ship in the history of science, this book joins Ronald Rainger's fine new study of the American Museum of Natural History (*An Agenda for Antiquity;* University of Alabama Press, 1991) to show that careful studies of scientific work at museums can tell us much about science—how it gets done, where, why, by whom, and to what ends.

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Plasmas Close at Hand

Auroral Physics. CHING-I. MENG, MICHAEL J. RYCROFT, and LOUIS A. FRANK, Eds. Cambridge University Press, New York, 1991. xx, 464 pp., illus., + plates. $120. Based on a conference, Cambridge, U.K., July 1988.

The realization that a giant natural plasma physics laboratory was close at hand came 30-some years ago when the advent of satellites allowed discovery of the earth's magnetosphere. Almost simultaneously, analyses of extensive auroral data sets acquired during the International Geophysical Year 1957–58 showed that the visual aurora was one of the best tools for probing the nature of complex processes within the magnetosphere. An often-expressed but accurate analogy holds that the aurora playing on the polar atmosphere reflects dynamical processes operating in the magnetosphere and at the outer magnetospheric boundary in the same way in which the variable image on the phosphor of a cathode tube indicates changing electric and magnetic fields and particle trajectories in the body of the tube. As many of the 34 review papers in this book acknowledge, the state of the global visual aurora is a measure of the state of the magnetosphere and its interaction with the solar wind.

Indeed, analysis of auroral behavior soon after the IGY led to several insights that are still important to modern understanding of how energy from the solar wind transfers through the outer magnetosphere to enter the auroral ionospheres and the inner magnetosphere's trapping region, the Van Allen belts. In 1961, noting the strong control that sun-earth geometry exerts on both the visible aurora and the magnetosphere, J. W. Dungey proposed energy transfer into the magnetosphere via magnetic reconnection. It is now believed that 90 percent of the transfer is by this process, which converts kinetic energy of solar wind particles to magnetic energy stored temporarily in the tail of the magnetosphere. Concurrently, and similarly influenced by observed patterns of auroral motion, W. I. Axford and C. O. Hines proposed a viscous-like interaction between the solar wind and the magnetosphere that involves the establishment of a large-scale electric field across the magnetospheric tail and a two-cell convective flow within the outer magnetosphere. That flow maps down through the geomagnetic field to the auroral atmospheres where it is seen in auroral motions. The auroral observations also led S.-I. Akasofu to recognize auroral (or magnetospheric) substorms—repeated impulsive events wherein the rate of energy transfer through the system increases radically.

A number of the papers in *Auroral Physics* demonstrate that parts of the field have matured. The characteristics of trapped and precipitating charged-particle distributions are now fairly well known, as are most details of auroral excitation processes. The interactions and feedback between the lower magnetosphere, the ionosphere, and the thermosphere are becoming increasingly well documented.

However, the cause and nature of the substorm remains a mystery, and many of the papers in this book deal directly or peripherally with this important issue. Substorms, lasting one to several hours, occur in both quiet and disturbed times, with a strength and frequency greatly enhanced when the interplanetary magnetic field is oriented in a way favorable to Dungey's reconnection process. Thus the condition of the solar wind is critical. Yet the substorm appears to be a process largely internal to the magnetosphere, initiated somewhere and somehow by a mechanism not yet understood. Authors in *Auroral Physics* discuss six or more different models of parts or all of the substorm, and others present data that bear on the problem.

Progress on the substorm problem has been slow these past 30 years. Part of the difficulty is uncertainty about where auroras map out into the magnetosphere. This book's first and last papers rightly stress the field's major need: better globally oriented observation of the aurora, the ionosphere, and the magnetosphere. The aurora is the easy part because the technology exists. The application of similar "imaging" techniques to yield global views of magnetospheric particle and current distributions and ionospheric currents is likely to bring significant advances in the years ahead.

This multi-author compendium, better than most of its breed, is well arranged by its editors, and the numerous references made to its contents in recent literature attest to its usefulness to specialists. Its depiction of the struggle to develop a comprehensive understanding of the substorm also is of interest to plasma physicists at large—for what transpires in the earth's magnetosphere has broad application elsewhere, both in the laboratory and in the cosmos.

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Superconducting Devices

SQUIDs, the Josephson Effects and Superconducting Electronics. J. C. GALLOP. Hilger, New York, 1991. x, 232 pp., illus. $90. Adam Hilger Series on Measurement Science and Technology.

Since the discovery of high-temperature superconductivity, the superconducting quantum interference device (SQUID) has been repeatedly touted as one of the first major applications of the new materials. The many times this possibility has been suggested have produced probably an equal number of questioners in search of a book that describes what SQUIDs are, how they work, and how to use them. Here is the book.

A SQUID consists of one or two Josephson junctions joined together with a loop of superconductor, typically 10^{-5} to 10^{-4} meter in diameter. SQUIDs measure magnetic flux but can be configured to measure magnetic fields or magnetic gradients, as well as voltages or currents. *SQUIDs, the Josephson Effects and Superconducting Electronics* starts with the basics of superconductivity, including the modern theories of superconductivity and the Josephson effect, continues on through the principles of operation of the two types of SQUIDs (RF and DC), and finishes with a long description of applications of the SQUID. The discussion of applications is one of the most extensive to date. SQUIDs made from both low- and high-temperature superconductors are discussed. The book could be used as a textbook for a course on SQUIDs that covers all aspects from start to finish.

The first-time user of a SQUID quickly learns that the price of working with one of the world's most sensitive amplifiers is that its exceptional sensitivity to a signal also means exceptional sensitivity to all types of magnetic fluctuations, external noise, and miscellaneous other signals from nearby galaxies. The lore of SQUID use is extensive and must be learned before useful measurements can be made. Here this book is unique; the chapter "A practical guide to