

accomplished by focusing NASA on innovation, technology, and discovery to obtain the most “dream advancement” per dollar from the agency’s far-reaching programs. As Tyson points out, a NASA that is focused on exploring deep space is much more inspiring than one going round and round in low Earth orbit.

By winning the 1960s race to the Moon, NASA made a lasting imprint on the economic, national security, and geopolitical landscape of the time. Told in a style that is a joy to read, *Space Chronicles* captures the challenges faced by our space program then as well as today and reminds the reader why NASA matters as much now as ever.

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100 Years of Superconductivity

Edited by Horst Rogalla and Peter H. Kes
CRC Press, Boca Raton, FL, 2012.
\$99.95 (830 pp.).
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Last year more than 1300 scientists gathered in The Hague for the Superconductivity Centennial Conference honoring Heike Kamerlingh Onnes’s landmark discovery. Out of that celebration came *100 Years of Superconductivity* edited by conference chairmen Horst Rogalla and Peter H. Kes. Contributors were asked to detail the historical roots and phenomenal growth of the science and technology of superconductivity over its first century. Far from being a conference proceeding, the book is a retrospective chronicling 100 years of serendipitous discoveries and intellectual triumphs—and technological breakthroughs that Onnes could not have imagined in 1911.

Superconductivity manifests quantum mechanics on a macroscopic scale. That single fact explains the century of excitement that has followed its discovery. On the theoretical side, superconductivity became a challenge to the brightest minds of the time, and a satisfactory microscopic theory of even the simplest materials had to await the development of a quantum many-body formalism. Experimentalists were challenged to discern subtle quantum effects in complex materials at cryo-

genic temperatures, and engineers struggled to exploit the advantages of superconductivity. In the end, science has triumphed. Over the past century, nine physicists have received the Nobel Prize for their contributions to superconductivity, and there has been much to celebrate.

The midpoint of superconductivity’s first century roughly divides scientific exploration from technological development. Although the bulk of *100 Years of Superconductivity* is devoted to technology, the exciting first half-century receives due attention. It was during those early years that physicists revealed the fantastic nature of the phenomenon. Experimentally, Onnes showed that the superconducting state exhibits zero resistance, and Walther Meissner revealed its perfect diamagnetism. Those observations were explained by the phenomenological theory of brothers Fritz and Heinz London, who assumed that electrons flow without scattering.

As quantum mechanics matured, it became apparent that scattering is suppressed when electrons condense into a single macroscopic quantum state. Applying that idea, Fritz London noted that the magnetic flux through a superconducting loop will be quantized. Then Vitaly Ginzburg and Lev Landau developed a phenomenological equation for the macroscopic wavefunction itself. Finally, the puzzle of the condensate was solved by John Bardeen, Leon Cooper, and Robert Schrieffer, who developed the amazingly complex microscopic BCS theory, based on an attractive force mediated by phonons, that binds a pair of electrons of opposite spin into a so-called Cooper pair (see the review by Malcolm Beasley of *BCS: 50 Years* in *PHYSICS TODAY*, July 2011, page 53).

The book details the long struggle to discover materials and engineer conductors that carry large currents in the presence of high magnetic fields. The path to superconductive applications began with Onnes’s vision of an electromagnet maintaining a persistent field without input power. To his great disappointment, Onnes discovered that magnetic fields above a modest value completely penetrated the materials of his day and destroyed their superconductivity. Large-scale applications, such as magnets and electric-power distribution, had to wait until Alexei Abrikosov saw the possibility of a second type of superconductor for which the field penetration is gradual and

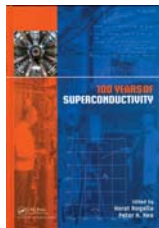
takes the form of individual flux quanta or vortices that leave the surrounding material superconducting. The practical conductors developed from such materials are now used in myriad applications, including magnets for magnetic resonance imaging and the bending and focusing magnets essential to CERN’s Large Hadron Collider.

Small-scale electronic applications largely rely on superconductive tunneling effects predicted by Brian Josephson. Motivated by the possibility of revealing the phase of the macroscopic wavefunction, Josephson applied BCS theory to solve the tunneling Hamiltonian for Cooper pairs and demonstrated that pair tunneling is sensitive to the difference in phase between two superconductors. Based on that effect, the superconducting quantum interference device is highly sensitive and capable of resolving a small fraction of a flux quantum. Its many applications at the frontiers of research include magnetoencephalography, quantum computing, and the search for dark matter.

From start to finish, the book includes historical vignettes, provides a comprehensive introduction to the science and technology behind a wide range of applications, and presents authoritative and often personal accounts of specialists in the field. The insights and anecdotes captured in *100 Years of Superconductivity* will be a delight to those engaged in the field and a significant resource to historians.

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The Theory That Would Not Die

How Bayes’ Rule Cracked the Enigma Code, Hunted Down Russian Submarines, and Emerged Triumphant from Two Centuries of Controversy

Sharon Bertsch McGrayne
Yale U. Press, New Haven, CT, 2011.
\$27.50 (320 pp.).
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For more than 200 years, a controversy has persisted over the incontrovertible theorem developed by 18th-century British amateur mathematician Reverend Thomas Bayes. The story is captured by Sharon McGrayne in *The The-*