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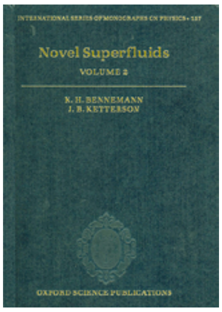

K. H. Bennemann and J. B. Ketterson (Editors)

Novel Superfluids
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This is the second of two volumes each containing about a dozen reviews covering the many new developments in collective quantum phenomena similar to the familiar superconductivity of metals and the superfluidity of ^{4}He. The editors of both volumes, Karl-Heinz Bennemann and John B. Ketterson, are well-known for editing other two leading two-volume compilations, one on "The Physics of Liquids and Solid Helium" (part I, 1976; part II, 1978) and the other entitled "The Physics of Superconductors" of which the first volume with subtitle "Conventional and High-T_c Superconductors" appeared in 2003 and the second "Superconductivity in Nanostructures, High T_c and Novel Superconductors, Organic Superconductors" in 2004. The new two volumes titled "Novel Superfluids" now appearing 10 years later serves several purposes: 1) to update the developments in the areas covered in the editors' earlier review books, 2) to cover the exciting new developments stemming from the discovery in 1995 of Bose-Einstein condensation (BEC) at ultra-low temperatures in gases, 3) to review the recent emergence of a new class of unconventional superconductors and, finally, 4) to cover related phenomena in nuclei, stars and the universe itself.

Volume 2 takes up upon many of the topics covered in the 11 chapters of Volume 1. The new volume starts with an introductory chapter by the editors, which provides a concise survey of novel superconductors, such as the high-T_c Cu oxides, heavy fermion superconductors, organic metal superconductors, and the new class of superfluids found in ultra-cold gases, where it has become possible to transform the system from a Bardeen, Cooper, Schrieffer (BCS) superconductor to a Bose Einstein condensate. The next Chapter 13 by M. R. Norman (Argonne National Laboratories) provides a well-written more comprehensive overview of the many different types of unconventional superconductors but with more emphasis on the physics underlying the heavy-fermion superconductors and the role of spin and the effect of magnetic fields. The current status of theories of the high-T_c cuprates is also discussed. Fe-based unconventional superconductors are also the subject of the short Chapter 14 by the editors. In Chapter 15 S. Maibi and A.V. Chubukov (University of Wisconsin) analyze the role of the novel electron pairing mechanisms, other than the familiar Cooper pairing, which in the unconventional superconductors conspire to overcome the intrinsically repulsive Coulomb repulsion. Much of their theory is based on the Kohn-Luttinger mechanism applied to lattice systems. The authors also discuss the interplay between superconductivity and spin density waves.

The next three Chapters 16, 17 and 18 are devoted to the new physical phenomena emerging from the manipulation of ultra-cold atoms trapped within 3D laser-produced optical lattices. The cooling of atoms to sufficiently ultra-low temperatures that they condense into a Bose-Einstein Condensate was previously introduced by F. Chevy and J. Dalibard in Chapter 7 of Volume 1. In Chapter 16 of the new volume N. Gemelke (Penn State University) and C. Chin (University of Chicago) discuss the experimental possibilities arising from the ability to laser control the coupling between the individual atoms localized singly in potential pockets of a 3D lattice. By changing the laser intensity the collective can be transformed from a Mott insulator (strong laser field: no coupling) to a superfluid (weak field: strong coupling). Chapter 17 by E. Duchon, Y. L. Loh and N. Trivedi (Ohio State and North Dakota University) analyze these and related phenomena in terms of Bose- and Fermi-Hubbard models. M. W. Zwierlein (MIT) in Chapter 18, discusses how the scattering length of fermions in optical lattices can be manipulated by magnetically fine tuning the hyperfine levels to produce Feshbach resonances. This makes it possible to convert the collective from a BCS superconductor to a Bose-Einstein condensate by inducing Cooper pairing.

Chapter 19 by M. Rontani (Modena) and L. J Sham (Uiversity of California, San Diego) takes up on the discussion of BEC of excitons in semiconductors, which was introduced in Chapter 8 of Volume 1, and goes on to describe phenomena related to the coherent transport of excitons. Special attention is given to the so-called Andreev reflection which occurs at the insulator/semimetal interface and Josephson oscillations. Chapter 20 by O. Dzyapko *et al.* (Münster, Kiev and Rochester, Michigan) follows up on Chapter 4 of Volume 1 and goes into more detail on experimental studies of BEC of spin-wave magnons using microwave parametric pumping of yttrium iron garnet films.

The final Chapters 21 and 22 are devoted to the superfluidity of nucleons as occurs in neutron stars. Chapter 21 by D. Page *et al.* (Mexico, New York, Ohio, Seattle) discusses Cooper pairing in neutron stars. Under conditions of very high densities pairing can even occur in quark matter. Neutrino emission processes and the effect of pairing on the observable cooling of neutron stars are also discussed. A more general discussion of neutron superfluidity and superconductivity and its relation to ultra-cold Fermi gases can be found in Chapter 22 by A. Gezerlis, C. J. Pethick and A. Schwenk (Guelph, Copenhagen and Darmstadt). Volume 2 ends with a brief epilogue by the editors.

Each chapter in the new volume is written by well-known authorities and starts with a clear general, partly historical, introduction into the basic physics before going into more detail. As in Volume 1 the chapters are enriched by many diagrams, illustrations and between 50 and 500 references. The new volume continues with many of the topics introduced in Volume 1 but with more emphasis on the theory. The reviewer found some of the articles, such as Chapters 14, 19 and 20 perhaps too specialized for most potential readers. Altogether Volume 2 is more suited for specialists and theoreticians.

The editors are to be congratulated on this up-to-date two-volume overview covering many of the recent advances in exploring BEC- and BCS-related phenomena occuring between densities of 10^{-10} g/cms and temperatures of 10^{-7} K in the ultra-cold gases and 10^{14} g/cm^3 and 10^9 K in neutron stars.

Unfortunately, the reader will not find many other topics of great current interest such as the recent developments in understanding turbulence in superfluid and solid ^{3}He, or the recent advances in exploring the unexpected properties of solid ^{4}He related to the continuing search for supersolidity. Also missing are recent developments in high pressure superconductivity, such as the recent observation of superconductivity in H_2S or the prediction of both superconductivity and superfluidity in hydrogen at extremely high pressures and, finally, the reviewers own area of research, superfluidity in finite-sized systems such as clusters with only a handful of He atoms. We can only hope that the editors are considering a third volume to bring us up to date about these and other recent findings in many-body quantum effects.

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