Hadron Collider. Those bricks have been gigantic and small, yet all have been essential parts of an endeavor that has in the past century strongly influenced human progress.

Any other book on particle-accelerator history would have included the two authors because of their influence on US and European accelerator development. Sessler is a former director of Lawrence Berkeley National Laboratory; Wilson, a visiting professor at Oxford University, led the commissioning of the Super Proton Synchrotron and once headed the CERN Accelerator School. The need for higher-energy beams for fundamental research has been the major motivation for advances in particle accelerators. The idea of an accelerator was first discussed publically in 1928 when Ernest Rutherford, during his presidential address to the Royal Society of London, asked for a beam of charged particles more energetic than those produced by natural radioactivity. John Cockcroft and Ernest Walton picked up the challenge; in the Cavendish Laboratory, they invented the high-voltage generator that is named after them. Eighty years later the new generation of high-energy accelerators is being made possible with the participation of research groups from numerous laboratories and funds from all over the world. The complexity of the machines has allowed researchers to increase the energy of the particles by orders of magnitude.

Researchers' intellectual curiosity for fundamental physics laws has generated technical progress on a range of accelerator applications—from synchrotron radiation to cancer therapy to spallation neutron sources. The flexibility of the community of accelerator physicists is evident in its ability to apply the most innovative physics for a collider to the most reliable technology for a medical application. The authors show the path from fundamental physics to technology to application in the book's 11 chapters, each of which discusses a different type of particle accelerator. Each chapter provides a self-contained description of its particular device and follows an approximate chronological order, which allows readers to keep track of advances. The past, the present, and some hints of the future are described with scientific yet literary language.

Sidebars are dedicated not only to the people who made particle-accelerator history but also to some of the laboratories where they worked, suffered, and celebrated together in the pursuit of scientific progress. Sessler and Wilson mention the protagonists' joy for life, their interests besides physics, and their love for music, sports, and literature; thus the authors add brushstrokes of humanity to the historical panorama. Many of the book's subjects have been awarded national and international honors, including the Nobel Prize. Some of their achievements have received generous recognition; the contributions of others who have not been acknowledged find, in Sessler and Wilson's book, their place in the chronology. The book also honors projects that were unsuccessful because of economical, physical, or political reasons but were a step forward in the pursuit of knowledge.

For researchers working with particle accelerators, the book represents a family history. Many of us will find in its pages our teachers, friends, and colleagues, and the laboratories where we started our careers or lived our adventures in this fascinating field of particle-accelerator physics. Younger readers who are familiar with accelerator types and devices will come to know the scientists who long ago had the strength and courage to transform their ideas into reality. Thanks to the fresh and pleasant language that Sessler and Wilson use, *Engines of Discovery* should appeal to anybody interested in the history of scientific progress. The authors dedicate a special section to young people, encouraging them to join the teams for which particle-accelerator research is alive and challenging. With this book, the authors ensure that the enthusiasm that has led so many people to dedicate their lives to this branch of physics will continue to grow.

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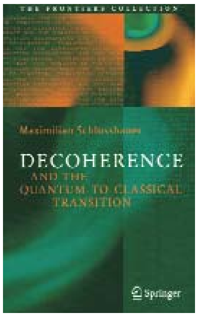
Decoherence and the Quantum-to-Classical Transition

Maximilian Schlosshauer
Springer, New York, 2007. $99.00 (416 pp.). ISBN 978-3-540-35773-5

Almost a century after it first engaged physicists, the relationship between quantum mechanics and classical physics remains problematic. Early in the 20th century, Niels Bohr formulated the correspondence principle as a guide to help construct the laws of quantum theory. But until the 1980s there was scant experimental motivation for examining the physical mechanism of the



transition between the microscopic quantum regime and the macroscopic classical domain.

When quantum mechanics was developed in the mid-1920s, questions regarding its connection with classical mechanics became urgent, because the measuring devices used to study atomic and subatomic quantum systems are governed by the laws of classical physics. Bohr promulgated the so-called Copenhagen interpretation, which became the central dogma for understanding quantum mechanics. He insisted on the logical primacy of the classical realm, where observable physical quantities such as position and momentum are operationally defined.

All along, though, there was a sense of dissatisfaction among quantum physicists. Rather than providing a unified description based on a seamless transition between the two regimes, physicists were compelled to treat the quantum world qualitatively differently from the classical domain. Remarkable advances in the past 25 years in atomic physics, quantum optics, and low-temperature physics have made it possible to exhibit quantum interference effects at mesoscopic and macroscopic scales, prompting the development of decoherence theory. Instead of describing the quantum measurement process as a discontinuous change of the state of the system—with its attendant reduction of the state, or collapse of the wave function—the decoherence model is based on the application of the Schrödinger equation to the system and the environment with which it interacts.

Decoherence and the Quantum-to-Classical Transition is based on Maximilian Schlosshauer's 2005 doctoral thesis and expands on his 2004 article in *Reviews of Modern Physics*. Schlosshauer, now a postdoctoral fellow in Melbourne, Australia, has written an excellent monograph about what the best current thoughts are on the link between quantum and classical physics. The key is the decoherence-inducing, ever-present interaction between a quantum system and its environment, an interaction that can be surprisingly efficient and swift. The tools needed to elucidate the quantum-to-classical transition via the process of decoherence—that is, turning a pure, or coherent, quantum state into a statistical mixture—involve a full arsenal of the typical features peculiar to quantum mechanics: superposition, entanglement, nonclassical correlations, superselection, and so forth.

Although much of the book is quite technical, many sections make for rewarding reading for physicists who do not have the time or the mathematical preparation to delve into all the details. For such readers, the book includes interesting and accessible discussions of recent experiments on single atoms, observations on superconducting quantum interference devices, quantum information theory, quantum cryptography, quantum erasure, quantum computers, and—you guessed it—Schrödinger's cat, just to mention a few. The author presents a fine treatment of the implications of decoherence for the various viable interpretations of quantum mechanics, and for some of the not so viable ones as well. The final chapter offers a tentative analysis of the role of the brain as the last link in the chain of devices—the von Neumann chain—that allow the human observer to form a perception in a laboratory experiment. This discussion of the "quantum brain" is necessarily as much philosophy as it is physics.

Now is a good time for physicists to take a fresh look at some of the fundamental issues in quantum mechanics (or "quantal mechanics," as Léon Rosenfeld tried vainly to persuade us physicists to call it, a linguistic analogy to classical mechanics), and Schlosshauer's *Decoherence and the Quantum-to-Classical Transition* is a welcome contribution. The index is well organized to help readers find their way around. And the more than 500 up-to-date references are a bonus for the more interested, persistent reader.

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