Hot Thin Plasmas in Astrophysics

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PREFACE

This volume contains all but one of the lectures and seminars presented at the NATO Advanced Study Institute on Hot Thin Plasmas in Astrophysics held in Cargèse, Corsica, from September 8 to 18, 1987.

The meeting was planned in collaboration with the members of the Scientific Organizing Committee, to whom I am grateful for suggesting a comprehensive and well balanced program. The SOC was comprised of Prof. J. Bleeker (Space Research Institute, Utrecht, The Netherlands), Dr. C. Cesarsky (CEN Saclay, France), Dr. R. Mushotzky (GSFC, USA), Prof. K. Pounds (University of Leicester, UK), Prof. H. Schnopper (Danish Space Research Laboratory, Denmark), Dr. H. Tananbaum (Center for Astrophysics, USA), Dr. G. Trinchieri (Arcetri Observatory, Italy), and Prof. J. Truemper (MPE, Garching, Germany). The ASI, fully supported by the NATO Scientific Affairs Division, was organized with the intent of providing a critical and up-to-date overview of our present knowledge and understanding of the properties of hot thin plasmas in astrophysics as they are revealed by X-ray observations from space.

The X-ray and UV emission from optically thin thermal plasmas is a common feature of many astrophysical systems. This type of emission occurs in the solar corona and in the coronae of other stars, in supernova remnants and in the hot interstellar medium, in normal galaxies and galactic halos, and in the intergalactic gas in clusters. Over the past few years, observations obtained with satellites such as EINSTEIN, IUE, EXOSAT, TEMNA, GINGA, SKYLAB, SMM, etc., have increased enormously our knowledge of hot astrophysical plasmas and have provided significant insights into the physical processes at work. A new generation of X-ray instruments with increased sensitivity and higher spatial and spectral resolution is under study for use in future missions (AXAF, XMM). New X-ray satellites (ROSAT, SAX, ASTRO-D, SOHO, SOLAR-A) are under construction or approved for launch in the next few years.

The Institute reviewed the results obtained recently and discussed thoroughly the capabilities of future X-ray missions. A global approach was adopted that went beyond the usual subdivisions of the field into galactic and extragalactic astronomy or solar and stellar physics. Astronomers from different disciplines were brought together to discuss the physical implications of recent observations and to address the fundamental questions to be answered by future space missions. Basic physical processes (radiation, plasma diagnostics, magnetohydrodynamics) were discussed in a series of introductory lectures, of genuinely tutorial character, that were devoted to young researchers just entering the field (we regret that the lectures on MHD processes could not be included in this volume). The principles of X-ray instrumentation were also discussed in detail and considerable attention was paid to the systematic uncertainties that affect measurements. The remaining lectures treated more specifically Solar and Stellar Coronae, Supernova Remnants, the Hot Phase of the Interstellar Medium, Galaxies, Galactic Halos, and the Intergalactic Gas in Clusters. More specialized topics (including a few which touched upon related, although optically thick, stellar sources) were presented in a series of seminars distributed throughout the conference.

Until 1975, the Sun was the only star known to possess an X-ray corona. Results of solar studies at X-ray and UV wavelengths were reviewed and it was shown that they are of great importance for many other areas of astronomy. The Sun is the only star for

which surface details can be observed and which is bright enough for the application of sophisticated plasma diagnostic techniques. The recent results from the EINSTEIN and EXOSAT Observatories on the coronae of other stars were also discussed at length and the importance of magnetic fields for understanding the observed emission was clearly demonstrated. In supernova remnants, the X-ray emitting gas is heated by shock waves produced in supernova explosions. The dynamics of the explosion was discussed in detail as well as the relationship between supernova remnants and the hot phase of the interstellar medium. Recent results were also presented on the supernova 1987 A, although because of their preliminary nature it was decided not to discuss them at length in these Proceedings. The spectra of stellar and galactic sources are rich in emission lines: it was shown that the interpretation of these spectra can give information on temperature, density, elemental abundances and non-equilibrium conditions. Finally, considerable attention was devoted to hot thin plasmas in isolated galaxies and in clusters of galaxies. Phenomena such as galactic fountains and ram pressure stripping were discussed in some depth. The structure and evolution of clusters was discussed at length, and the evidence was reviewed for the presence of cooling flows in the central regions of clusters.

In summary, the single most important aspect of the ASI was trying to avoid a narrow-minded approach to astrophysical problems and the usual subdivision of the study of hot plasmas into separate areas with little relation one to another. These Proceedings reflect such an approach. We felt that this was particularly important for young people, who in this way can obtain a better understanding of the relevant physical processes and may be ready to work on a variety of different problems, thus taking full advantage of the many opportunities offered by future space missions. The presence at the ASI of a large audience of young astronomers who had only recently started their scientific careers also explains why we devoted so much attention to future space opportunities.

I wish to express my gratitude to the Scientific Affairs Division of the North Atlantic Treaty Organization for the generous support given to the Institute, and to the lectures and participants who contributed so much to the success of the ASI. I also thank the European Physical Society for granting its sponsorship and the Osservatorio Astrofisico di Arcetri and its Director Prof. Franco Pacini for contributing to the organization of the meeting by providing personnel and facilities. The National Science Foundation is gratefully acknowledged for providing travel grants to four young American participants.

Special thanks are due to Mrs. Fern Bongianni for her dedicated work during the organization of the ASI and her assistance throughout the meeting, and to Miss Marie-France Hanseler for arranging the great hospitality of the Institut d'Etudes Scientifiques de Cargèse and for taking care of the local organization. I am deeply grateful to her for ensuring a smooth and pleasant running of the meeting throughout its duration. Least but not last, one of the reasons of the success of the ASI was certainly the beautiful setting of Cargèse, and the wonderful experience we had of visiting such an extraordinary place as the island of Corsica.

Roberto Pallavicini

Director of the ASI

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