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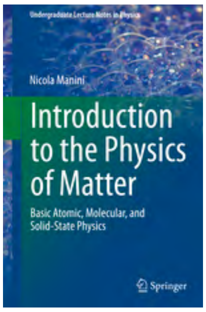

Nicola Manini

Introduction to the Physics of Matter
Basic Atomic, Molecular, and Solid-State Physics

Undergraduate Lecture Notes in Physics.
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The old course of Structure of Matter taught half a century ago at the University of Milano has definitely known a tremendous evolution, as – I suspect – everywhere else. Among the fifth semester courses it was considered the least, under the assumption that the basics of atomic physics and statistical mechanics came from the first course in theoretical physics, the molecules from the first-year chemistry, while the basics of solid state physics were just a complementary exam at the end of the undergraduate course. The conceptual conversion of "structure of matter" into "physics of condensed matter" is the substance of that evolution.

It is a fact that in the last half a century about two thirds of the Nobel Prizes in Physics have been awarded to condensed matter physicists (besides those who got it in chemistry). Consistently the courses of condensed matter physics and of quantum mechanics have become together the central body of the undergraduate teaching of physics. The central position regained by condensed matter physics reflects the adage that there is just one physics. The old and present exchanges among particle and high-energy physics, nuclear physics, astrophysics and cosmology, on one side, and condensed matter physics, low temperature physics, quantum optics, etc., on the other side, have been immense. Consider moreover the extension of condensed matter physics to other fields like materials science, nanotechnologies, nanomedicine, energetics, complexity, econophysics, etc. There is no less beautiful physics: the beauty of physics consists in the way and method of looking at the world, from the Planck scale to the universe, in the pleasure of discovery which adds something to our knowledge, whether big or small. A good condensed matter physics course (but I think this holds true for any discipline) should transmit the sense of unity of physics, and highlight what is common to other areas and therefore essential.

This appears to be the underlying inspiration of these Nicola Manini's Lecture Notes introducing undergraduate students to condensed matter physics. The book, of friendly size as compared to the extension of modern atomic, molecular and condensed matter physics, meets perfectly well the scope of being an expert assistant guiding the student across what looks today an intricate jungle, pinpointing what is essential and general and what is less, and providing the basic notions for safely enlarging, or specializing, the study on many other excellent, though ponderous, textbooks (listed in the fifty references at the end of the book). The original notes that for many years students could download from Nicola's website, together with the class lessons, absolved this basic pedagogical role. I could myself verify the excellent reponse of my own condensed matter physics students to that webpage.

That is why I am particularly glad that finally those web notes have now seen the light as a book in the Springer series of Undergraduate Lecture Notes. I recommend them as a very useful support to any basic course in atomic, molecular and condensed matter physics, whether for undergraduate students in physics or materials science. They will find the basic concepts and ingredients in the introductory chapter. The second chapter covers the theory and spectroscopy of one/electron and many electron atoms. The next chapter on molecules deals with the fundamental issue of adiabatic separation between electronic degrees of freedom, responsible for both the strong (chemical) and weak (van der Waals) bonding, and the nuclear degrees of freedom determining the roto/vibrational spectra.

The fourth chapter on statistical physics, while integrating the notions of thermodynamics from the previous semesters, introduces the quantum statistics, some concepts on ultracold gases and the application to matter-radiation interaction and laser physics. The last part of the book condenses in about one hundred pages the basic notions on the different types of solids from the point of view of the microscopic structure, the electronic energy bands and the phonon dynamics. The textbook is completed by a short outlook which opens a window on the rich phenomenology and applications arising from the fundamental interaction of condensed matter, that between the electronic and nuclear degrees of freedom, in and beyond the Born-Oppenheimer approximation. An appendix recollects the notions and methods of quantum mechanics which are indispensable for the comprehension of the textbook.

Altogether these undergraduate lecture notes, despite (or thanks to) their condensed form, offer with exemplary clarity an idea of the great change occurred in the teaching, role and perception of quantum condensed matter physics. With reference to the specific case of the University of Milano they also pay a tribute in the preface to the teaching of Luciano Reatto, who has so much contributed to that change.

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