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BOOK REVIEW

Superfluid States of Matter

Peter V. E. McClintock

Department of Physics, Lancaster University, Lancaster LA1 4YB, UK
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Superfluid States of Matter by Boris Svistunov, Egor Babaev, and Nikolay Prokof'ev, CRC Press, London, 2015, pp. xix + 561. Scope: monograph, £63.99, ISBN 978-1-4398-0275-5 (Hardcover). Level: postgraduates, research scientists.

Superfluids are among the strangest and most counterintuitive states of matter, in which flow can take place without encountering any resistance from walls or obstacles. The viscous drag with which we are all familiar from everyday life is completely absent. The first superfluid to be discovered (1911) was the electron gas in a superconducting metal. Liquid ^{4}He followed (1938), and there was then another long gap before superfluidity was observed (1972) at millikelvin temperatures in the other stable isotope of helium, ^{3}He. At that stage, superfluidity still seemed a rare phenomenon. Since then, however, superfluidity has appeared or been predicted in a whole host of other systems including e.g. high temperature superconductors, laser-cooled atomic ensembles (both bosons and fermions), excitons, polaritons, nuclei, neutron stars and other astrophysical systems. So, although they remain as strange as ever, superfluids no longer seem quite so rare.

The book by Svistunov *et al.* is devoted to the theory of superfluids. It is big, with 15 substantial chapters divided into 5 parts. The authors open with a discussion of superfluidity from the perspective of classical fields, including finite temperatures, rotation, and different manifestations of the superfluid phase transition. The second part deals with superconducting and multi-component systems in terms of gauge theories and encompasses e.g. flux quantization, Ginzburg-Landau models, vortices, fractional vortices, Skyrmions, and multi-component flows. Part III considers the quantum field perspective, path-integrals, supersolids, and quantum turbulence. The theory of weakly interacting gases – which more traditionally might have been covered first – is addressed in part IV starting with a Green's function approach. The intrusion of reality, discussing the extent to which Nature reflects the large body of theory developed in chapters 1–13, takes place in part V. This consists of two chapters: an historical overview, and a discussion of the superfluid states of different real physical systems.

The authors are scientists of international distinction, and their book is written with impressive assurance and authority. It is very much a theorists' tome and the connection with experiment is relatively tenuous, e.g. the writers seem unaware that (when vortex creation is excluded) the breakdown of superfluidity in liquid ^{4}He is found experimentally to be governed by the Landau criterion. Not much is provided in the way of comparison of theory with experiment until the end and, even then, the offering is quite selective. Does it matter? I do not think so. The book provides a *tour de force* on theories of superfluidity which is doubtless what the authors were aiming for.

Although experimentalists are likely to find the presentation slightly too formal and mathematically abstruse for comfort, the book seems well-matched to the prime readership at which it

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is aimed: “graduate students interested in systems and topics where superfluid states of matter manifest themselves...”, provided that they are theorists. In addition, the book should serve well as “the main text for a graduate course on the theory of superfluidity and superconductivity” as the authors also suggest.

Peter V. E. McClintock
Lancaster University
p.v.e.mcclintock@lancaster.ac.uk