PREFACE

An increasing interest in electromagnetic phenomena has characterized research in cosmical physics during the last decade. This development also reflects itself in an enlargement of the space devoted to electrodynamics in some recently held meetings. Two symposia on cosmical gas dynamics, at Paris in 1949 and at Cambridge in 1953, were organized by the International Astronomical Union (I.A.U.) in co-operation with the International Union of Theoretical and Applied Mechanics (I.U.T.A.M.). The programmes of these symposia included discussions on magneto-hydrodynamics, but the first meeting to be concentrated entirely on this subject was held at The Royal Society in London on the initiative of Sir Edward Bullard.

This forms the background of a subsequent symposium 'Electromagnetic Phenomena in Cosmical Physics' which was organized by the International Astronomical Union. It was held on 27–8 and 30–1 August 1956 at the Royal Institute of Technology in Stockholm, and on 29 August at the Stockholm Observatory in Saltsjöbaden. Financial support was given by I.A.U. ($3000), I.U.P.A.P. (Union of Pure and Applied Physics; $1500) and U.G.G.I. (Union of Geodesy and Geophysics; $750) from U.N.E.S.C.O. funds. The Swedish Government contributed 10,000 Sw. Crs. (about $2000) and further support was given by Telefonaktiebolaget L. M. Ericsson, Stockholm.

The organizing committee consisted of H. Alfvén (Stockholm), chairman; L. Block (Stockholm) and B. Lehnert (Stockholm), secretaries; H. W. Babcock (Pasadena), L. Biermann (Göttingen) and T. G. Cowling (Leeds). Together with the invitations a preliminary programme was sent out in advance by the organizing committee. A shortened version of this programme has been published in a circular of the I.A.U. in April 1956. Some weeks before the start of the symposium summaries of more than three-quarters of the contributions were distributed among the participants.

The following persons were present at the meetings:

Australia: J. H. Piddington (Sydney).

Belgium: P. Ledoux (Liège).

Finland: J. Tuominen (Helsinki).

France: Alice Daudin (Paris), J. F. Denisse (Paris), J. Heidmann (Paris), L. Leprince-Ringuet (Paris), E. E. Schatzmann (Paris).

Germany: L. Biermann (Göttingen), A. Ehmert (Weissenau), W. Fricke (Heidelberg), A. Schlüter (Göttingen), S. Temesváry (Göttingen).

Great Britain: P. M. S. Blackett (London), R. Hanbury Brown (Jodrell Bank, Manchester), O. Buneman (Cambridge), T. G. Cowling (Leeds), J. W. Dungey (Cambridge), H. Elliot (London), A. von Engel (Oxford), V. C. A. Ferraro (London), T. Gold (Greenwich Observatory), R. Hide (Harwell), F. D. Kahn (Manchester), R. Latham (London), A. C. B. Lovell (Jodrell Bank, Manchester), F. J. Lowes (S.M.R.E., Harpur Hill), D. Mestel (Leeds), R. S. Pease (Harwell), P. H. Roberts (A.W.R.E., Aldermaston), Pamela Rothwell (London), P. A. Sweet (London), R. J. Tayler (Harwell), W. B. Thompson (Harwell), P. C. Thonemann (Harwell).

India: V. Sarabhai (Ahmedabad), D. Venkatesan (Ahmedabad; temporarily in Stockholm).

Italy: Francesca Bachelet (Roma), G. Righini (Firenze).

Japan: Y. Fujita (Tokyo).

Netherlands: H. C. van de Hulst (Leiden).

Norway: Guro Gjellestad (Bergen), E. Jensen (Oslo), H. Trefall (Bergen).

Poland: K. Serkowski (Warsaw), W. Zonn (Warsaw).

Sweden: H. Alfvén (Stockholm), E. Åström (Stockholm), L. Block (Stockholm), E. Å. Brunberg (Stockholm), A. Dattner (Stockholm), D. Eckhartt (Stockholm), Aina Elvius (Saltsjöbaden), T. Elvius (Saltsjöbaden), N. Herlofson (Stockholm), G. Larsson-Leander (Saltsjöbaden), B. Lehnert (Stockholm), B. Lindblad (Saltsjöbaden), S. Lundquist (Stockholm), E. Lyttkens (Uppsala), Y. Öhman (Saltsjöbaden), A. Reiz (Lund), A. E. Sandström (Uppsala), W. Stoffregen (Uppsala).

U.S.A.: H. W. Babcock (Pasadena, Calif.), A. Baños (Los Angeles, Calif.), W. H. Bostick (Hoboken, N.J.), G. R. Burbidge (Pasadena, Calif.), L. Davis (Pasadena, Calif.), A. Deutsch (Pasadena, Calif.), S. E. Forbush (Washington, D.C.), E. O. Hulburt (Washington, D.C.), A. Kantrowitz (Everett, Mass.), G. F. W. Mulders (U.S. Office of Naval Research, London), E. Parker (Chicago, Ill.), K. Prendergast (Yerkes Observatory, Wis.), J. A. Simpson (Chicago, Ill.), S. F. Singer (College Park, Md.), L. Spitzer (Princeton, N.J.), W. F. G. Swann (Swarthmore, Penn.).

