PREFACE

This Symposium was held at Surfer's Paradise, Queensland, Australia, from 7 to 11 September 1973. The Organizing Committee, chaired by J. P. Wild, consisted of A. Boischot, A. Bruzek, J. T. Jefferies, G. Newkirk, T. Takakura, and V. V. Zheleznyakov. We are indebted to the Local Organizing Commettee, chaired by S. F. Smerd and including R. G. Giovanelli, R. E. Loughhead, N. G. Seddon, K. V. Sheridan, and J. P. Wild, for advice in preparing this volume as well as for the smooth arrangement of the sessions. In addition, the session chairmen and reporters are to be thanked for their assistance in preparing the recorded discussions. It is a pleasure to thank Mrs R. Toevs and Mr A. Csoeke-Poeckh of High Altitude Observatory for assistance in editing these Proceedings. The financial aid for the Symposium afforded by the International Astronomical Union, the Ian Potter Foundation of Melbourne, and the Sunshine Foundation of Melbourne, as well as generous assistance of the CSIRO Divisions of Physics and Radiophysics is gratefully acknowledged.

That the solar corona is not a quiescent plasma was first fully appreciated through the discovery of solar radio bursts thirty years ago. Since that time intensive research has uncovered a vast variety of coronal disturbances and revised our concept of this region of the solar atmosphere to that of a dynamic medium undergoing continuous expansion, constantly evolving under the influence of underlying photospheric activity, and frequently traversed by transient phenomena. Such transients were the subject of this Symposium. Many, but not all, coronal disturbances are initiated by flares or sub-flares; in fact, we have begun to realize that an important class of such disturbances accompany eruptive prominences and may represent a significant factor in the evolution of the corona. The development of those disturbances initiated by flares may conveniently be discussed in terms of two stages of development; the flash phase, characterized by the cataclysmic release of energy, acceleration of particles to energies of a few keV to BeV per nucleon, X-ray, microwave, and type III radio bursts, and the onset of thermalization; and the post flash phase, characterized by coronal shock waves, type II and IV radio bursts, further particle acceleration, coronal depletions, and interplanetary shocks. The Symposium brought out several new perspectives and raised new questions in each of these areas.

Many puzzles remain concerning the fundamentals of flare energy release. One in particular is the acceleration of particles to high energy. Although it cannot yet be stated that we have a complete picture of this process, a possible view has emerged – that the acceleration occurs by two comparatively distinct processes. The first step appears to be direct acceleration predominantly of electrons to moderate energy by the Fermi or betatron mechanisms in rapidly changing magnetic configurations. The stage is then set for subsequent acceleration of these electrons and resident ions to higher energy in the turbulent shocks which race through the corona. There appears to be no question that the source of this acceleration is low in the corona rather than in the chromosphere or photosphere. In addition, as spacecraft observations are pursued to lower and lower particle energies, it becomes apparent that a major fraction of the total flare energy may reside initially in these fast particles.

Diagnosing such coronal disturbances as type III bursts has presented many problems since it could not be ascertained until recently whether the exciting particles were electrons or protons, how the beam of particles propagates through the corona, and where the beam moves in relation to coronal magnetic and density structures. Simultaneous *in situ* detection of low frequency type III bursts and electrons at 1 AU appears to have resolved the first question – the exciter is a beam of electrons having energies 10–100 keV. However, just how the excitation occurs remains a problem. A complete explanation of how such a beam manages to propagate through the corona out into interplanetary space without complete dissipation is particularly elusive. However, one question concerning the generation of the radio burst – whether interplanetary type III's radiate at the fundamental or first harmonic – appears to have been resolved in favor of dominance of the harmonic for most bursts. Thus, the electron densities inferred from these bursts are now in quite good agreement with those inferred optically or measured directly from space probes.

High resolution radio as well as synoptic coronal observations appear on the threshold of determining just where the electrons exciting type III bursts traverse the corona and the long accepted dictum – that type III's propagate out along the dense cores of coronal streamers – seems to be overthrown. It now appears that the favored path for the type III electron beam is outwards along open magnetic field lines emerging from active regions containing the flare source but not necessarily along coronal streamers. Other electrons, temporarily trapped in closed magnetic arches where the coronal density is high, give rise to the type V radio continuum.

During and following the flash phase, those accelerated particles which have not escaped the sun give up their energy to the surrounding corona or impact on the chromosphere. Observation of the resulting X, EUV, microwave, and visible radiation provides a powerful potential tool for the diagnosis of this complex process. Hopefully, the new observations of high temporal and spacial resolution, when combined with new theoretical methods, will allow a determination of which parts of this rich spectrum arise from impact on the chromosphere, bremsstrahlung in the corona, thermal radiation from the corona, and conduction from a superheated corona to the chromosphere.

Among the most spectacular post flash phase coronal disturbances are the coronal shocks, type II radio bursts, and interplanetary shocks. We have come to recognize that these are all various ramifications of the same type of disturbance although many aspects of the phenomena, such as the patchy spacial appearance of type II bursts, have remained perplexing. Interpretation of these bursts as fast-mode MHD shocks appears to offer a convincing explanation since such waves are refracted away from regions of high Alfvén speed and intensify into shocks in the low Alfvén speed regions, which tend to reflect the intricate density structure of the corona. At long last, the optical counterpart of such shocks have been observed by space-borne coronagraphs. In some cases, such disturbances appear to accompany realignments of the coronal magnetic field leading to a subsequent depletion of the inner corona and complete restructuring of its form. In others, magnetic arches are expelled from the Sun carrying with them a significant fraction of the coronal plasma. These dramatic new observations are bound to produce new perspectives on the nature of coronal disturbances.

Satellite probes have provided a wealth of definitive data on these shocks as they propagate into interplanetary space and much of our knowledge of the nature of shocks as they exist in the corona is derived from such observations. Interpreted in the simplest fashion, interplanetary shocks appear to invove $\sim 10^{16}$ g and $\sim 10^{32}$ erg and thus comprise a substantial fraction of the mass and energy ascribed to a flare. However, such coronal disturbances are complex, and the question of distinguishing between the primary flare-induced shock and a subsequent (or coincident) modification of the coronal magnetic field leading to an escape of plasma remains unresolved.

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