Symmetry of Crystals & Molecules

Mark Ladd's book is about symmetry, and comes with a clean white cover that attracts the eye, showing spheres with symmetrically arranged objects. In fact, it seems to be only one Nautilus or Ammonite shell, reproduced and arranged through symmetry, beautifully rendered by M. C. Escher. Is it that Mark Ladd intends to bring symmetry to life, in all forms and shapes, utilizing mathematical concepts? The title restricts though to crystals and molecules, but it is clear from running through the pages at first sight of the book that other examples are presented as well.

A new book, first edition 2014, about symmetry and crystals, published, thus, in the International Year of Crystallography: this is no coincidence. It is difficult to name every monograph written on this subject through the centuries, and looking at a few of those on my own bookshelf, would I want to add Ladd's work for any other reason but to extend my private collection?

The content is comprehensive, covering symmetry operations, stereographic projection, application to X-ray diffraction, group theory, as well as spectroscopy, and gives links to free to download software from the internet for further studies. The latter alone may grant a place on the list of course materials for any class that reads "symmetry" in the syllabus. The software selection given applies to specific applications that may have crossed the path of the author but may not necessarily solve the average reader's problems.

Very appealing is the use of "stereoview" renderings of lattices and molecules for enhanced 3D visualization which was found to be essential in the comprehension of scientific concepts.[1] The reader needs to look at the two images of a molecule with eyes parallel, something that requires a bit of practice. Each chapter is spiced by a set of problems, suitable to keep students well occupied during a crystallography course. Solutions of the problems are listed at the end of the appendix together with a summary of mathematical concepts used throughout the text.

The book's main interest is on symmetry aspects of three-dimensional objects. However, it touches two-dimensional symmetries, important for surface physics, or higher order symmetries used to describe quasicrystals. It is with my pleasure to note that the author is allowing his own thoughts and judgment to enter the text, for example when he discusses how the International Union of Crystallography changed its definition of crystals to relate to anything that has a distinct diffraction pattern, maybe so that quasicrystals remain a subject within crystallography. This reminds us to remain in a vigilant state so not to blindly consume what is called common knowledge, but to stay critical even of widely accepted concepts. Comments, however, are distinguished from factual readings on the basis of a detailed and referenced literature listing given at the end of each chapter.

Having the beauty of crystals in mind may be enough to satisfy interest in them, as exhibited by many mineral collectors. But crystals with their expressed anisotropy of atomic ordering also exhibit a multitude of features not observed in amorphous or glassy materials. The light that idiomorphically grown crystal faces reflect is indicative of that anisotropy. Moreover many physical properties like for example optical rotation ("optical activity" in the book) depend among other conditions on the direction with which one looks through the crystal, and even the possibility of the effect being present at all depends on symmetry. However, Ladd's book touches only the surface of physical crystallography and the cited literature is too selective to represent the historical developments in this field.

A Foreword by Jan Boeyens from the University of Pretoria, in itself worthy to serve as a book report, does not restrain from criticizing the treatment of molecular orbitals in the book, albeit applauding the content in large measures. Jan Boeyens reminds us of the crucial necessities of applying symmetry for solving crystal structures and refers to mathematical procedures introduced in the early stages of structure determination. Those methods, as mentioned by Boeyens, involved Beevers–Lipson strips. I hoped to find a link to a definition of those strips within the about 10 index pages. Having been unsuccessful in this endeavor indicates that the book is not a monograph on practical X-ray structure determination or its history, but it introduces well enough into the field.

The treatment of group theory and application to spectroscopy is very detailed. Here the book shines with instructional discussions of several problem sets. I find reason to recommend the book, not to be read from beginning to end like a novel, but to be studied selectively for those subjects that have fallen a bit behind during the course of a scientist's life. I am glad to see it on my bookshelf now, with its white cover.

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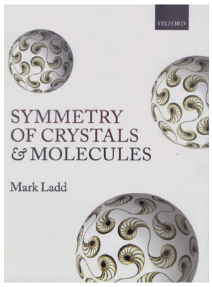
[1] J. Wai, D. Lubinski, C. P. Benbow, *J. Educ. Psych.* **2009**, *101*, 817.



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