
Since almost all of the (non-'dark') matter in the Universe is in the plasma state, or approximates it more closely than any other, it befits all astrophysicists to acquire a working knowledge of the basic principles and problems of plasma diagnostics. (Indeed most astrophysical observation and modelling work can be regarded as the application of remote passive plasma diagnostic methods on the grandest scale.) To obtain a sound foundation in the basic principles of this field, one could do no better than to work through Hutchinson’s excellent monograph. While so doing, the reader will simultaneously acquire a good grounding in the basic theory of plasmas and of radiation processes, which the text expounds with an unusual combination of clarity, physical insight, and mathematical rigour.

Plasma diagnostic techniques can be broadly subdivided into local and remote, depending on whether measurements are made in situ or properties are inferred from radiations received at a distance, and into passive and active, according to whether conditions are simply measured from the plasma and its own radiation or from its effect on active ‘probes’ such as laser scattering. Hutchinson’s text deals with all of these domains, since it is primarily aimed at the laboratory plasma physicist. Consequently, about half the contents are of astrophysical interest only to the space plasma community whom it will serve well, whether in the area of charged particle and field analysis or of neutral particle emissions from planetary magnetospheres. The other half, however, will be useful to pure solar- or astrophysicists in diverse areas including primary continuum and line radiation processes, and their diagnostic uses, and the propagation of electromagnetic waves through magnetized plasma media.

The contents of the book are well organized, and readable either as a whole or as individual units, according to the background and interests of the reader. Following a survey of basic plasma properties and categories of diagnostics, three chapters deal with magnetic diagnostics, particle flux diagnostics, and a wide variety of plasma analysis methods by refractive index measurements. Subsequent chapters deal with radiation from free plasma electrons, bound plasma electrons, and scattering of electromagnetic radiation. These will be of particular value as source material for astrophysicists, covering numerous relevant areas of basic physics from atomic rate coefficients and line broadening, through continuum radiation theory, to the problem of three-dimensional source reconstruction from X-ray images. The final chapter deals with ion processes, for both charged and neutral particles, and incorporates much theory of relevance to astrophysics even though the direct diagnostic applications are of restricted relevance there. The book closes with a valuable set of short appendices on key areas of mathematics, on radiation technology, and on definitions and notation. The only areas in which the contents might be judged as lacking, are more complete discussions of non-thermal processes and diagnostics and of interpretation of diagnostics when applied to inhomogeneous structures, both of special interest in astrophysics.

In summary, this monograph is a pleasure to read, is a must for the plasma physicist, and an invaluable addition to any astrophysicist’s library. It is a multifaceted work which will not only serve the rôle of its title but also provide a good teaching and research text in basic plasma and radiation theory. While primarily theoretical in content, the book’s style is such as to remain always in touch with the practical and difficult problem of interpreting remotely sensed data on complex macroscopic systems, an all-important matter for astronomy.—J. C. Brown.