ing. The cast of characters, past and present, making nuclear policy in India is a lengthy one, and Perkovich seems to have been diligent in exploring the roles, influence, and attitudes of a large fraction of them. He has done so with great sensitivity and in a generally nonjudgmental way, which is quite remarkable, considering his strong personal convictions about nuclear proliferation and many of the actions of India, Pakistan, and the US.

For anyone interested in India's nuclear weapons history, there is no other account I know of that can offer as much as Perkovich's. Read it (the first 443 pages, anyway), and at least thumb through the many endnotes.

Quantum Phase Transitions

Subir Sachdev
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The quantum theory of solids developed over the past 70 years is primarily constructed in terms of weakly interacting electron and hole excitations. This framework works wonderfully in describing simple insulators, semiconductors, and metals. But it is becoming increasingly clear that large classes of new materials—ranging from transition metal oxides, such as the cuprate superconductors, to the heavy fermion materials—are "misfits," which don't conform to the standard paradigm. It is generally believed that a satisfactory understanding of these complex materials will require an incorporation of strong Coulomb interactions and that new—and previously unimagined—quantum phases might be lurking within. In Subir Sachdev's new book, *Quantum Phase Transitions*, such interaction effects are brought to the fore.

Quantum phase transitions separate different quantum phases (phases of matter at zero temperature). Strictly speaking, such phase transitions can be accessed only by a varying parameter—like pressure—at absolute zero temperature. But as Sachdev emphasizes, proximity to a quantum phase transition can sometimes dominate the material properties even well above room temperature. Frequently a quantum phase transition separates two quantum phases having different symmetries, such as the well-studied superconductor-to-insulator transition in thin films. But this need not be the case.

Quantum phase transitions are intrinsically complex, involving the subtleties of quantum mechanics acting in concert with static and dynamic critical fluctuations. As with their classical counterparts, such as the well-studied liquid–gas critical point, quantum phase transitions are blessed with a remarkable degree of universality—an insensitivity to microscopics that emerges due to the presence of characteristic lengths and frequencies well separated from the atomic scales. This happy situation enables Sachdev to focus almost exclusively on comparatively simple but effective models that share this universal physics despite providing an overly simplified caricature of the underlying atomic physics.

Sachdev develops the theory of quantum phase transitions by comparing and contrasting with their classical cousins. By using an imaginary time Feynman path integral approach he recasts these effective quantum models in a form that resembles a classical statistical mechanics problem in one higher dimension. This allows an application of standard renormalization group and scaling techniques, but there are several new and subtle twists, which emerge only in the quantum context. In particular, it is essentially impossible to extract information about real-time dynamics near the quantum phase transition from the imaginary-time formulation, especially on time scales long compared to the critical dephasing time. Progress here requires a direct dynamic formulation in real time, involving a semiclassical particle or wavelike framework appropriate to each quantum phase transition. This area was pioneered by Sachdev over the past decade, and his book contains the first pedagogical account of this important new development.

Another complication particular to quantum phase transitions is the presence of complex "Berry's phase" terms, which reflect the underlying particle discreteness implicit in the quantum fields. Many of the later chapters in the book are devoted to deriving and analyzing the effects of these confusing yet important Berry's phase terms.

Scaling provides one of the most powerful means of attacking strongly interacting many-body problems, and it rightfully plays a central role in Sachdev's book. In Chapter 2, scaling is introduced in the context of familiar single-particle quantum mechanics, allowing even readers unfamiliar with field theory to appreciate its central role. But soon thereafter, the theoretical demands placed on the reader rapidly increase, and later chapters are written at a level that will undoubtedly challenge even the most talented theoretical graduate students.

Toward the end of the book, Sachdev includes a wonderful introduction to the method of bosonization that is clearer than any other I have seen. He also gives an abridged introduction to disordered systems that will enable the reader to appreciate the new subtleties that arise.

Taken as a whole, this book is something of a theoretical masterpiece. With its tight organization, the book leads the determined (and theoretically inclined) reader on a tour encompassing some of the most challenging yet beautiful topics in contemporary theoretical physics. Along the way, the reader is introduced to a remarkable breadth of field-theoretic techniques. Virtually every chapter contains a theoretical "gem," certain to be novel even to the most experienced practitioners. The equations are manipulated with flair and elegance that are testamony to Sachdev's talent as one of the world's premier theorists.

Perhaps the only weakness of this book is that the beauty of the physics can sometimes be obscured by the beauty of the formalism, which flows so readily in Sachdev's writing. In some ways the book is too complete; many readers will almost certainly feel overwhelmed. On the other hand, this book should be required reading for any budding theorist who wishes to explore the quantum wonders of complex materials.

Matthew P. A. Fisher
Institute for Theoretical Physics
University of California, Santa Barbara

Laser Cooling and Trapping

Harold J. Metcalf and
Peter van der Straten
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For the past 15 years, the rapid rate at which laser-cooling and atom-trapping techniques were being invented and applied to new problems scared off most would-be textbook writers. The thought was that the field should settle down a bit before a textbook could present it in a proper perspective. As a result, the introduction to cooling and trapping to date has been left to special issues of journals, review articles, conference texts, isolated book chapters, and a few PhD theses.