



Book Review: *Carl Størmer, Auroral Pioneer*

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Carl Størmer (1874–1957) was a pioneer in the study of aurora borealis, as well as a mathematician who derived conditions for the formation of aurora and their trajectories in the atmosphere. Carl Størmer was educated at the University of Kristiania (Oslo) and the University of Sorbonne, Paris, and was appointed Professor of Mathematics at the University of Kristiania in 1903.

This book on the life and work of Carl Størmer, begins with an overview of the economic and social structure of Norway in the 19th century. A comprehensive history of the Størmer family is provided. The description of Carl Størmer's high school education, college education and upbringing, in Chapter 2, also provides a picture of contemporary society. Detailed reports from local newspaper articles and family papers are extensively used as resources.

Seeking the outdoor life and bounty of a short summer is ingrained in Scandinavian culture. Additionally Carl Størmer's father was a pharmacist, who collected herbs and medicinal plants in the summer; thus, the family took trips in the summer to collect and identify plants, and this is where Carl Størmer showed his early interest in and advanced grasp of botany. He was also keenly interested in physics, geology, astronomy and photography. Details of his interests emerge from diaries he kept as a schoolboy. In high school however, he showed an interest in mathematics and physics as well as botany. His family took an active interest in his education and he had private tutors in mathematics. They introduced him to the young faculty of the University who encouraged him in his progress. As a high school student he was invited to give a talk on trigonometric series at the University. His parents consulted Professor Eling Holst and Kristian Birke-land who were at the University of Kristiania, about future directions of Carl's studies. His focus on mathematics at university, followed after the death of Axel Blytt, Professor of

Botany, with whom he had made several field trips. The chapter offers much detail about the nature of university education at that time.

Chapter 3 is most extensive and is divided into several parts which cover more than half the book, describing auroral science – in the main observations unique to Norway. Details of Størmer's work and theoretical advances in the study of auroral phenomena from 1909 to 1957 are described here. From preliminary photography of aurora, developments made by Størmer and Krognes that radically improved photography, and campaigns led by Størmer for several seasons all over Norway, to detailed characteristics of aurora that began to emerge. Some of Carl Størmer's seminal contributions are preparation of an auroral atlas, spatial and temporal distribution and perhaps the most important: calculating the height of auroral displays. This was pioneering work by Størmer that led to an understanding of the influence of solar charged particles in the atmosphere. The chapter also deals with developments in theory, terrella experiments and the significance of these studies. Details in this chapter capture the pace and progress of field observations as well as theoretical developments of the study of aurora that influenced understanding of magnetic variations and disturbances. Scientists in different parts of the world contributed separately to this and communicated their results, albeit at a much slower pace than at present. Nevertheless, the understanding of magnetic variations, the role of charged particles and magnetic fields emerging from the sun was fundamentally sound and was subsequently validated by direct measurements in space after 1960. This chapter also describes the kind of networks and associations that helped Størmer get funding and facilities for these studies. It is an interesting insight into funding, logistic and manpower requirements in that era. Størmer's contributions to the International Polar Years, International Geophysical Year (IGY), and dawn of modern space exploration are recounted here.

The significance of this tremendous body of work is however, described separately in Chapter 6. It would have been

helpful if some markers of contemporary work had been introduced in Chapter 3. This would have helped one to follow the progress of auroral studies and solar terrestrial physics, along with Størmer's work, since it actually covered an extraordinary period of development in space science and geomagnetism.

Brief chapters describe other interests of Carl Størmer: noctilucent clouds and botanical exploration in Chapters 4 and 5, and his mathematical contributions in Chapter 6. Biographies of his teachers, mentors, colleagues and contemporaries are introduced too abruptly in all the chapters. Chief of these contemporaries was Kristian Birkeland. His relationship with Birkeland was very fruitful for many years, but ended in conflict and discord.

Størmer's accomplishments have been covered in retrospect (Chapter 10), outlining the significance of his findings and their relevance to contemporary theory. Some developments described here are based on important findings in Chapter 3, but the link is not evident except to those already familiar with geomagnetism. The context of each aspect of Størmer's work could have been mentioned in Chapter 3, providing a link to later explanations. For example the significance of Alfvén's contemporaneous work and Størmer's auroral trajectories to magnetospheric physics could have been stated more clearly.

The book gives a very detailed and clear description of Størmer's life and work. The tremendous effort involved in making thousands of observations of aurorae has been authentically presented. The significance of this experimental work and deductions from this leading to formulation of theories of particle trajectories are clearly explained. His mathematical contributions and their long-lasting impact on space science have been presented. This book would be of considerable interest to physicists, earth scientists and science historians. It also provides a good resource for research students.

However, the book lacks smooth narrative. The biographies of mentors and associates of Størmer have been abruptly introduced into the text. There are several errors in editing and language. Figures have been authentically reproduced from original texts. It is fortunate that the Størmer family has maintained a large collection of photographic and written material that make this book more interesting.

In all, this is an important retrospective of the significant achievements of a scientist whose work closely parallels the development of modern geomagnetism and space science. Many scientists and students in this field will benefit from the collection of archival scientific material in one volume.