Preface

The physics of complex plasma systems containing a colloid "macroscopic" particle component ("dust") is a rapidly emerging area at the forefront of the physics and chemistry of plasmas and gas discharges, space physics and astrophysics, and materials science and engineering. Complex plasma systems with nano- and microscopic particle inclusions is now a hot topic for many research areas. Such plasma systems present an excellent example of complex systems because of the many and varied constituents, and the space and time scales involved, with extensive interaction between them.

In our decision to write this book, we were mostly motivated to introduce, in a systematic and easy-to-follow manner, our understanding of the fundamental physics and industrial applications of complex plasma systems. The recent progress in the field has been so remarkable that several novel directions and paradigms in complex plasma research have emerged. Therefore, we have decided to focus on the most important (as we see them) current topics, and new paradigms in the research on and applications of complex plasma systems. We also review the role of "dust" in laboratory plasmas and discuss various challenging applications of the nano- and micrometer-sized particles in high-tech industries. We systematically present the current state of research and the physical insights, including the advanced theoretical models and results of extensive computer simulations, complemented with the laboratory experiments specifically designed to elucidate the fundamental physics of complex plasmas.

This book provides a broad perspective and opens up future development of this rapidly expanding field to interested researchers normally working in various areas. Even though the main attention in this book is given to the conditions relevant to the laboratory gas discharges and industrial plasma reactors, most of the fundamental concepts discussed here are also

applicable to space and astrophysical plasmas. A specialized and comprehensive description of the most recent theoretical, experimental, and modeling efforts to understand the unique properties of complex plasma systems, including the stability, dynamics, and self-organization of colloid particles and their associations, is given. Special attention is paid to the physical concepts and most recent technological advances in various industrial applications of the micrometer- and nano-sized particles.

The first chapter introduces complex plasmas as a new and unusual state of matter with fascinating physical properties. Chapters 2 and 3 present the fundamentals of the theory of interactions of the colloid particles with ionized gases and experimental methods of production and diagnostics of complex plasmas. Topics important to the physics of strongly and weakly coupled particle-plasma systems are discussed in the following three chapters. In Chapter 4, key attention is paid to the particle dynamic phenomena, as well as particle arrangement and stability in complex ionized gas systems. Chapter 5 covers the self-organized gaseous, liquid and crystal-like structures, and phase transitions in dusty plasmas. Collective waves and oscillations in weakly-coupled colloidal plasmas are reviewed in Chapter 6. The concluding Chapter 7 focuses on the advanced industrial applications of micron- and nano-sized particles.

The knowledge is presented in a concise and comprehensive manner, with a categorized overview of the underlying physics followed by up-to-date details. Leading references are given to key original research results describing the unique features and high-tech applications of complex plasma systems. As such, this book is suitable for undergraduate and graduate students, as well as for researchers who work either inside or outside the field. We thus expect that our book will be interesting to researchers and students working in the areas of gas discharge and plasma physics, applied physics, space physics and astrophysics, soft condensed matter physics, and materials and electrical engineering.

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