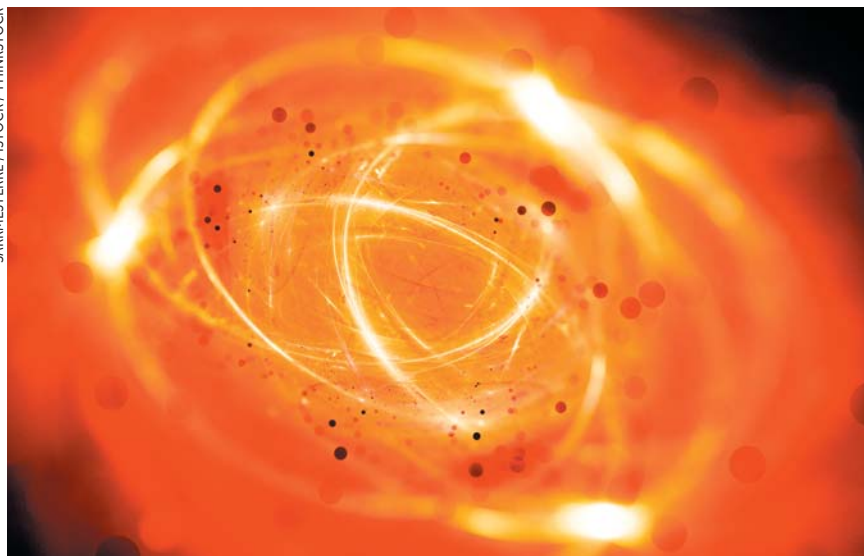




Strongly interacting plasmas

The visible universe is almost entirely composed of matter in plasmas whose states range from the rarefied interstellar medium to crystalline structures in white dwarf stars to solids warped by extreme magnetic fields in neutron stars. Scientists regularly produce states similar to all of those closer to home, most often with lasers.

In recent decades important advances have been made in the size of lasers, as exemplified by the kilometer-long laser at the National Ignition Facility in California, and in their photon energy, as exemplified by widespread x-ray free-electron lasers. Those instruments allow us to produce and probe plasmas in various states. Plasmas are often created at very high densities comparable to their astrophysical counterparts; such are considered nonideal plasmas, in that they display behavior less like that of a gas and more like that of a Coulomb liquid, whose electrons and ions strongly interact.

When I was being trained in the field, the standard text was Setsuo Ichimaru's two-volume *Statistical Plasma Physics* (1992). Later came the excellent text *Quantum Statistics of Nonideal Plasmas* (2005) by Dietrich Kremp, Manfred Schlanges, and Wolf-Dietrich Kraeft, which was based on the pioneering works of collaborative teams from universities in Berlin, Moscow, and Rostock. Now Werner Ebeling, Vladimir E. Fortov, and Vladimir Filinov have produced a new graduate-level text, *Quantum Sta-*

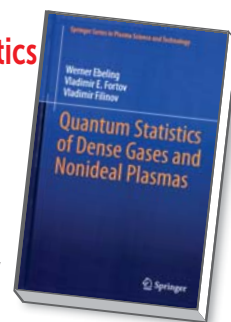
tistics of Dense Gases and Nonideal Plasmas. The three authors are giants in this field and are also from the Berlin-Moscow-Rostock school.

The book begins with an overview in chapter 1 of types of nonideal gases and plasmas. Chapter 2 covers the physics of dense gases, with a focus on the equation of state; the chapter is the only one devoted to dense gases. Chapter 3 is a gentle introduction to many of the concepts that will be treated in much more detail later in the book, including strong coupling, ionization states, and screening. Chapters 4, 5, and 6 then cover the basics of equations of state in detail, including the obvious issues associated with partial degeneracy and strong coupling, but also important issues arising from atomic physics.

Kinetics is covered in chapters 7 and 8, with an interesting interlude on hopping kinetics in tight-binding models. Chapters 9 and 10 discuss path-integral Monte Carlo methods and results for dense hydrogen, content not covered in the books by Ichimaru or Kremp and colleagues. The final two chapters, 11 and 12, also cover material not usually found in texts. There, Ebeling, Fortov, and Filinov make the connection between electromagnetic plasmas and quantum chromodynamic plasmas through relativistic generalizations of the formalism presented in the earlier portions of the book. The main application treated in the last two chapters is quark-gluon plasmas. Throughout the book, draw-

Quantum Statistics of Dense Gases and Nonideal Plasmas

Werner Ebeling,
Vladimir E. Fortov,
and Vladimir Filinov
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ings of familiar plasma physicists by artist Thomas Husing are a nice touch.

Of course, no book is perfect, and I would be remiss if I didn't discuss some of this work's limitations. *Quantum Statistics of Dense Gases and Nonideal Plasmas* is poorly edited. Many acronyms are never defined, or are defined only long after they are first used, and some of the figures are almost unreadable due to their low resolution. The index is nearly useless and should be many times its current four-page length. On the technical side, the book is missing a detailed discussion of finite-temperature density functional theory (DFT), an increasingly commonly used technique. The wide availability of powerful computational resources and of open-source DFT code has facilitated the development of many computational tools. State-of-the-art methods like time-dependent DFT and multiscale methods are also not mentioned. However, the book does cover all of the basic foundations underlying the development of those methods.

The main aim of the book, as stated on the back cover, is to offer a pedagogical exploration of the basic principles of quantum statistical thermodynamics as applied to various states of matter. The book does not provide enough background information to fully achieve that aim; it assumes a great deal of knowledge on the part of the reader. However, students with a strong background in statistical mechanics will find that the book details a wide range of applications to dense gases, nonideal plasmas, and quark-gluon plasmas. *Quantum Statistics of Dense Gases and Nonideal Plasmas* will be useful to early graduate students in physics who have finished their basic graduate courses and are planning a career in high-energy-density physics.

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