U.S.S.R.: L. A. Artsimovich (Moscow), I. N. Golovin (Moscow), A. J. Kipper (Tartu), E. R. Mustel (Moscow), A. B. Severny (Simeis), J. P. Terletzsky (Moscow).

The discussions were confined to such questions as could be investigated by theory, experiments and observations with a reasonable hope of success. Further considerations on the purpose and formation of the symposium programme are given by H. Alfvén in the 'Opening Address' of this volume. The main subjects of the sessions as well as the titles of the presented papers are given in the table of contents.

A chairman and a secretary were elected for each session. The arrangements were as follows:

Monday, 27 August

Morning. Chairman: W. F. G. SWANN, Secretary: R. HIDE. Opening Address and Papers 1–4.

Afternoon. Chairman: J. H. PIDDINGTON; Secretary, R. HIDE. Papers 5–7.

Tuesday, 28 August

Morning. Chairman: P. M. S. BLACKETT; Secretary, B. LEHNERT. Papers 8–11.

Afternoon. Chairman, G. RIGHINI; Secretary, O. BUNEMAN. Papers 12–17.

Wednesday, 29 August

Chairman: P. LEDOUX; Secretary, E. PARKER. Papers 18–25.

Thursday, 30 August

Morning. Chairman: V. C. A. FERRARO; Secretary: A. SCHLÜTER. Papers 26–30.

Afternoon. Chairman: L. SPITZER; Secretary: E. JENSEN. Papers 31–35.

Friday, 31 August

Morning. Chairman: L. LEPRINCE-RINGUET; Secretary: R. TAYLER. Papers 36–42.

Afternoon. Chairman: A. B. SEVERNY; Secretary: J. HEIDMANN. Papers 43–46.

In addition, notes were taken, a tape-recorder was used and the comments were written down on special forms by the speakers taking part in the discussions.

On 27 August a tour was arranged around the Department of Electronics. The present work on cosmic ray intensity variations, cosmic ray orbits, electron orbits, plasma-resonance, model experiments on the

aurorae and magnetic storms and magneto-hydrodynamic experiments with mercury was shown. Further, the Stockholm Observatory in Saltsjöbaden was visited on Wednesday, 29 August. Professor B. Lindblad gave a survey of the history of the observatory, and the instruments and some observational results were demonstrated to the visitors.

On Saturday, 1 September, and Monday, 3 September, some papers on high current discharges were added to the original programme. Many of the participants were still in Stockholm and took the opportunity to listen to these reports. They are included in Part VI. Part VII contains papers connected with subjects discussed at the symposium. They were not read at the conference, partly because of lack of time, and partly because some of the authors were not able to join the meetings.

Further research in the field of cosmical electrodynamics was certainly stimulated by a great number of interesting discussions. The motion of magnetic-field lines in an electric conductor was considered in connexion with a hydromagnetic dynamo and the behaviour of a magnetic field at a neutral point. Final conclusions were not reached, but the discussions clearly showed the many changing aspects of magneto-hydrodynamics and the danger of making generalizations. The importance of pressure-balanced magnetic fields was stressed in connexion with the magneto-hydrostatic equilibrium of cosmic gas masses.

A rigorous theory on magneto-turbulence has not yet been established. This makes it somewhat difficult to assess the importance of turbulence for phenomena in solar physics, interplanetary space and cosmic radiation. There has earlier been some confusion about the electrical conductivity in a magnetic field. The difficulties now seem to have been overcome and the 'friction coefficient' between the ion and electron fluids in a fully ionized gas is accepted as a fruitful approach.

Experiments are valuable tools in magneto-hydrodynamic research, and there are even interesting experimental results which are not predicted by theory or observations, e.g. the plasmoids. Care is necessary, however, when an extrapolation is made of experimental results to cosmical physics.

In the session on solar electrodynamics interesting attempts were made to explain the solar flares as a pinch effect, as the form of a neutral point discharge or, finally, as the result of collisions between an oscillating plasma and a neutral gas. Some new aspects were presented on the origin and structure of sunspots.

The problem of magnetic variable stars is still open for discussion. The observed field variations may be due to magneto-hydrodynamic oscillations, to the motion of the star as a rigid rotator, or to both effects.

Too little is still known of the physics of interplanetary space. Therefore the connexion between solar phenomena and associated terrestrial phenomena such as magnetic storms and aurorae is rather speculative, and entirely different theories can exist side by side in this field.

Finally, cosmic radiation and its time variations can be explained in many ways. One important question is how the obtained data are affected by observational methods.

The Unions express their gratitude to U.N.E.S.C.O. for the financial help to this symposium. A publication grant for this volume is gratefully acknowledged. I want to express my sincere thanks to Mrs B. Törnell for invaluable help during the symposium and for skilled assistance with the manuscripts and discussions of this volume. I am also indebted to my father Prof. E. Lehnert for valuable help with the manuscripts.

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