes were present. This region was termed “elektrophor” which is the name of a carrier of electricity (capacitor).
- A lightning flash should be formed when another conducting cloud approached to the first and a spark forms, or when a strong wind separated the “electrophor” from the cloud.
- Polarity was believed to be distributed in the sense: earth negative – cloud positive.
- So-called “weather strokes” went from cloud to ground but those going from ground to the cloud were also known. It was also known that lightnings hit presumably elevated points.
- Thunderstorms were known to form in all seasons because electrical separation is possible at any time. However, heat in summer and sun radiation were believed to easier emanate electrical matter.
- Positive charged clouds near the horizon should induce negative electricity in the adjacent air and the ground. This should explain why “downstreching” weathers produced cloud-to-ground flashes.

What could be done to avoid damages?

Physicists were amused on popular explanations of electrical phenomena:

- Many superstitions like blowing into snail-shells or whipping the air or praying were recognised as ineffective. Only installation of lightning conductors were acknowledged as “powerful arms”. Experiments with an artificially charged paper cloud (diameter 90 cm) and paper houses provided with lightning conductors were constructed in the lab to test these hypothesis. Tips were known to be more efficient in producing sparks than bowls.
- Could ringing the bells or shooting of cannons help against thunderstorm or lightning damages? Such experiments were made and relatively early found to be inefficient for

physical reasons. Sound or noise or a sharp detonation were known to produce vibrations of the air, which are different in kind. But physicists concluded that the effects were too weak and a detonation, in order to make an effect, should be able to stop the movement of a cloud which obviously was not the case.

Confirming reports were brought into discussion however they were unmasked like the following statement: "I have made a study and I have created the evening".

Thunder was explained in analogy to the noise of detonations.

- lightning conductors were believed to act also as hail conductors.
- Some people believed that earthquakes were also caused by electricity – in a sense of underground thunderstorm –, but this was not accepted by physicists.
- the permanent air electrical field was discovered by performing relevant experiments.

Some more reports:

The effect of electricity on the growth of plants was investigated and the experimenter was convinced, to achieve an acceleration of growth. (Prof. F. Bams, Wien; s. Ephemeriden 1781 Vol. 1, Notation 108.)

Electricity and magnetism:

Meteorol. Ephemerides, **1781** Vol. 1 (Editor: Prof. Epp, Bayer. Academie der Wiss. 1781: p. 76:

not. 106. The most astonishing observation is, that during a brilliant polar light, starting at 8 pm and ending after 10 pm, the magnetic needle showed deviations around six minutes (*). Fifty three days after that polar light weather changed which resembled a gentle fall month up to that date. Powerful coldness reigned that the thermometer for ten days, from 6 – 16 of the winter-month, only three times swung over the ice point.

(*) Some hints followed, how polar lights can be observed by means of a so-called acimutal-quadrant. The observation could be successfully made only in the countryside but not in the city.

not. 124.: During a thunderstorm no deviation of the magnetic needle was observed, however, during a polar light.

Meteorol. Ephemerides, **1782:**

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March: During a storm at 12. and 13. strong electrical fields were established on the Hohenpeißenberg: The electricity meter on the Hohenpeißenberg repeatedly showed a change, frequently a lack of "Agtstein"-power. Sparks over a distance of 6 Parisienne lines (ca 13.5 cm!) were measured, and it was most astonishing to observe the magnetic needle to deviate by 10' towards west.

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The northern direction at Hohenpeißenberg deviates by up to 1° 36' against other stations.

p. 120:

Remark to conclusion 1781: During no thunderstorm any variation of the magnetic needle could be observed, however, during a polar light.

Another remark in 1782:

"Both observations could be made this year. On 8th of Oktober at 9 pm the magnetic needle was in permanent motion; the permanent movements back and forth brought the Mr. Observer at the Hohenpeißenberg to the thought, a polar light should be present in the atmosphere, however, he could see nothing because of dense clouds. In other regions a nice polar light was seen on 8th and 9th of October. During some thunderstorms in Munich as well as on

Peißenberg a deviation of 15 to 20 minutes was observed. After the end of the thunderstorm the magnetic needle came back to its former position.”

Remarks in Ephemerides 1783

Duke de la Cepede is cited, who established as a result of relevant experiments, “that the many deviations of the magnetic needle originate from electrical matter in the air. If so, the magnetic needle must show many movements, depending on the accumulation of electrical matter in the air.” The Duke proved his postulations by experiments with electrical isolation of the magnetic needle. Again systematic deviations of the northern directions between monastery Rott on river Inn and Peißenberg (up to 1°5′). 1784 measuring errors in Rott were reported and corrected and the differences became smaller.

Remarks in the Ephemerides of 1784

Investigations and results of Prof. Celsius (Sweden) are mentioned like (I) the daily cycle of the magnetic needle and (II) that during polar lights the magnetic needle deviates more when the polar light is more intensive.

Polar lights were observed at 3th of March and 3th of April during the evening.

Another translation of a Swedish publication by U.P. Hiorter is cited:

“I could not keep away from adding the following thoughts. Mr. Baron Wolff has interpreted polar lights as unripe thunderstorms: thunderstorms have disturbed the compasses, as was observed aboard ships. In addition, one is assured that the matter of thunderstorms resemble very much the electrical matter and Robius has established, as is described in the “Hamburg Magazin”, that electricity effects the magnetic needle. Perhaps the coming times will bring these scattered sentences into a context. The investigator of nature often must firstly follow several sideways, as the miner, before he finds the main vein, before they come to an agreement.”

Conclusion

The scientists started with studying the various phenomena of electricity and magnetism and their interaction. They were very open to all types of possible effects and they designed numerous experiments to prove or disprove their hypothesis. They were also critical with their own results and thus identified and eliminated measuring errors. Conclusions were drawn only when arguments were completely logical and when various aspects withstood any argument against it. The international exchange of observations, findings and results was well developed and was well observed with great interest. Popular explanations of electrical phenomena were refuted.

Literature:

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A. Schwaiger, 1791 Versuch einer meteorologischen Beschreibung des hohen Peißenbergs. A. Franz Ww. München.

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Ephemerides (ed. J. Epp) 1781 - 1784