Ways to get into the solid state

C.J. Gilmore

Solid State Chemistry: Techniques. Edited by A.K. Cheetham and Peter Day. *Clarendon: 1987. Pp. 398. £35, $70.*

SOLID state science has been in the headlines recently with the advent of a new class of metal oxide superconductors capable of operating at temperatures much higher than hitherto possible. A whole new world in science and technology has opened up, and it was an appropriate time for the appearance of a book devoted to the techniques of solid state chemistry — the very methods used by research groups exploring the world of high-temperature superconductors. It is intended for final-year undergraduates and first-year graduate students working in solid state chemistry, and a companion volume surveying compounds with important and useful properties is scheduled for publication soon.

There are ten chapters, each covering a technique or related set of techniques in detail, and each written by a separate specialist. Often the result of this method of putting together a textbook is a piecemeal product, but in this case the strong editorial hand of Cheetham and Day has succeeded in producing a book of remarkable homogeneity. There is, of course, some diversity of writing style and nomenclature from chapter to chapter, but the overall uniformity is very good, and the book also achieves the right balance of theory and description for its intended readership. Only the index is rather weak, with a mere four pages of entries. In a book such as this, where cross-references from chapter to chapter are necessarily minimal, a more detailed index would have added greatly to the ease of use.

The techniques discussed are synthesis, diffraction, X-ray photoelectron spectroscopy, magnetic measurements, optical methods, magic-angle scattering NMR, computational techniques, transport methods, vibrational spectroscopy and thermodynamics. The chapter on computational techniques is a pleasant surprise in an undergraduate text. The use of computers to simulate crystal structures and their physical and defect properties, and hence the ability to carry out on a computer experiments that are impossible in a laboratory, is a technique of increasing importance (although one by no means universally accepted by the scientific community). However, as its use grows, and as methods become increasingly sophisticated, a future generation of superconducting materials may be designed by computer simulation studies.

Most of the book is equally up to date, with the references complete to 1985. The chapter on diffraction, for example, discusses synchroton X-ray and neutron spallation sources which, by virtue of their intensity and wavelength tunability, are opening new doors in the crystallography of powders, and, at the other end of the complexity spectrum, biological macromolecules. The chapter also includes a section on electron microscopy, something of such importance in solid state chemistry, however, that it really deserved a chapter to itself — all too often the topic appears as an adjunct to a chapter on X-ray crystallography.

This is not a book that one person can review — its scope is too wide — so I have discussed it with several colleagues, who all share my enthusiasm. The field is not overloaded with general texts, so the book should find a wide audience, and I look forward to the second volume in due course. □

C.J. Gilmore is a Lecturer in the Department of Chemistry, University of Glasgow, Glasgow G12 8QQ, UK.

Thinking very big

Owen Gingerich

Cosmic Understanding: Philosophy and Science of the Universe. By Milton K. Munitz. *Princeton University Press: 1987. Pp.287. $25, £15.80.*

FOR those who live with complete faith in the power of reason and who believe that the observable cosmos is all there is or was or ever will be, Munitz's *Cosmic Understanding* should be a profoundly disturbing book. In a thoughtful and closely structured account, Munitz defends two intertwined concepts. First, reality, often depicted solely as a simple physical process, albeit wondrous and infinite, is actually something mysteriously deeper. In particular, he argues that the evolutionary nature of the universe points to some larger transcendental quality. Secondly, he reasons that the perceptual world is a human construct, always only incompletely knowable.

Is reality limited to a physically describable universe? Munitz reaches back to ancient Greece to show that great philosophers have often thought otherwise. Anaximander's transcendental Boundless, an inexhaustible, eternal source without shape, quality or form, gives birth to the mortal cosmos. Heraclitus's Logos, like the Delphic oracle, "neither declares nor conceals but gives a sign" to the enlightened about the unity of nature that transcends the cosmos itself. Parmenides's Being, Munitz suggests, is not some particular entity that *exists,* but rather the idea *that* the world exists.

After this selective tour through the pre-Socratics, Munitz turns to the question of the intelligibility of the universe itself. He mentions first the problem addressed in Kant's epistemology, that the known world must conform to the mind's own structuring capabilities, and then poses the question of the meaning of language itself as analysed in Wittgenstein's later work.

Having laid the foundations for a challenge to the commonly held view that our theories are describing physical reality as it "really" is, Munitz moves, seemingly effortlessly, from philosophy to modern cosmology and physics. He describes, in a clear fashion, such technical points as Robinson–Walker space time, the Penrose–Hawking theorems, and the inflationary model of the expanding universe. These lead to a discussion of a series of ever-expanding conceptual horizons. All of this is grist for his neo-Kantian mill, which, to my mind, effectively pulverizes the traditional realistic metaphysical views. He writes:

> The only access [to an intelligible universe] is *via* a cosmological model. The universe as a whole can be described only by means of the grammar of the cosmological model. . . . The grammar is not external to that entity; it is internal to it. It constitutes what it is to be such-and-such an intelligible universe. Therefore, apart from that grammar (that model), there is no intelligible universe, no universe as a whole.

Munitz now comes to the apex of his argument, that the universe is embedded into some larger, unknowable whole without time, space, or dimension. Most of us are familiar with the concept of transcendence from theism, where the transcendent is identified with God, the Supreme Being who is wholly different from the spatio-temporal world of objects He created. Munitz pays homage to this Western tradition with an extended critique of Spinoza's rationalistic realism and Spinoza's God, so dear to Einstein's heart. From this dicussion there emerges the idea of an "existent", a class containing at least one, non-fictional, temporally bound entity. Since modern cosmology has converged to a view in which the universe has a beginning and ending, the universe, Munitz claims, qualifies as an existent.

If his argument has an Achilles' heel, it may lie here, for much of modern cosmology reckons with a semi-infinite universe, one with a beginning, but without a distinct ending. Despite his insistence that a temporal duration is required for an "existent" and despite extensive technical discussion of the beginning of the universe, Munitz glosses over its ending.