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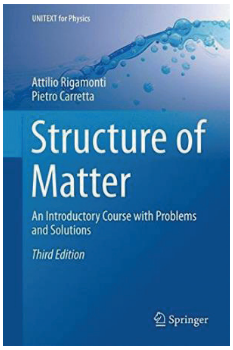

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Structure of Matter
An Introductory Course with Problems and Solutions (third edition)

UNITEXT for Physics. Springer, 2015

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With respect to the first edition of this outstanding textbook, on which I reported nine years ago in this journal, the 3rd edition, planned and published in 2015 within the *UNITEXT for Physics series*, presents four new additional chapters, which raise the number of pages from 474 to 605. This alone tells about the success of this textbook, whose first edition appeared in 2007 when the Bologna Process was gradually being operative in most European countries. The 3+2 system implied for the physics and materials science curricula a sequence of basic and advanced courses on the quantum theory of condensed matter, from multielectron atoms and molecules, to solids and possibly quantum fluids, distributed between the "3" (after the basic quantum mechanics course), and the "2" (with its different branches). A risk implicit in the 3+2 system was the possible loss of correlation between undergraduate and graduate studies (amended in some countries with final exams encompassing all the 5 years), with a hasty and superficial approach to the undergraduate phase: just knowledge without knowing how.

The authors, relying on their long teaching experience at the University of Pavia, the *alma mater* for various generations of prominent condensed matter physicists, conceived a textbook which intends to transform the undergraduate student into a professional scientist, whether in physics or in materials science, or in any other area where some basic notions of condensed matter physics are applied. To this purpose no distiction ought to be made between knowledge and know-how. A major merit of this textbook, besides the exemplary clarity of text and equations, is in fact the pedagogic approach: at the end of each section, or even subsection, the student finds one or more problem with the respective solutions (or hints) so as to check that the previous text is fully understood and ready to use. It is assumed that the student has already at his command the foundations of quantum mechanics and the hydrogen atom theory, which is however briefly presented in Chapter 1 in order to endow the students with concepts and quantities ready to be extended to multielectron atoms. The subject is then developed in the next chapters: Russell-Sauders and *jj* coupling schemes, the Hund rules, the multiplet structure, the electric and magnetic field effects, up to the hyperfine structure, the magnetic spin resonance and spin-echo spectroscopies (Chaps. 2-6)

The same pedagogical approach characterizes the next Chapters 7-10 on the physics and spectroscopy of molecules. After introducing the Born-Oppenheimer adiabatic approximation and discussing the classification of molecular electronic states, the reader is confronted with the diatomic molecules and some paradigmatic polyatomic molecules, such as ammonia (giving occasion for an interesting appendix on masers), water and benzene. The vibrational and rotational properties of molecules and relative spectroscopies, explained in Chapter 10, prepare the reader to the electronic and vibrational structures of extended forms of condensed matter such as the crystalline solids (Chaps. 11-14): the crystallography, the electronic band structure and the typology of solids, including magnetism, the vibrational structure and the thermal effects.

The new four chapters (15-18) are dedicated to the phase diagrams and transitions, and the signatures on the response functions. After a tutorial introductory chapter, the properties and phase transitions of dielectrics (*e.g.*, ferroelectricity), of magnetic systems (with an excursus on scaling and universality) and superconductivity are presented. These subjects, which are generally found in solid-state physics textbooks at the graduate and post-graduate level, actually follow in the most natural way from the previous chapters, preserving the same level of clarity and pedagogical style. In particular I find the last chapter on superconductivity, one of authors' favourite research subjects, a succint masterful tutorial on the phenomenology and theoretical understanding of superconductors, from their discovery in 1911 to the recent novel classes of superconductors, including high critical temperature and low-dimensional systems.

The history of superconductivity can be well summarized by Brecht's motto from *Lebens des Galilei* that the authors adopted, together with another by Miklos Gyulassy, for their textbook: "*Die Wahrheit is das Kind der Zeit, nicht der Autorität.*" There were in the seventies autoritative rules which established an upper limit for the superconducting critical temperatures: no more than 30 K. Karl-Alex Müller and Georg Bednorz showed in 1986 that this was not true, then receiving a plebiscitarian Nobel Prize a year later, and now we are above 200 K! This is perhaps the most important message that this book aims at transmitting to students, similar to the answer I received from Frederich Hund when I congratulated him in Göttingen for his 90th birthday, asking what are the three rules to get to 90 in such a good shape: "Very simple: do things with the maximum spin, follow things which have the maximum momentum, but go in the opposite direction!".

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