ter fresh debate on the formation of disciplines and the sometimes surprising ways in which scientists have chosen to carve up the empire of nature.

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Explorations of the Cosmos

Observational Cosmology. ADELAIDE HEWITT, GEOFFREY BURBIDGE, and LI ZHI FANG, Eds. Reidel, Dordrecht, 1987 (U.S. distributor, Kluwer, Norwell, MA). xxvi, 854 pp., illus. $149. International Astronomical Union Symposium no. 124 (Beijing, China, Aug. 1986).

Symposiums on topics related to observational aspects of cosmology were held in Crete in 1983, in Tallinn in 1977, and in Cracow in 1973. Another took place in Balatonfüred, Hungary, in 1987, subsequent to the 1986 symposium in Beijing on which this book is based. The setting of the 1986 meeting was significant, not only because of ancient China's many contributions to astronomy and cosmology, but more particularly as an example of modern China's current eagerness to develop its scientific capabilities through international contacts and exchanges. This opening up is part of a renewal of university life that can be felt as a strong undercurrent of optimism (and often of impatience) among Chinese students and academics. Cosmology has played a significant indirect role in this movement, since Li Zhi Fang, China's best known cosmologist and an editor of the book under review, is known throughout his country as an outspoken supporter of intellectual liberalization in universities.

A comparison of *Observational Cosmology* with the proceedings of the earlier symposiums shows a continuity of concerns and goals as well as some substantial progress. Looking to the future in his summary remarks at the 1973 symposium, Martin Rees hoped soon to see the detection of fluctuations in the microwave background radiation, measurements of its deviation from a blackbody spectrum at millimeter wavelengths, the discovery of quasars and x-ray-emitting galaxy clusters at high redshift, and (with a perhaps ironical "of course") continuing progress on the "classical" problem of determining the size and density of the universe. In addition, he expected substantial progress on fundamental problems related to the physics of the early universe. There has indeed been an explosion of new ideas in this last area since about 1980, but the organizers of the Beijing symposium decided to exclude such topics from their meeting in order to keep a better focus on *observational* cosmology. Most of Rees's other hopes still remain hopes today. The reflex of the motion of our Galaxy has been detected as a dipole anisotropy in the microwave background, but there is still no unambiguous detection of small-scale anisotropies from which we might decipher the origin of galaxies. A significant excess background at submillimeter wavelengths was discovered in 1987, after the Beijing symposium, apparently a result of energetic activity in the pregalactic universe, but we are only now beginning to find quasars and galaxy clusters at redshifts significantly higher than those known in 1973. The traditional tests for size and geometry of the universe remain inconclusive and controversial.

On the other hand, these tests have provided the stimulus for one of the most striking areas of recent progress. In the late 1970s it became clear that the geometry of the universe could not be derived without a detailed understanding of the evolution of the galaxies used to trace its structure. Recent observational advances have made it possible to study the stellar and gas content of galaxies at such large distances that we see them as they were when the universe was less than half its present age. As a result we can now study galactic evolution directly, and the observations are gradually revealing a complex and fascinating story: we may be beginning to see galaxies in the process of formation. Several papers in *Observational Cosmology* give good reviews of this topic, but the reader should note that there have been significant advances since the Beijing symposium.

A second area of substantial progress has been the elucidation of the structure of the universe on large scales. The ability to measure redshifts, and thus rough distances, for large samples of galaxies has made it possible to map the structure of their distribution in three dimensions. The observational advance in this area is easily appreciated by comparing the maps in *Observational Cosmology* with those of earlier volumes. As new data have accumulated the structure has been characterized successively as cell-like, filamentary, frothy, bubble-like, and spongy. It seems clear that our ability to characterize the galaxy distribution and draw physically meaningful conclusions from its structure has not advanced as fast as the observations. However, this is currently a very active area of theoretical research.

Other areas in which our observational understanding is advancing rapidly include the intergalactic medium, dark matter in the universe, and gravitational lenses. A strong point of *Observational Cosmology* is the almost uniformly high quality of the review papers covering these forefront topics. There are also a number of very good papers reviewing less rapidly developing areas of study where it is easier to be complete and the discussion is slower to be outdated. Although the standard of the contributed papers in the volume is more uneven, they give a fair cross section of current observational research and of theoretical efforts to interpret the data. The book opens with a particularly fine historical survey by Sandage and closes with a highly readable summary by Longair. All in all it provides a good introduction to the present state of the farthest frontier of observational astronomy.

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Biotic Changes

Global Bio-Events. A Critical Approach. OTTO H. WALLISER, Ed. Springer-Verlag, New York, 1986. x, 442 pp., illus. Paper, $38.50. Lecture Notes in Earth Sciences, 8. From a meeting, Göttingen, F.R.G., May 1986.

"Global bio-events" are profound, relatively rapid, worldwide changes in fossil biotas. Their recognition is not a new phenomenon—fossils have long been used to demarcate the stratigraphic record. What is new is an increased appreciation of the importance of sudden change in the history of the earth and life. Hypotheses of punctuated equilibrium, asteroid impact, and periodic extinctions have made current interpretations of earth history and the tempo of evolution more in the spirit of Cuvier and less in the spirit of Lyell. Instances of rapid change in the stratigraphic and fossil record, rather than seen as evidence of an imperfect record, are now likely to be taken seriously.

This volume, the proceedings of the Fifth Alfred Wegener Conference (the first international meeting of International Geological Correlation Program Project 216), consists of six general papers that provide the theoretical rationale and methodological framework for the study of global bio-events and 35 short descriptions of work on particular time intervals.

In his introductory chapter, Walliser notes that bio-events may be originations, rapid diversifications, dispersals, or extinctions; that they may have a complex of terrestrial and extraterrestrial causes; and