range of the chapters, articles on the reception of the Copernican theory in Germany, France, Italy, and China are conspicuous by their absence. Part of this lack has been amended in a small supplementary volume of late papers, which we can only hope Reidel will also publish in the West. This second volume contains a 60-page article on Copernicus in China by Nathan Sivin, an important piece of scholarship that traces the introduction of heliocentrism and subsequent confused backtracking by the Jesuit missionaries. My own piece "The role of Erasmus Reinhold" fills part of the gap on the Copernican reception in Germany, and Eugenio Garin's article on an early and previously undiscovered anti-Copernican manuscript in the National Library in Florence presents at least one aspect of its reception in Italy.

In December 1972 the American Association for the Advancement of Science stole the march on the Copernican year by scheduling its own celebration of the anniversary, and, aided by this head start, its symposium is now in press as volume 17 of *Vistas in Astronomy*. Like the previous volumes of the series, it is marked by handsome typography and abundant illustrations. Sessions on the scientific and humanistic significance of Copernicus and on the nature of scientific revolutions were held before a limited but international audience of scientists, historians, and theologians. These were followed by an evening lecture and a public AAAS session on the impact of Copernicus and his work. The 16 papers covered a broad variety of topics ranging from John North's study of the medieval background for Copernicus to a contribution of mine on Copernicus and the impact of printing.

A fascinating and somewhat unusual approach is taken by Benjamin Nelson, who argues that "the struggles for and against Copernicanism in the 'West' and 'East' alike were powerfully caught up with battles over the entire structure of credibility and of the grounds of proof and evidence in all spheres of thought." One of the finest papers in the volume is Stillman Drake's brilliant comparison of the Copernicanism in Bruno, Kepler, and Galileo. Edward Rosen has contributed a remarkable blast against Arthur Koestler, who is repeatedly called "our detractor" but never identified by name. Thomas Kuhn, though not actually present, powerfully influenced the papers on the nature of scientific revolutions. His thesis was criticized, but his vocabulary permeated the entire debate. A long verbatim record captures the spirit of the ensuing discussion.

Much scientific and historical scholarship was marshaled for this anniversary, which in effect marked the birthday of modern science. The results of at least four major symposia or lecture series have yet to appear. Although no major reinterpretation of Copernicus has emerged or is in prospect, his work and its complex relationship to the science both before and after him have been more clearly delineated. All of this material should help secure the foundations of a hoped-for new definitive biography of Copernicus.

To what extent Copernicus himself precipitated a revolution or participated in it is still debatable. To what extent he and his successors believed the heliocentric system was reality or a mathematical model is likewise debatable. These questions continue to challenge historians and philosophers, and the Copernican cornucopia of 1973 has provided more grist for their mills. Whether the fact that more scientists than ever before have been exposed to the historical foundations of their profession will in any way alter their approach to science remains to be discovered.

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Looking Outward

Mars and the Mind of Man. A panel discussion, Pasadena, Calif., Nov. 1971. RAY BRADBURY, ARTHUR C. CLARKE, BRUCE MURRAY, CARL SAGAN, and WALTER SULLIVAN. Harper and Row, New York, 1973. xiv, 144 pp., illus. $7.95.

The Cosmic Connection. An Extraterrestrial Perspective. CARL SAGAN. Doubleday, New York, 1973. xiv, 274 pp., illus. $7.95.

Life beyond Earth and the Mind of Man. Proceedings of a symposium, Boston, Nov. 1972. RICHARD BERENDZEN, Ed. National Aeronautics and Space Administration, Washington, D.C., 1973 (available from the Superintendent of Documents, Washington). viii, 106 pp., illus. Paper, $1.25. NASA SP-328.

Not to be taken as "mere discussions of the space program," these intriguing books are about the essential motivations of mankind, the meaning of God, and our own place in the history of the universe—that is, they are about what science is really about. These are attractive, modestly priced books that ought to be read by high school and college kids, college dropouts, your nephews and nieces, everybody who ever uttered a word against science and technology, and by Richard Nixon and Gerald Ford.

