

Michael Bonitz
Jose Lopez
Kurt Becker
Hauke Thomsen *Editors*

Complex Plasmas

Scientific Challenges and Technological
Opportunities

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Preface

Plasma physics is an extremely broad field covering charged particle systems with temperatures from micro-Kelvins to millions of degrees, and densities ranging from the dilute matter in interstellar space to plasmas in the interior of compact stars that are million times denser than ordinary condensed matter. *Complex plasmas* are a special type of low-temperature plasmas characterized by the presence of nano or microparticles, by chemical reactions as well as by the interaction of plasmas with solid surfaces. These additional ingredients give rise to many technological applications that have emerged only recently. At the same time, complex plasmas have many peculiar properties and are experimentally and theoretically quite complicated. Complex plasmas have strong overlap with other fields of physics, including atomic and molecular physics, condensed matter physics, and material science. They require special techniques and approaches that are often not covered in standard plasma physics textbooks or courses.

Responding to this challenge, the present book provides a collection of tutorial style review articles that give graduate students and young researchers an introduction into various aspects of complex plasmas. This book continues and extends the material of the successful book “Introduction to Complex Plasmas,” edited by M. Bonitz, N. Horing, and P. Ludwig that was published by Springer in 2010. It contains new results in basic and applied research and has a particular focus on modern technological applications of complex plasmas.

Part I of this book is devoted to dusty plasmas and covers fundamental issues such as phase transitions and nonequilibrium effects in streaming plasmas. Part II is devoted to quantum effects of the electrons that become increasingly important in complex plasmas and their description with modern simulation techniques. Part III covers fundamental properties of lower temperature plasmas including experimental diagnostics and modern computer simulations. Part IV concludes the book with an overview of various modern technological applications of complex plasmas.

This book is based on tutorial lectures given at the Third Graduate Summer Institute on “Complex Plasmas” at *Seton Hall University*, South Orange, NJ (USA) from July 30 to August 8, 2012. The workshop was jointly organized by the SFB-TR24 “Fundamentals of Complex Plasmas” Greifswald/Kiel (Germany) and Seton Hall University. We gratefully acknowledge financial support by the Deutsche Forschungsgemeinschaft via SFB-TR24, the Army Research Office

(ARO), National Science Foundation (NSF), the U.S. Department of Energy (DoE), the Polytechnic Institute of New York University, and the Princeton Plasma Physics Laboratory (PPPL) and the help of many people who have made the workshop and this tutorial book possible.

Kiel, NY, USA, October 2013

Michael Bonitz
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