Foreword

During the second week of the Third General Scientific Assembly of the International Association of Geomagnetism and Aeronomy, held in Seattle, Washington August 22 to September 3, 1977, four special sessions devoted different aspects of auroral processes were convened. The sessions were entitled:

Timing of Substorm Events;
Electromagnetic and Electrostatic Instabilities on Auroral Field Lines;
Rapid Auroral Fluctuations and Associated Phenomena; and
Mechanisms for the Formation of Auroral Structures.

The sessions were convened by the Division II–III Working Group on the Auroral Oval under the chairmanship of Bengt Hultqvist and myself as vice-chairman. Divisions II and III are the IAGA divisions concerned with the ionosphere and magnetosphere, respectively.

The purpose of the session on the timing of substorm events was to come to grips with one of the key experimental issues of substorm research. Many techniques are available for studying substorm phenomena. Substorms may be identified in auroral photographs. They can be recognized by their production of magnetic pulsations. They can be seen in the records of ground based magnetic observatories as ionospheric and magnetospheric currents build up and decay. They can also be identified in spacecraft records obtained deep in space. These multitude of diagnostics lead to problems because they are not intercalibrated. There is intense controversy over whether the onset of a substorm defined by one technique is the same as another.

The purpose of the second session was to review our understanding of plasma wave instabilities on auroral field lines. The auroral ionosphere is filled with a variety of ELF, VLF, and LF emissions. These wave phenomena are not just curiosities, or secondary by-products of auroral processes, but instead appear to be fundamental in the auroral acceleration process. In fact, the energy flux of the terrestrial kilometric radiation (TKR) is a significant fraction of the energy in auroral beams, and hence its source represents an efficient mechanism for the transformation of energy from particles to waves. Study of these phenomena truly involves plasma physics in space, rather than a study of the physics of the space plasma. Many of the techniques used to study these processes, such as computer simulations, are the same as used in other aspects of plasma physics research, such as, fusion research. Many of the observed phenomena have their analogues in other plasma regimes. Yet the auroral plasma is unique. We can probe it locally with multi-diagnostic techniques and yet not disturb it, for our probes are infinitesimal compared to the
plasma scale lengths. On the other hand, we are restricted to local measurements and hence often lack the global picture. Thus, these studies often complement laboratory research.

The purpose of the third session was to review rapid auroral fluctuations and their associated phenomena. One of the most characteristic features of aurora is their dynamic behavior. They are constantly moving, changing. This behavior is sometimes chaotic but often very regular. That the aurora can and do undergo regular periodic changes is a clue to the source processes for the aurora. Other clues lie in the nature of other periodic phenomena that accompany the auroral fluctuations.

The final session was an attempt to review first the structure of aurora and the relationship of aurora to field-aligned currents and particle precipitation, and then the main theories on auroral source processes. This session brought together many of the top experimentalists with some of the best theorists and proved to be very stimulating to both groups.

The proceedings of these sessions are being published as two special issues of JGG. In JGG Vol. 30 No. 3 we present the principal review papers presented during the first two sessions; in Vol. 30 No. 4 we present the papers of the second two. In order to publish seventeen review papers in these two issues we have had to ask the authors to limit the size of their papers. The authors have done so, yet in most cases presented a comprehensive overview of their particular topic. In addition to the invited papers, many authors of the contributed papers have prepared summaries of their presentations, and we have included these papers after the invited talks in each of the sessions.

C.T. Russell
Institute of Geophysics and Planetary Physics
University of California at Los Angeles
Los Angeles, California, U.S.A.