John Robert Schrieffer

Daniel Arovas, Greg Boebinger, and Nick Bonesteel

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OBITUARIES

John Robert Schrieffer

A towering figure in theoretical condensed-matter physics, John Robert Schrieffer died on 27 July 2019 in Tallahassee, Florida. He is best known for his crucial contributions to the theory of superconductivity, a problem that since its discovery in 1911 had vexed physicists searching for a microscopic explanation of the phenomenon.

Born in Oak Park, Illinois, on 31 May 1931, Schrieffer moved with his family to Eustis, Florida. At his small high school, he was encouraged to pursue self-study in mathematics and sciences. His interest in building radios was kindled in 1944 when, while babysitting, he began reading a copy of *The Radio Amateur's Handbook*. Schrieffer set his sights on studying electrical engineering at MIT, where he instead became captivated by physics. He completed his bachelor's thesis under John Slater.

Schrieffer had intended to do graduate studies in nuclear physics, and he received a Fulbright scholarship to the UK to work with Léon Rosenfeld and Patrick Blackett. But fate intervened; because of the Korean War and his father's failing health, he remained in the US. Schrieffer knew of John Bardeen and the transistor, so he was delighted to be offered the opportunity to study under him at the University of Illinois at Urbana-Champaign. Initially, Schrieffer worked on surface electron transport in semiconductors, even performing experiments in Bardeen's laboratory. In spring 1955, sensing that Bardeen was gearing up for another attack on superconductivity, Schrieffer selected it as a thesis topic. Postdoctoral researcher Leon Cooper arrived in Urbana that fall.

In the early 1950s, work by Herbert Fröhlich and Bardeen independently derived an isotope effect for the critical temperature, but the main phenomenon remained unexplained, largely because no techniques were available to address the many-body problem. By the time Bardeen, Cooper, and Schrieffer began their assault, Bardeen was convinced of two important aspects: that the electronic spectrum must exhibit an energy gap, and that the many-electron wavefunction must reflect a condensation in momentum space, with long-range phase coherence. A major advance was made when Cooper solved the problem of two electrons above a quiescent Fermi sea. He took into account the effective attractive interaction mediated by phonons, which resulted in a bound state of electrons. Schrieffer's focus crystallized on finding a many-electron theory that could incorporate Cooper's bound pairs, which, though not quite bosons, somehow needed to be condensed.

The crucial inspiration came several months later, while Schrieffer was in New York City for an American Physical Society (APS) meeting; during a subway ride, he first scrawled the iconic BCS wavefunction on paper. The publication in 1957 of their revolutionary approach, known as BCS theory, was swiftly recognized as a definitive work and indeed proved seminal. A torrent of results soon followed, which explained or were validated by numerous experiments. The microscopic theory of superconductivity had been solved. (Subsequent work by Philip Anderson and Yoichiro Nambu would resolve the subtle issue of gauge invariance.) The significance of BCS theory was recognized in 1972 with the Nobel Prize in Physics. Schrieffer's oral history interviews with the American Institute of Physics (https://tinyurl.com/tklwrlx) provide a wonderful account of the early days of BCS.

As an NSF postdoc in fall 1957, Schrieffer went first to the University of Birmingham and then to the Niels Bohr Institute in Copenhagen, where he met Anne Grete Thomsen, his future wife. After a year teaching at the University of Chicago, Schrieffer joined the University of Illinois faculty in 1959. He was at the University of Pennsylvania from 1962 to 1980, when he went to the University of California, Santa Barbara, and was the second director of its Institute for Theoretical Physics. His presence at the institute and on the physics faculty contributed greatly to the university's stature and to its rise to prominence in the sciences and engineering. His final academic appointment, starting in 1992, was as a Florida State University professor and chief scientist of the National High Magnetic Field Laboratory, where, once again, he helped establish the credentials of a major new endeavor.

For more than four decades, Schrieffer worked at the forefront of condensed-matter physics. In 1979 Schrieffer, Wu-Pei Su, and Alan Heeger developed their celebrated model of polyacetylene. They found a mechanism for spin–charge separation—that is, excitations with charge but no spin or spin but no charge, as if the electron, which is a fundamental particle, had split into two pieces. Further work by Schrieffer and others explored the phenomenon of fractionalization. That reified earlier field theoretical models and identified for the first time materials, such as polyacetylene and fractional quantum Hall systems, where fractional charge, spin, and statistics are manifested by their low-energy excitations.

John Robert Schrieffer

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In 1983 Schrieffer was awarded the National Medal of Science, and he served as APS president in 1996. Sadly, due to illness, the last 20 years of his life were extremely difficult and indeed tragic. Throughout his struggles, Anne stood by him until her death in 2013. In addition to his brilliance—and the light in his eye when he discussed physics—Bob's kindness and avuncular nature were treasured by his many students, colleagues, and friends.

Daniel Arovas
University of California, San Diego
La Jolla
Greg Boebinger
Nick Bonesteel
National High Magnetic Field Laboratory
Florida State University
Tallahassee