

PHYSICS OF NONNEUTRAL PLASMAS

A nonneutral plasma is a many-body collection of charged particles in which there is not overall charge neutrality. The diverse areas of application of nonneutral plasmas include: precision atomic clocks, trapping of antimatter plasmas and antihydrogen production, quantum computers, nonlinear vortex dynamics and fundamental transport processes in trapped nonneutral plasmas, strongly-coupled one-component plasmas and Coulomb crystals, coherent radiation generation in free electron devices, such as free electron lasers, magnetrons and cyclotron masers, and intense charged particle beam propagation in periodic focusing accelerators and transport systems, to mention a few examples. *Physics of Nonneutral Plasmas* is a graduate-level text — complete with 138 assigned problems and the results from several classic experiments — which covers a broad range of topics related to the fundamental properties of collective processes and nonlinear dynamics of one-component and multispecies charged particle systems in which there is not overall charge neutrality. 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 in circumstances where intense self fields play a major role in determining the evolution of the system. The theoretical analysis includes the full influence of dc space charge effects on detailed equilibrium, stability and transport properties. The statistical models used to describe the properties of nonneutral plasmas are based on the nonlinear Vlasov–Maxwell equations, the macroscopic fluid–Maxwell equations, or the Klimontovich–Maxwell equations, as appropriate, and extensive use is made of theoretical techniques developed in the description of multispecies electrically-neutral plasmas, as well as established techniques in classical mechanics, electrodynamics and statistical physics.

Physics of Nonneutral Plasmas emphasizes basic physics principles, and the thorough presentation style is intended to have a lasting appeal to graduate students and researchers alike. Because of the advanced theoretical techniques developed for describing one-component charged particle systems, this book serves as a useful companion volume to *Physics of Intense Charged Particle Beams in High Energy Accelerators* by Ronald C. Davidson and Hong Qin.