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Principles of Plasma Electrodynamics

With 51 Figures

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Preface

The manuscript tackles one of the most interesting branches of plasma physics, the electrodynamics of the plasma. 99% of matter in the universe occur in the plasma state, – e.g., stars, gaseous nebulae, interstellar gas. The plasma also widely occurs on earth. Thus, the ionosphere protects human beings from the destroying effects of the solar radiation and provides the long-distance radio communication. Plasmas also show up in metals and semiconductors, and it is difficult to overestimate their importance in our everyday life. But even more important is that the power engineering of the future is connected with plasmas since the plasma is the fuel for thermonuclear reactions and a practically unlimited source of energy harmless to the environment.

For the description of a hot plasma a unique logically complete and consistent theoretical model has been developed on the basis of the Maxwell-Vlasov equations. We tried to carry this idea through the entire text, which aims to present an orderly exposition of electromagnetic properties of the plasma within the Maxwell-Vlasov model. Both linear and nonlinear electrodynamics of the plasma are presented.

The first part (Chap. 1–5) deals with the linear electromagnetic properties of the plasma in thermodynamic equilibrium. The basic equations of the Maxwell-Vlasov model are introduced and the properties of the plasma in equilibrium are studied in the linear approximation of the electromagnetic field. The second part (Chaps. 6–9) analyzes the properties of the non-equilibrium plasma. The general theory of electromagnetic instabilities of such a plasma is developed in this part of the book. Note that the real plasma is always far from thermodynamic equilibrium and is usually unstable. Finally the principles of the nonlinear plasma electrodynamics along with the most characteristic nonlinear effects in the plasma are described in the third part (Chaps. 10–12). Presently the nonlinear electrodynamics of the plasma develops rapidly, therefore in the future the third part may undergo significant changes. However, we have made an attempt to cover the most complete and exploited branches of the nonlinear electrodynamics of the plasma.

The description is mathematically strict and systematic; the text is written as a manual supplied with many exercises and their solutions. It is quite sufficient for studying the electrodynamics of the plasma but is intended for a

comparatively well prepared reader, i.e., physics students and young scientists. It is also useful for all specialists in plasma physics.

Compared to the 1978 Russian edition the English one is significantly revised and complemented. We hope that this book will be of interest for the foreign reader, too.

We wish to express our appreciation to Professor G. Ecker for his helpful assistance in the revision and preparation of the manuscript and to Dr. H. Lotsch for his attention, benevolence and effective help in improving the English version of the book.

Moscow, January 1984

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