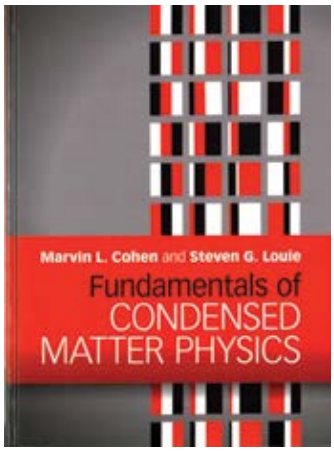
BOOK REVIEW



Fundamentals of Condensed Matter Physics

By Marvin L. Cohen and Steven G. Louie

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Reviewed by Professor Mukunda Das, RSPE, The Australian National University, Canberra.

This book is written by two well-known condensed-matter theorists and is mainly based on lectures delivered for graduate courses covering a period over five decades. It is another useful addition to a large number of text/reference books on Condensed-Matter Physics. The authors have correctly admitted in their preface, "It is probably impossible to produce a book that fills the complete bill for a course…" Therefore they have chosen a *selected* range of topics from the current CMP scenario.

Modern Condensed-Matter Physics evolved from the old Solid-State Physics by embracing many-body/collective aspects of matter. At centre it deals with all kinds of systems consisting of Fermions and Bosons interacting in all kinds of configurations. In the last five decades new exciting discoveries appeared under the name of "emergent phenomena". This complex – and fundamental – aspect is no longer ignorable in modern advanced treatments of CMP, not only theoretically, but in the near future in terms of device design. Examples are: the fractional quantum Hall effect; topological states; High Tc superconductivity; meta-materials; multiferroics etc. Some of these would justifiably have found a place, even if briefly, in this book. I fully agree with the authors that for a one-volume edition, one cannot possibly deal with every important condensed matter phenomenon, for which one has to refer to individual specialized papers/books. Nevertheless something is missing in this book related to the above background.

Primarily the book is divided into four parts with unequal emphases. Part I is very basic and pedagogic. It begins admirably with conceptual models of interacting atoms and elementary excitations. Examples of band-structure aspects are given for some semiconductors, using empirical pseudo-potential approach. Part II deals with interacting electrons in solids, dynamics of electrons, and response of electrons to a weak external potential (linear response). Density functional theory for the ground state and the Kohn-Sham method are described clearly, though briefly. The dielectric function is derived at the basic level of the *random phase approximation* (RPA), with many useful applications.

Part III covers optical and electron transport of materials with and without magnetic fields. Only the integer quantum Hall effect is treated. This part puts major emphasis on various properties: vibrational, thermal, optical and transport behaviour of real materials. The final Part IV begins with a sketchy many-body introduction. Landau's Fermi liquid theory, indispensable for the weakly interacting electrons in normal metals, appears in a small paragraph. Superconductivity is described in some detail, though at times the origin of various aspects is left unexplained. Multi-order parameter superconductivity or vortex phase diagrams are excluded.

Chapter 15 on magnetism is too brief. The last Section of Part IV gives a bird's eye view of low-dimensional systems, including nanostructures. Under the assumption of a clean ballistic limit, the so-called Landauer formula is derived without the most cursory examination of scattering, both elastic and inelastic. Finite conductance, whose inverse is of course finite resistance (rendering the system dissipative) should demand some attention to the mesoscopic physics of dissipation.

There are unfortunate misprints and undefined quantities. Examples: the "Bethe-Goldstone" Eq. (14.91) is incorrect. On p322 the parameter H_{cb} is undefined and on the next page it is identified as H_c, the bulk thermodynamic field. Eq (14.79) for Type I superconductivity is inappropriate, as there is no upper critical field H_{c2} for type I superconductors. How magnesium becomes ferromagnetic under certain condition (p386) is unexplained. In the chapter on magnetism (Ch.15) the Kondo effect and Hubbard model, two relevant and very important items, are described too briefly, with merely one page each. Some Sections are better treated than others. There are many such problems. I expect the authors will address those in the next edition.

Despite these weak points the book may be helpful for students interested in basic condensed-matter phenomena. The authors have listed many additional reference books and reviews, though now rather elderly.