Mars and the Mind of Man is a record of a public symposium held at the California Institute of Technology a few days before Mariner 9 went into orbit around Mars, together with pictures from the mission and a post-mission recapitulation by each participant. To bring together science fiction writers Bradbury and Clarke, scientists Sagan and Murray, and *New York Times* science journalist Sullivan was a stroke of genius. These are not NASA public relations officers or a group of half-interested writers but the originators and doers of space exploration, talking here in a relaxed and witty manner directly to the reader. The scientists are not fumble-tongued, as in stereotype, but eloquent. Bradbury tells us in poems and prose that behind every scientist is a romantic. (This is probably widely true, except perhaps at Caltech, where romanticism must be either stamped out or overlain with cynicism.) The 21st century may regard Bradbury as the man who *really* understood why we left the Earth. Sagan reviews the history of Mars observations. Murray agonizes about the significance of the apparent decline in the space program —or is the shuttle a forerunner? Sullivan cites intriguing examples of the modern social impact of the idea of life on other worlds. Clarke concludes that if there is no life on Mars now, there will be by 2000. The theme here is the hopelessly human jumble of romanticism, sobriety, work, and dreaming that has gone into the study of the nearby planets, from the time of Jules Verne, Percival Lowell, *et al.* to the present.

Sagan's *Cosmic Connection* I was prepared to dislike. I think this had to do with the phrase "produced by Jerome Agel" on the cover. I had always thought that the producer of a book was its author. This ominous phrase led me to wonder if we are approaching an era when each scientist will have his own producer who stirs up support and acts as advance man. Whatever Agel did (Carl Sagan might need a producer but he certainly doesn't need a ghost writer), the book emerges as 39 genuine, vintage Sagan dinner con-

versations. They are varied, often delightful and witty essays. Some ideas, such as the loneliness of Earth and the need for reverence for life, have been treated as well elsewhere, for example by Loren Eiseley; other ideas are seeds for science fiction stories, here germinating as essays. Some are amusing, such as Sagan's alleged run-in with CIA spies and his advice to Stanley Kubrick on *2001*. Some are thought-provoking, for example, oxygen chauvinism, the need to get U.S. and U.S.S.R. military into space ("the more of them engaged up there, the less of them engaged down here"), and the engineer's dream of "terraforming" another planet. Pithy Saganisms abound: "I know of a sun the size of the earth—and made of diamond." Evocative line drawings and photos illustrate the book. The essays appear to be raggedly disconnected, but together they form an astronomical perspective on 20th-century Earth. The book should especially appeal to student readers and might convince a few incipient antiscience pseudointellectuals that scientists are not (always) monsters who work on H-bombs.

NASA is to be congratulated on issuing the inexpensive paperback *Life beyond Earth and the Mind of Man*. This is the record of a symposium held at Boston University in 1972. Of the three books, it is the most restricted in subject, being a speculative discussion of the social impact and mechanics of the possible discovery of alien life in the universe. Here, the mixture includes two astronomers, an anthropologist, a biologist, a physicist, and a theologian. They are all eloquent, but the short essays and question-and-answer session seem to leave several of them too cramped for space to make a coherent presentation. Nonetheless, fascinating ideas fly back and forth. The viewpoints that emerge are contradictory and sometimes unexpected. Sagan endorses a search for alien life as a character-building activity for the human race. George Wald is vaguely unhappy about the whole thing; he seems afraid the aliens will wipe us out, spiritually if not physically. Ashley Montagu is horrified; he expresses a curiously impertinent view that we, through our evil natures, will wipe out the aliens. Theologian Krister Stendahl philosophizes without clear conclusion on the advantages of realizing our small place in the scheme of things, the priority of the search, and the viciousness of frightened man. Pragmatic Philip Morrison asserts that the discovery will come in any case by radio, and pictures it as a fascinating analog to our receipt of 10,000 books of knowledge in one-way transmission through time from the Greeks, with no hope of two-way dialog. Editor Berendzen adds instructive connecting remarks. NASA has here given us proof that not only a few astronomers but a broadening spectrum of intellectuals are coming to grips with the possibility of alien life. Whether these six Americans appraise this idea realistically is entirely unknown; Montagu reminds us of the impetuous audacity of our own culture by quoting Gandhi's comment on Western civilization: "I don't think it would be such a bad idea."

