

EXTREME PHYSICS

Properties and behavior of matter at extreme conditions

Most matter in the Universe, from the deep interior of planets to the matter of stars, is at a high temperature or a high pressure compared with the matter of our ordinary experience. This book offers a comprehensive introduction to the basic physical theory on matter at such extreme conditions and the mathematical modeling techniques involved in numerical simulations of its properties and behavior.

Focusing on computational modeling, the book discusses topics such as the basic properties of dense plasmas; ionization physics; the physical mechanisms by which laser light is absorbed in matter; radiation transport in matter; the basics of hydrodynamics and shock-wave formation and propagation; and numerical simulation of radiation-hydrodynamics phenomenology. End-of-chapter exercises allow readers to test their understanding of the material and introduce additional physics, making this an invaluable resource for researchers and graduate students in this broad and interdisciplinary area of physics.

JEFF COLVIN is a physicist at the Lawrence Livermore National Laboratory. His expertise ranges from hydrodynamics and turbulence and laser–matter interaction physics to the computational design of materials science experiments on lasers.

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Acknowledgments

This book grew out of a short course we have been teaching on an irregular basis to graduate students and post-doctoral staff at the Lawrence Livermore National Laboratory (LLNL) in Livermore, CA where one of us (JC) is a staff scientist. The other (JL) is a consultant to LLNL – as well as other national laboratories and many universities – to support the radiation-hydrodynamics computer codes (HYADES and h2d) that he developed. The course we put together consists of “tutorials,” in which we teach the basic physics on which radiation-hydrodynamics modeling and computations is based, and a “practicum,” in which the students gain some hands-on experience in how to do computations. The course content was pieced together from our own notes and from a number of published sources, and the content grew and evolved over the years. Occasionally, a career LLNL staff scientist would enroll in our course. The original suggestion to turn our course notes into a textbook came from one of these staff scientists who took the course, Hector Lorenzana. We are very grateful to Hector for this suggestion.

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