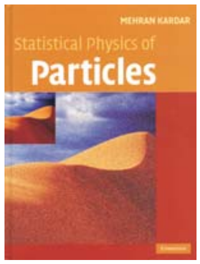
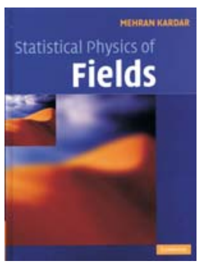
derivation of statistical field equations governing the system's dynamics. Admiring what he was showing me, I asked him how he did it. He shared his logic, and it proved to be a useful lesson. Now, Kardar shares his approach with everyone who chooses to read *Statistical Physics of Fields* (and thus ends whatever undeserved advantage I held over some of my competition). The book is the second of two volumes—the other being *Statistical Physics of Particles*—that Kardar has written based on a two-semester statistical mechanics course he offers at MIT to physics graduate students. Over the past two decades I have admired Kardar's contributions to theoretical physics, and now I admire his contribution to teaching physics.





Long ago, statistical mechanics was a tangential topic of physics, one that a single graduate textbook could summarize with reasonable completeness. That changed starting in the 1970s, when the importance and breadth of the field began to grow enormously. Statistical mechanics is now indispensable in virtually all of the natural sciences and beyond, from mathematical physics to molecular biology, from economics to social networking. One reason for its growing and unifying role is the development of renormalization group theory, which played out in the 1970s. Another is the ease of numerical simulation, which also began around the same time. Those and related developments changed the sociology of theoretical physics and placed statistical physics at its center.

Nowadays, no one- or two-volume text can cover the entire field. Nevertheless, a good text will provide a foundation for students who can then venture far beyond. I believe that Kardar's two volumes serve that purpose. The discussions are succinct, focused, often elegant, and almost always demanding. Much of the physics is presented through solutions to exercises appended to all but the second volume's last two chapters, and in using the books, students will learn by example. The first volume contains roughly 200 pages of standard text and about 100 pages detailing solutions to many, but not all, of the exercises; the second volume has about 250 pages of text plus about 100 pages of problem solutions. Students will not find the books easy going, but they will be substantially rewarded for their hard work. Precocious students might use the texts successfully without an instructor. They will likely need to be comfortable with mathematics typical of a graduate-level quantum mechanics course, and they will need to intuit the meanings of some notations.

Together, the two volumes cover many of the standard topics—ensembles, real gases, Bose–Einstein condensation, equilibrium Landau–Ginzburg theory, the Ising model, and so forth. Nonetheless, there are notable absences. Among the most significant omissions is a systematic treatment of linear response and the connections between measurements and correlation functions. Also, the book does not include a substantive discussion of numerical methods; it has only the briefest mention of the simplest of Monte Carlo schemes.

What Kardar's text does have—in the first eight chapters of the second volume—is a superb treatment of time-independent statistical field theory that starts with a discussion of elasticity in ordered solids and ends with the two-dimensional Coulomb gas and 2D melting. Several other good texts treat phase transitions by means of scaling, series expansions, and renormalization group theory, but Kardar's coverage is special. Students getting their first exposure to the topic will obtain an excellent foundation through a remarkably compact yet reasonably complete and understandable presentation of the essentials of symmetries and physical reasoning and also the nuts and bolts of lattice sums, combinatorics, functional integrals, and field-theoretic perturbative calculations. Expert readers will enjoy seeing how Kardar does the job, and they might gain new insights.

The first volume includes cursory discussions of time dependence, but nonequilibrium phenomena are not otherwise discussed until the last two chapters of the second volume. Entitled "Dissipative dynamics" and "Directed paths in random media," they survey several of the most interesting topics to which Kardar has contributed significantly. The approach taken in those chapters is closer to that of a review article than that of a textbook. Although they are a useful compendium, I prefer something more like the first eight chapters, with an assortment of exercises and illustrative problem solutions.

The first volume, *Statistical Physics of Particles*, is distinguished by its useful feature of teaching by example, but otherwise its presentations are similar to those in other excellent texts of similar level. On the other hand, the first eight chapters of *Statistical Physics of Fields* are stunning. With that volume Kardar has produced an excellent and unique textbook that will serve our community well for many years.

