Eumorphous amorphs

Robert W. Cahn

Physics of Amorphous Materials.

By S.R. Elliott.

Longman: 1984. Pp.386. £25, \$60.

ONE of the joys of contemplating amorphous materials is their affinity with paradox. *Amorphous*, etymologically, signifies *shapeless, without form*; yet the book under review has an 80-page chapter on structure. One of the key theorems general to all amorphous solids is the Kauzmann Paradox, which tells us that for all glasses (a concept not quite coterminous with amorphous solid) there is a temperature above 0K at which the entropy must decrease below that of a crystal of the same composition; Dr Elliott offers a careful discussion of the implications of this paradox, which belongs to the category of impossible things that Lewis Carroll's White Queen liked to believe before breakfast.

Again, Dr Elliott repeatedly insists that an amorphous material has no reciprocal lattice, and this poses enjoyable obstacles to theorists who seek to understand, in particular, electron transport in these materials. But even this "reciprocity failure" may not be a universal attribute of amorphous materials, as witness the publication, a few weeks ago, by Shechtman and others, of evidence of a non-periodic metallic phase (a quasicrystal), neither glass nor crystal, which yet gives a sharp diffraction pattern... of fivefold symmetry!

There is a plethora of textbooks and monographs on glasses, but until recently the word has tacitly connoted oxide glasses. A leading exemplar of this large category is *Glass Science* by R.H. Doremus, published in 1973, which is entirely about oxide glasses, an excellent book, subject to that limitation. J. Zarzycki's *Les Verres et l'Etat Vitreux* (1982) takes this classic approach to glass science as far as it will go. Lately, a flood of literature, but no textbooks, about metallic glasses has appeared. Other textbooks again, notably Mott and Davis's celebrated *Electronic Processes in Non-Crystalline Materials*, have covered the theoretical physics of conduction in chalcogenide glasses.

Elliott approaches the field in a new way. He treats amorphous materials quite generally in terms of preparation strategies, ease of glass formation, the glass transition and its statistical mechanics and thermodynamics, and, in particular, structure. That chapter has the clearest exposition of diffuse diffraction from glasses and of EXAFS that I have seen. Defects are also discussed; of course, a genuinely formless material could not possibly have defects, since the existence of defects implies the existence of a non-defective structure! The author pursues a resolutely quantitative

approach but combines it with frequent pauses to see where he has got to in terms of a physical model. The reader is thus helped to keep track of the argument. Problems at the end of each chapter, linked always to the relevant mathematics, will help the conscientious reader to cement his understanding.

The heart of the book is a more specialized theoretical treatment of spectroscopy and electron transport, mostly with reference to semiconducting (chalcogenide) glasses but also to metallic glasses. A number of difficult topics are painstakingly set out; I have never seen such a clear discussion of the difficult concept of two-level

systems. However, as the author himself specifies, the reader must be competent in solid-state physics somewhat beyond the level of Kittel's *Introduction to Solid State Physics*, and this distinctly narrows the readership.

This fine book has at present no effective rival. Although — inevitably — it barely touches on some aspects of some types of amorphous solid, it is yet an excellent basis for an advanced course on the amorphous state for physicists. □

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On the ground

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Geomorphology.

By Richard J. Chorley, Stanley A.

Schumm and David E. Sugden.

Methuen: 1984. Pp.605. £17.95, \$30.

The Nature of the Environment: An Advanced Physical Geography.

By Andrew Goudie.

Basil Blackwell: 1984. Pp.331.

Hbk £22.50, \$39.95; pbk £7.50, \$14.95.

Environmental Systems: An Introductory Text.

By I.D. White, D.N. Mottershead and S.J. Harrison.

George Allen & Unwin: 1984. Pp.495.

Hbk £30, \$50; pbk £11.95, \$19.95.

MORE than 80 years ago, long before the current environmental movement began, geography was described as "the study of man in his environment". However physical geography, environment and geomorphology, as covered by these three volumes, have differing meanings. There is, nevertheless, sufficient overlap to make it useful to look at them together.

In the narrower field of geomorphology, concerned with the geometry of the surface features of the Earth, the new work by Chorley, Schumm and Sugden must be hailed as a masterly review of the development of the science and of its present status and subject matter. It will rank with the classical presentations of Lobeck (1939) and Von Engel (1948). Its publication may, indeed, come to be regarded as marking almost as significant a stage in the evolution of the subject as the major works of Davis (1909), Penck (1924) and King (1967). Time will be needed to test this view, which some may regard as premature and perhaps extravagant.

The great merits of the book are its balanced presentation of the different ways of looking at the development of landforms and the integration of the historical and functional approaches. Part 1 represents the clearest, most concise and penetrating introduction to the subject which it has been my pleasure to read.

While the whole work is clearly aimed at advanced students and professional geomorphologists, this section can be recommended even to first-year students. This is so even though they may not fully comprehend the whole of it and despite the fact that it does less than justice to the studies of denudation chronology, largely carried out by students of that greatest of English Davisian disciples, S.W. Wooldridge. Part 3 is a comprehensive review of contemporary Earth surface processes which brings the advanced student to the very frontiers of research. The remaining sections on geological (Part 2) and climatic geomorphology (Part 4) are penetrating syntheses of these areas of the subject.

The book as a whole is a balanced statement of the present position in geomorphology. The specialist interests of the authors have been combined in a most successful unified approach, and while it is sometimes possible to detect the authorship of particular sections only those very familiar with their individual work will be able to do so.

It is probably unfair to compare this outstanding volume with the new study of the environment by Professor Goudie, which is sub-titled *An Advanced Physical Geography*. This book covers not only geomorphology but includes also climatic and ecological sections and a consideration of man's impact on the environment. Nevertheless, by far the greater part of the subject matter is the same as in Chorley *et al.* In addition, the publishers claim that Goudie's book "is informed by the latest advances in theory and research" and that it "will surely become the standard work". For these reasons alone comparison becomes inevitable.

It has to be said at once that *The Nature of the Environment* suffers in the comparison. It is written in a discursive and descriptive style, with frequent statements of the obvious such as "The great bulk of the world's water is in the oceans" and "During glacials the ice caps of the world were greatly expanded" which one might expect to find in a first year essay. One example serves to show that the publisher's claim for a research basis is somewhat