Author's Foreword

Physics of Nonneutral Plasmas was first published in 1990 by Addison-Wesley (Reading, Massachusetts) when the author was Professor of Physics at the Massachusetts Institute of Technology. During the intervening period, research on nonneutral plasmas has evolved into a well-developed subfield of plasma physics, and I am delighted that World Scientific Publishing Co. has offered to reissue this graduate-level text on nonneutral plasmas, which has become a standard reference in this rapidly evolving area of physics research. *Physics of Nonneutral Plasmas* has been 'field-tested' in numerous graduate-level course offerings, including those given by the author at the Massachusetts Institute of Technology, Princeton University, and the United States Particle Accelerator School.

A nonneutral plasma is a many-body collection of charged particles in which there is not overall charge neutrality. The simplest examples are *one-component* pure ion plasmas, or pure electron plasmas. Since *Physics of Nonneutral Plasmas* was first published, this area of physics research has developed into a sophisticated subfield of pure and applied plasma physics. The diverse areas of application include: the nonlinear dynamics and collective processes in charge bunches in high-intensity accelerators for high energy and nuclear physics applications; investigations of nonlinear vortex dynamics and turbulence in nearly-inviscid two-dimensional fluid flow; the development of precision atomic clocks; coherent electromagnetic wave generation by energetic electrons interacting with magnetic field structures, as occurs in magnetrons, free electron lasers, and cyclotron masers; periodic focusing induction linac accelerators for the acceleration and transport of space-charge-dominated heavy ion beams;

research on properties of strongly correlated (including crystalline) one-component nonneutral plasmas; basic studies of the collective properties and nonlinear dynamics of laboratory-confined nonneutral plasmas in Malmberg-Penning traps and Paul trap configurations; studies of the basic thermal equilibrium and thermodynamic properties of one-component nonneutral plasmas; research on the formation and confinement properties of positron plasmas; investigations of the production of antihydrogen for basic physics studies by the mixing of positron and antiproton plasmas; and the equilibrium and stability of intense nonneutral electron and ion flow in high-voltage diodes, to mention a few examples. *Physics of Nonneutral Plasmas* provides an thorough physics foundation for advanced scientific research in these and related areas.

Physics of Nonneutral Plasmas has been prepared as a graduate-level text which covers a broad range of topics related to the fundamental properties and applications of nonneutral plasmas. The subject matter is treated systematically from first principles using a unified theoretical approach, and the emphasis is on the development of basic concepts that illustrate the underlying physical processes, which are often similar in different application areas. *Physics of Nonneutral Plasmas* includes 138 problems, 143 figures and illustrations, and the results from several classic experiments illustrating fundamental processes in nonneutral plasmas. In view of the book's emphasis on basic physics principles, and the thorough presentation format, it is intended to have a broad and lasting appeal to graduate students and researchers in the field.

Finally, because of the advanced theoretical techniques developed for describing the properties of one-component charged particle systems, *Physics of Nonneutral Plasmas* provides a useful companion volume to *Physics of Intense Charged Particle Beams in High Energy Accelerators* (World Scientific, Singapore, 2001) by Ronald C. Davidson and Hong Qin.

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