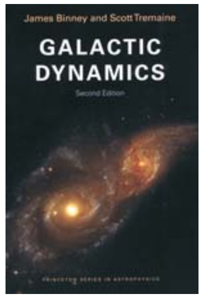
David Chandler
University of California
Berkeley

Galactic Dynamics

James Binney and Scott Tremaine
Princeton U. Press, Princeton, NJ, 2008. 2nd ed. $110.00, $60.00 paper (885 pp.).
ISBN 978-0-691-13026-2,
ISBN 978-0-691-13027-9 paper

The first edition of James Binney and Scott Tremaine's *Galactic Dynamics* is the bible of its field. Written by two of the world's leading dynamicists, it educated a generation of graduate students and serves as a reference book for researchers of all specialties who work on the subject. Since the book's publication in 1987, galactic dynamics has witnessed major developments and shifts in perspective, and new dynamical techniques have emerged for modeling and interpreting observations. Nowadays galaxies are not considered in isolation; astrophysicists recognize that their evolution cannot be separated from their formation in the broader cosmological context. Dark matter, an immature concept in 1987, is now seen as the dominant element in the formation and dynamics of galaxies. It is a good time for a second edition.

The new edition incorporates several changes. It expands on the use of Lagrangian and Hamiltonian mechanics and more strongly emphasizes orbit-based methods for constructing stellar systems. In response to increasingly sophisticated *N*-body simulations, the new edition includes more on numerical methods for evaluating gravitational fields and following orbits. Discussions of dark matter are integrated into the other chapters. Moreover, *Galactic Dynamics* now has an introductory section to set the cosmological context. The final chapter on galaxy formation and cosmological structure formation includes a short section on star formation and feedback. The topic is far from mature, but it is an appropriate one with which to end the book because it is potentially so important for galactic dynamics. Back in 1987 the community's understanding of dark matter—



the concluding topic for the first edition—was similarly undeveloped.

Galactic Dynamics begins with an observational introduction that is broader in scope than its predecessor. As one who frequently teaches galactic dynamics to students who had somehow missed out on basic astrophysics, I find the new introduction very useful. It provides a comprehensive overview of essential stellar astrophysics, galaxies, star clusters, clusters and groups of galaxies, and the basic concepts of collisionless dynamics and cosmology.

In the 20 years since the first edition was published, astronomers have developed powerful new numerical orbit-based techniques for constructing stellar systems, each of which is tailor made to match the observational constraints on a system's structure and kinematics. We have learned much about massive black holes at the centers of galaxies and about how those black holes affect the dynamics of their host galaxy. The use of stellar kinematics as a mass detector has advanced greatly, both for central black holes and for application to more general problems in galaxies. The halos of dark matter that envelop galaxies are affected by adiabatic compression as stellar disks grow slowly in the halos' inner regions, and the halos in turn influence the behavior of the disks. Those and other topics appear in the chapters on potential theory, orbits, and the equilibrium of stellar systems.

Dynamicists have changed their perspectives concerning spiral structure in galaxies, and there is now more interest in how transient spiral structure and the central bars in galaxies can affect the stars of the disk by transporting angular momentum and inducing observable resonant effects. Nonetheless, the more classical theory of spiral waves remains interesting and is still thoroughly presented. The chapter on kinetic theory includes the dynamics of binary interaction, the statistical mechanics of gravitating systems, the gravothermal catastrophe, and the evolution of stellar systems as they are affected by those processes. Much of the chapter pertains more to the dynamics of star clusters than to galaxies, but the dynamics is nonetheless interesting and important because it is essential for understanding the star-cluster populations observed in galaxies.

In the current cold-dark-matter cosmology, galaxies are built from the merging of smaller entities. For that reason, the encounters, merging, and destruction of galaxies are important topics in dynamics. Dynamical friction, tides, and high-speed encounters are all relevant, and the new edition contains an expanded discussion of those topics. It also includes new material on the evolution of binary black holes and additional information on the evolution of tidal tails and streamers.

The book ends with an expanded and useful set of technical appendices. A new feature, the use of boxes, highlights special points of interest. Those boxes are not detailed in the table of contents; it would be helpful to list them in a future reprinting.

The second edition of *Galactic Dynamics* is a successful revision of its 1987 predecessor and will long be a reference for those working on galaxies. Astronomers teaching advanced courses in galactic dynamics will also use it widely, in part because it includes an expanded collection of interesting and demanding problems for teaching and consolidation of the wealth of material presented in the book.

Ken Freeman
Australian National University
Canberra

The Black Hole War

My Battle with Stephen Hawking to Make the World Safe for Quantum Mechanics

Leonard Susskind
Little, Brown and Co, New York, 2008. $27.99 (470 pp.).
ISBN 978-0-316-01640-7

The Black Hole War: My Battle with Stephen Hawking to Make the World Safe for Quantum Mechanics is a highly informative and entertaining book about a fundamental debate in physics. Leonard Susskind, an innovative physicist and a father of string theory, gives a fast-moving, personal account of his clash with Stephen Hawking about whether black holes permanently remove information from the universe.

In 1974 Hawking discovered that black holes are not completely black but instead emit what is now called Hawking radiation. That means that black holes will lose mass and, presumably, eventually evaporate away. But what happens to the information that falls into the black holes?

Not long after his seminal discovery, Hawking proposed that such information