

that can be studied, whereas the abundances of carbon or of iron may vary by one or two orders of magnitude. The big bang theory in its simplest form predicts not just the synthesis of helium when the Universe was one minute old, but even the observed abundance. And this prediction is insensitive to the controversy over whether the Universe is open or closed. Cosmologists have pounced on this coincidence as evidence for the big bang theory itself.

Deuterium is another element that may reflect the history of the early Universe. A by-product of the synthesis of helium, deuterium is also destroyed very effectively, first almost immediately after it forms if the density of the Universe is sufficiently great, and second when stars form. The high temperature achieved in the interior of a star as its nuclear fuel supply of hydrogen burns into helium results in the burning of any pre-existing deuterium. By searching for matter that has not yet undergone this stellar cookery, astronomers have succeeded in detecting deuterium in very young stars and in interstellar matter. The deuterium is believed to have originated along with helium in the big bang; if so, the Universe must be of low density and open in order for a significant quantity to have been synthesized.

Those cosmologists who prefer a dense Universe are unhappy with this result. Fortunately, the discovery announced in 1980 of the possible existence of a mass for the neutrino has managed to satisfy practically everyone. Now, one has the prospect of a dense Universe dominated by neutrinos. At the epoch of nucleosynthesis, the neutrinos play no role, and the Universe behaves as though it had a much lower density, corresponding to that of the protons and producing deuterium in the desired quantity. The massive neutrino promises also to affect many other results in cosmology, especially the work on galaxy formation that is reviewed in the Les Houches lectures by Richard Gott, Brandon Carter and Peter Mészáros.

One of the obvious omissions is the discussion of the pancake theory of galaxy formation. The Moscow school of cosmologists is its most ardent protagonist. Great structures form on the scales of clusters of galaxies, and provide an intriguing picture of the Universe as it appears to be on very large scales, full of sheet-like arrays, filaments and gaping holes. But on the largest scales of all, on the order of and beyond the present horizon, homogeneity is very much apparent, as the lectures of Martin Rees bring out.

One of the joys of *Physical Cosmology* is its illustrations of the lecturers in action. From Wagoner on the grass to Rees at the blackboard, these candid shots add a dash of vitality that provides an extra reward for those brave souls who have mortgaged their possessions to buy this book. □

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Sites of special spiritual importance

Kenneth Mellanby

The IBP Survey of Conservation Sites: An Experimental Study. IBP, 24. Edited by A.R. Clapham. Pp.344. ISBN 0-521-22697-X. (Cambridge University Press: 1980.) £25, \$57.50.

ONLY within the past hundred years have there been attempts to conserve wildlife for its own sake, and to establish nature reserves in which plants and animals can continue to exist under something approaching natural conditions. It has not always been easy to decide upon what criteria nature reserves, national parks and other protected areas should be selected. In the early days we relied on the instincts of a few dedicated naturalists. Today, many would like to use more scientific methods.

The International Biological Programme (IBP) was established in 1964, to try to obtain a better understanding of the environment as a basis for rational management of natural resources. Much of its work concerned productivity and potential food production in a world with a growing population. Its Terrestrial Conservation Section (CT) decided "to initiate a world-wide study of the great variety of terrestrial ecosystems, leading to the selection of representative samples of all the more important ones". This book contains the results of the survey.

The method used to evaluate sites was the IBP check-sheet survey. 13,000 copies of the check-sheet, details of which are given in a 22-page appendix, were distributed world-wide. 3,010 were returned, 2,690 satisfactorily completed. Most returns came from the developed countries, Britain, the USA, Europe (where Poland excelled), Japan and Australia. These results may seem disappointing, but they gave much more information than had previously been available on a world scale. The book describes how the information was processed, and includes critical discussions of the methodology. It should be of great value to those concerned with the survey and classification of vegetation on an international and a national scale. With its

appendices dealing with different techniques for vegetational classification it will be a useful tool for others involved in this field, though it can hardly be recommended as a good read even for the most dedicated ecologist.

No one can doubt the scientific value of this study, as an academic exercise in ecology. Its value in the selection of potential nature reserves is more doubtful. In the past most reserves have been established because the area has appealed to the emotions of the selector, and because it has been available. The process has been essentially hit or miss — it may be surprising that there have been so many hits, and that so many of the older reserves are still obviously of considerable value. There are many who still consider that this is the best method of selection, particularly in Britain where most of the treasured sites have been profoundly altered by human activities. Many of the scientific reasons for nature conservation, such as maintenance of a large heterogeneous gene-pool or the perpetuation of the full diversity of the world's plant and animal communities, have been described as rationalizations of decisions made for aesthetic and emotional reasons. It has even been suggested that Sites of Special Scientific Interest might be better designated Sites of Special Spiritual Importance.

I believe that these subjective emotions are often the reason why many of us are interested in wildlife conservation. However, this does not mean that a scientific study of the results of emotions is not still valuable. So this exercise is to be welcomed as giving us a clearer picture of the world scene, and if its application means that more unspoiled areas can be preserved for future generations we should all be grateful for those who completed what, to me, would have been a very tedious operation. □

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Polyhedra for chemists (and aesthetes)

Michael Mingos

Transition Metal Clusters. Edited by B.F.G. Johnson. Pp.681. ISBN 0-471-27817-3. (Wiley: 1980.) £33, \$88.15.

THE scientific interest in polyhedra can be traced back to ancient Greece, and the understanding of the mathematical properties of polyhedra developed then and subsequently have often proved to be

relevant to physics and chemistry. With this long tradition, therefore, it is not surprising that during the past 20 years transition metal chemists have been particularly interested in synthesizing new "cluster" compounds which have between four and forty metal atoms bonded together in a wide variety of polyhedral arrangements. Aside from the aesthetic