

Hetherington, Norris, (ed.), *Encyclopaedia of Cosmology: Historical, Philosophical, and Scientific Foundations of Modern Cosmology*, New York and London: Garland Publishing, 1993.

## Preface

The culture of a people, the totality of their creativity and intellect, has many components. These include aesthetics, behaviors, beliefs, biases, conventions, customs, desires, emotions, fads, fashions, forms, habits, inclinations, manners, modes, mores, paradigms, patterns, practices, predispositions, preferences, styles, superstitions, tastes, traits, values, and ways. Culture is more than a little arbitrary; at times, it is even irrational. Culture is also something pertaining to others, something alien and exotic in the behavior of other people for us to study and wonder at.

Our own ways, of course, seem to us natural, inevitable, and beyond question. At the pinnacle of our culture is our science. Its nature and content, when we think about them at all, presumably are dictated by an underlying factual universe increasingly discoverable by experiment and observation. In such a universe, an account of our cosmology—our understanding of the organization and evolution of the universe—would consist of little more than a straightforward listing of known facts.

Yet we are not entirely unaware that we, too, have a culture, just as other peoples have. Correspondingly, our science, although more subject to empirical test than are many of our other intellectual creations, must also be recognized as part of our culture, and as an intellectual creation worthy of study as such. Once cosmology is thought of in this manner, we have opened one of the greatest of human achievements to analysis and to an increased appreciation.

Just as the recognition of arbitrary social conventions in the cultures of other peoples can furnish us with a more productive perspective from which to view our own behavior, a study of the cosmologies of other peoples can help us recognize our own cosmology for the intellectual creation that it is. The replacement of initial obliviousness to familiar aspects of one's own culture by astonishment, and sometimes even by outrage to the point of action, is not unheard of; awakened or heightened sensitivity often follows from exposure to a familiar object or condition in a new setting. Henry George, after visiting New York, where he was shocked by the contrast between monstrous wealth and debasing want, returned home to California, where he also perceived an unjust distribution of wealth and wrote *Progress and Poverty*. Meanwhile, Edward Bellamy, a resident of the eastern United States, was about to publish *Looking Backward*, his solution for the problems of political and social inequality, after a consciousness-raising tour of urban slums in Germany, where the extent and conse-

quences of man's inhumanity to man were somehow more apparent to him than in his more familiar haunts in New York. To bring such examples around to astronomy, we may consider the case of Norman Lockyer, a British scientist. On vacation in Greece, he noticed that the foundations of some temples had been changed after their original construction, apparently to realign the temples slightly. Next, Lockyer investigated Egyptian temples, using descriptions from German and French expeditions, and found solar and stellar alignments. Only after all this did Lockyer turn his attention to an object in England and realize that Stonehenge, too, had been aligned to face sunrise at the summer solstice.

There is much to be said for the enlightening and intellectually liberating advantages of travel, with its exposure to different cultures. In addition, the current interest in multicultural education—for all its potential for racial divisiveness and distortion of history to serve political agendas—in focusing long-lacking and well-warranted attention on the accomplishments of often overlooked cultures promises ultimately to increase our understanding and appreciation of our own culture. The cosmologies of many cultures constitute an especially interesting part of a genuine multicultural education, and study of them will heighten our sensitivity to otherwise hidden aspects of our own cosmology.

A look at the cosmologies of other cultures can help us recognize that certain elements of our own cosmology which might otherwise escape our notice and pass as inevitable developments consist, instead, of arbitrary choices and values. Native American cosmologies, we learn, were not tied to geometrical predictive models derived from the mathematics of spherical geometry, nor were they tied to any physics of the heavens, such as Aristotle's physics of ethereal spheres or Newton's force of gravity. Still, like our own cosmology, Native American cosmologies were tied to empirical observations of celestial phenomena, to theoretical models rendering the observations intelligible, and to general explanatory themata influencing other aspects of the general culture as well. Who is to say, in any absolute and eternal sense, which cosmology was wrong and which was right?

In this volume, there are, in addition to the entry titled NATIVE AMERICAN COSMOLOGIES, the entries CAVE DWELLER COSMOLOGY, CHINESE COSMOLOGY, EGYPTIAN COSMOLOGY, ISLAMIC COSMOLOGY, MEGALITHIC COSMOLOGY, and MESOPOTAMIAN COSMOLOGY. Any one of these articles can awaken us to an appreciation of cosmology as an intellectual creation, not merely a collection of facts. Taken together, the studies must impress upon even the most resistant of us the fact that science in general, and cosmology in particular, can be conceived differently by different peoples in different places at different times.

