

## Book Reviews

*Works intended for notice in this column should be sent direct to the Book-Review Editor (J. H. Robertson, School of Chemistry, University of Leeds, Leeds LS2 9JT, England). As far as practicable books will be reviewed in a country different from that of publication.*

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**Crystallographic and metacrystallographic groups.** By W. OPECHOWSKI. Pp. xix + 628. Amsterdam: North-Holland, 1986. Price Dfl 365.00.

The author is well known for his work on magnetic structures, published in successive collaboration with R. Guccione, T. Dreyfus and D. B. Litvin. It is this work which forms the core of the book (Chapters 15 to 18 occupying pp. 400–495), and which has determined its overall plan. The execution of that plan, however, reveals internal tensions and contradictions which the author has not fully resolved.

The first tension is between the general and the specific. The author coined the term 'metacrystallographic' – in imitation of 'metaphysics' which came after 'physics' in the works of Aristotle – to denote what is studied after 'crystallographic'. Whereas crystallographic groups consist of symmetries which act upon points of a crystal  $X$ , the metacrystallographic groups consist of elements which act upon functions  $f: X \rightarrow Y$  for some choice of  $Y$ . The author aims at a level of generality which subsumes many possible choices of  $Y$ . In practice, however,  $Y$  is a finite set of 'colours', in which case  $f$  is a colouring, or  $Y$  is a space of 'vectors', in which case  $f$  is a magnetic moment or spin structure, or  $Y$  is space-time, in which case  $f$  is a magnetoelectric structure. An additional complication is that the set of possible  $f$  may be restricted, for example to be compatible with the action of some group on both  $X$  and  $Y$ . Of course something can be said at the level of full generality, but not much; thus the author is forced to become specific, branching out from the core of the book with additional chapters on spin groups and (rather sketchily) on the  $(3+d)$ -dimensional superspace groups of Janner & Janssen. In the other direction he becomes more general, branching out from the core of the book with preliminary chapters on colour groups, electromagnetic properties and relationship with quantum mechanics. But despite all these efforts the impression remains with the reader that 'metacrystallographic groups' constitute a collection of distinct phenomena rather than one grand theory.

The second tension is between accepting history and starting again from the beginning. The material described above is contained in Chapters 12 to 22 occupying pp. 349–558. What of the rest of the book? On the one hand there are over 450 references with interesting footnotes,

which is sufficient indication that the author is aware of the gradual development of this subject over the past 100 years and values its history. On the other hand he sets out to introduce anew not merely crystallographic groups (lattices, point groups, space groups, classes, systems, flocks *etc.*) but the entire necessary background including definitions and elementary theorems concerning groups, transformations of affine and Euclidean space and isometries. Thus a treatise on magnetic symmetry groups has become a *magnum opus*. It seems to me that there is something of a contradiction here: the student who is ill prepared to read Chapters 15–18 will certainly have difficulty in reading the preliminary Chapters 1–11 and will not see the point of the generalities of Chapters 12–14. This difficulty arises from three features of the author's style. Firstly, he is very careful and pedantic, distinguishing for example between the points of a lattice and the translation vectors which are represented by such points, and hence between 'point lattice' and 'lattice group'. Secondly, this very carefulness leads to considerable notational complexity and often to idiosyncratic notation unlikely to be found in other mathematical and crystallographic literature and making no concessions to the reader. Thirdly, and most astonishing of all, there are no diagrams. (Correction: the author claims in the *Preface* that there are in fact two. One illustrates four-colour point groups on p. 379 and the other is presumably the dust jacket which could usefully have appeared on p. 234 to illuminate the derivation of Bravais lattices.)

My own opinion is that the roughly equivalent concepts of colour symmetry and metacrystallographic symmetry have become over-extended and over-elaborated in attempts to apply the concept to a wider range of applications than it can reasonably bear. Thus two short books – one the core of the present volume on magnetic symmetry groups, and one still to be written on modulated crystals and superspace groups – which assumed a basic knowledge of lattices, space groups and point groups, and which did not alter widely accepted notation and terminology, might have been much more helpful to both crystallographers and mathematicians.

R. L. E. SCHWARZENBERGER

*Science Education Department  
University of Warwick  
Coventry  
England*