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Symmetry Relationships between Crystal Structures

Symmetry relationships between crystal structures are a cornerstone for understanding phase transitions and comparing solids. The time needed to obtain structural results is becoming ever shorter, and the information in databases is growing exponentially, but knowledge about symmetry among the many scientists who produce and interpret these structures seems to show the opposite trend by declining. The International Tables for Crystallography and the Bilbao Crystallographic Server offer all the necessary tools for an applications-focused chemist or materials scientist, both as hardcopy and online. However, at least for those without a basic crystallographic training, it needs either a dedicated course of instruction or a "hands-on" instruction book to get started. Dedicated courses have been available for decades, but only address a comparatively small number of motivated participants. Therefore, it was high time for this book!

From at least two aspects, there is more to this book than its title suggests. Firstly, it not only deals with the relationships between crystal structures, it also explains the whole toolbox of symmetry and group theory that is required for the understanding and competent description even of individual structures. These crystallographic and mathematical foundations are laid in the nine chapters of Part I. Secondly, this text is also a masterpiece in didactics: when I first looked at the table of contents, I was afraid that the reader might have to endure the first half of the book repeating fundamental knowledge before meeting his/her first Bärnighausen tree. Fortunately, I was wrong: already on page 4 the first appetizers are served! From this beginning, the reader already knows that the foundations he or she is about to learn will be rewarding. For concepts that are mandatory but abstract, examples are provided. Thus, when coset decompositions are introduced, the author refers back to the symmetry elements of the square introduced earlier; a geometric analogy is offered for the relationship between subgroup and factor group; normalizers are not only defined, but examples of their (comparatively small) unit cells are shown; (non-)isotypism is associated with well-known chemical compounds.

At the beginning of Part II of his book, the author has managed, so far, to acquaint his readers with 130 pages of "foundations" in the first part without the risk of boring them. In perfect harmony with Part I, a Bärnighausen tree is provided on page 135, this time making use of the basic concepts. Here again, in the middle of the book, the reader can be confident of being on the right track. In Chapter 11, examples of the different categories of group–subgroup relationships are given and coded in Bärnighausen trees. After these positive examples, potential sources of errors are described in Chapter 12. The next two sections are devoted to two different crystal chemistry models: symmetry descent may be accomplished either by occupying interstices in close-packed structures, or by virtue of the lower point symmetry of covalent building blocks. After the comparison between chemically different structures, Chapter 15 discusses the relationship between different phases of the same compound, and Chapter 16 deals with the phase transition itself; more demanding aspects of Landau theory have been shifted to Appendix B. Two issues beyond the title subject follow: group theory may help to determine the correct space group for an individual structure and to derive yet unknown but possible structures. The book concludes with a historical summary.

The author repeatedly, and for good reason, credits H. Bärnighausen and H. Wondratschek as the fathers of the concept, but he himself has also been involved at several levels: as an author, he has contributed to the primary scientific literature in the field, he is one of the editors responsible for Volume A1 of the International Tables, and he has regularly taught courses for graduate students. It is no real surprise that his book is flawless, and that typos are rare. The German edition appeared in 2012 in a series entitled "Studienbücher Chemie", a fact that underlines the didactic character of this text. Exercises at the end of each chapter push the reader to use pencil and paper, and ensure that the message has been not only read but also understood; these exercises often relate to real-life problems in crystal chemistry, and occasionally even to published "nonsense".

Ulrich Müller's book refers to the International Tables and enables the reader to use them efficiently. *Symmetry Relationships between Crystal Structures* is a must for scientists specializing in solid-state aspects of structural chemistry. Even readers familiar with the subject may learn a lot. Thanks to its clear structure and the excellent selection of exercises, the book can also be highly recommended for advanced students in chemistry, physics, and materials science. With regard to basic crystallography and group theory, students can already benefit from Part I at the first-degree level, and they can seamlessly consult Chapters 7–18 at a later stage of their specialization.

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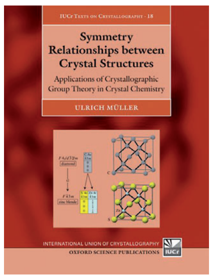

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