Much the same realization can be obtained from a study of our own cosmology, particularly its historical evolution. We can look to the entry GREEK COSMOLOGY and the elaboration of themes by Plato and Aristotle, and something of a culmination in the work of Ptolemy. The entry MEDIEVAL COSMOLOGY sees a continuation of Greek themes, expressed in a wider context in the writings of Dante and Chaucer. Then the Renaissance—and Copernicus, Tycho Brahe, Kepler, Galileo, Descartes, and Newton. Some of the impact of this reborn Western cosmology is examined in the entry COPERNICAN REVOLUTION.

William Herschel opened a new, observational age of cosmology in the eighteenth century. Much that followed is recounted in the entries NINETEENTH-CENTURY COSMOLOGY and SPECTROSCOPY AND COSMOLOGY. Wider issues in cosmology and culture appear in the entries KANT'S COSMOLOGY and ROMANTIC COSMOLOGY.

As we come to the twentieth century, a plethora of trees threaten to obscure any overall view of the forest. But we can at least begin to create a history of modern Western scientific cosmology—this history being an intellectual creation with its own inevitably arbitrary aspects and human values, based in turn on another intellectual creation, the cosmology itself. The entry COSMOLOGY 1900–1931 tells a general story, supplemented by entries HUBBLE'S COSMOLOGY and RELATIVISTIC COSMOLOGY. Einstein's universe was a universe invented in the mind, not discovered by observations and measurements, and his philosophical endeavor continued through much of the 1920s with little impact from observation. Initially, observational astronomers were equally oblivious to theoretical developments, and the eventual joining together of relativistic theory and astronomical observations may come to be seen by later generations of historians as a major turning point in modern science.

It may be difficult to accept the fact that there was once any credible alternative to the big bang cosmology that arose in the 1930s, although E.A. Milne's cosmology, developed at the same time, won some temporary adherents, as did steady state theory in the 1950s. For the latter, we are fortunate to have an account of its origin from one of its originators. We are similarly blessed with an account of the pioneering work on primordial nucleosynthesis by two of its creators. This theory considerably extended big bang cosmology.

Contemporary cosmology is increasingly driven by considerations from particle physics. The entry INFLATIONARY UNIVERSE, written by its leading proponent, makes this clear, as does his complementary entry GRAND UNIFIED THEORIES and the entry QUANTUM COSMOLOGY. Astronomers have come to believe that some 90% of the universe has so far escaped detection, in the form of dark matter. The question of large-scale structure and galaxy formation has become a central one. Cosmic strings may provide an answer. Quasars will be part of the answer, just as they now are part of the problem. Much of the evidence now known, quite a bit of it distressingly soft, is listed in the entry FUNDAMENTAL COSMOLOGICAL PARAMETERS. A strong philosophical component is evident in working scientists' reflective accounts of their work in modern cosmology. Philosophical aspects of modern cosmology are explicitly tackled by articulate philosophers in the entries ANTHROPIK PRINCIPLE, CREATION IN COSMOLOGY, MULTIPLE UNIVERSES, PHILOSOPHICAL ASPECTS OF THE ORIGIN OF MODERN COSMOLOGY, and PLURALITY OF WORLDS.

If we understand philosophy to be a search for understanding more through thought than observation, and comprising human values as well as logic, religion might well be encompassed within this intellectual realm. Certainly there is intellectual interaction between religion and science, as noted in the entry RELIGION AND COSMOLOGY, although cosmology and religion are no longer as closely intertwined as they once were. Recent cosmology may not offer religious believers easy arguments in support of their faith. Indeed, the new cosmology poses challenges with which reli-

gious people must come to grips. At the same time, religious beliefs and values of individuals inevitably have entered into our modern cosmology, since it is created by thinking human beings.

With this, we have come full circle. After remarking on strange elements in ancient alien cosmologies and noticing apparent aberrations in the early history of our own cosmology prior to the triumphant appearance of contemporary Western scientific cosmology, we can now begin to analyze our own cosmology more as a cultural artifact than as an inevitable development in which every detail is strictly dictated by indisputable empirical fact. Nor are we now forbidden to return our attention to earlier cosmologies with an increased sensitivity.

Finally, we can look to the future. The many authors of this volume have consciously and conscientiously rejected the conventions of many standard science texts, in which matters tend to be stated too positively and majority views are misrepresented as established fact while mention of contemporary and historical debates is systematically excluded. Often, little is said about the dramatic battles sometimes required for the acceptance of a new theory. Too often, authors of didactic accounts shorten the duration of and depth of doubt. Pedagogues may suggest a clear progression from experiment to theory. Accounts of science can ignore how scientists think and wrestle with problems. In contrast, this volume features many substantial articles by authorities in their fields who emphasize how we have reached our current stage of knowledge and the possibilities of further achievements. In a subject changing as rapidly as cosmology, it should be particularly useful to recount its history, philosophical assumptions, scientific methods, and human struggles.