It is hard to escape the idea that the more books like these there are, the more likely we are to have a civilization.

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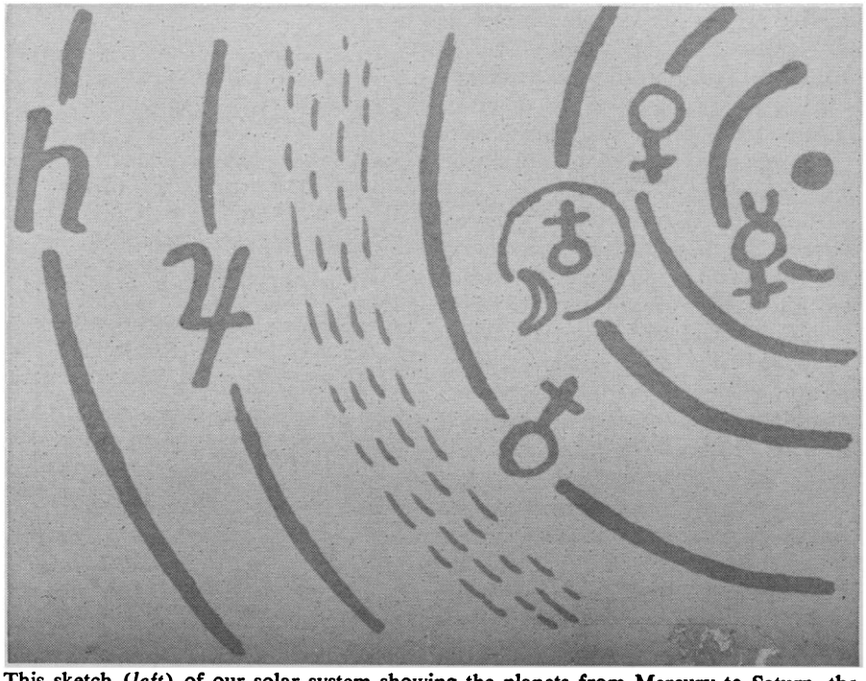
The Further Story of Jodrell Bank

Out of the Zenith. Jodrell Bank, 1957–1970. BERNARD LOVELL. Harper and Row, New York, 1974. x, 256 pp., illus. + plates. $12.50.

In his new book Sir Bernard Lovell continues and expands *The Story of Jodrell Bank*, an earlier volume about the giant 250-foot radio telescope and its work, including moments of drama when he feared he was about to be jailed for a cost overrun. That fate was averted by the auspicious appearance of the Sputniks in 1957, which helped save the day. The present book, which is a melange of history, branches of radio astronomy, and practical politics, describes the work of the telescope from its beginning in 1957 until 1970, when the great bowl was turned to the zenith for modification and improvement; the title *Out of the Zenith* celebrates its emergence into a new life in November 1971 as the Mark IA.

Many current topics of radio astronomy are traced back to their recent origins, and the lines of reasoning governing the Jodrell Bank participation are displayed. We go back to the time in 1960 when Rudolf Minkowski obtained a spectrum of the visible object identified with the strong radio source Cygnus A and found it to be receding at a velocity exceeding 40 percent of the velocity of light. At that time, it



This sketch (*left*) of our solar system showing the planets from Mercury to Saturn, the moon, and the asteroid belt was transmitted in February 1964 on a frequency of 160 Mhz from the 250-foot dish at Jodrell Bank up to the NASA Echo II balloon and back down to a 50-foot dish at Gorki, U.S.S.R., where it was received (*right*). "The Russians