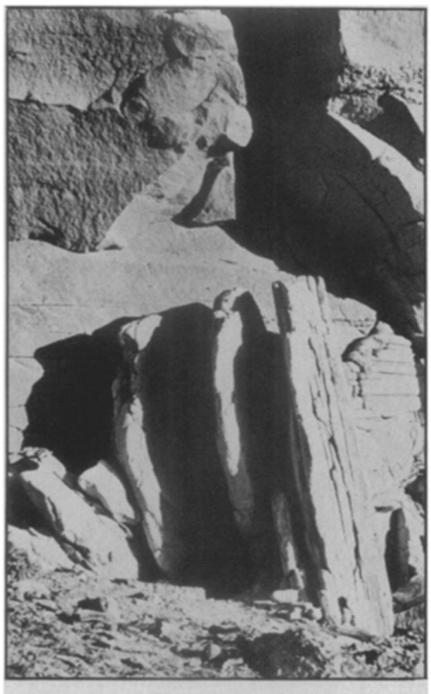
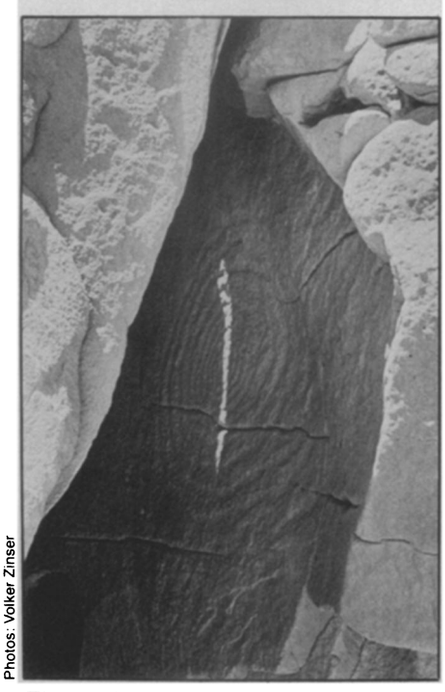
SOLSTICE-WATCHERS OF CHACO

Prehistoric Pueblo Indians of the Southwest had a sophisticated awareness of astronomy. Horizon solstice markers abound, but now the first probable noon marker of summer solstice has been discovered.

BY KENDRICK FRAZIER





Photos: Volker Zinser

The sun beats down on three upright slabs (above) creating a moving shadow on the wall behind them. As the sun moves horizontally a dagger of light moves vertically through a carved spiral petroglyph. The precise curvature and angles of the slabs cause the dagger to bisect the spiral at noon on summer solstice.

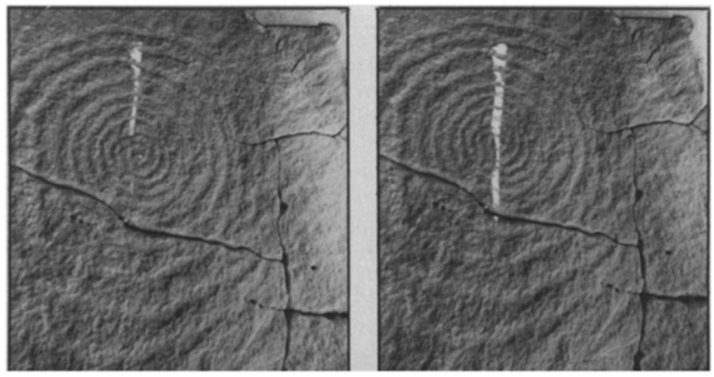
One of the more interesting sets of recent discoveries about early peoples of the Americas is their sophisticated knowledge and use of astronomy. This discovery has caused a lot of surprised comment, but upon reflection it is apparent that many of us have operated under a form of chauvinism that has failed to appreciate the integral role of astronomy in the lives of early peoples everywhere. Compounding this has been a degree of 20th-century parochialism that vastly underestimates the abilities and intelligence of prehistoric and nonindustrialized men and women. And we've all suffered under the tradition of a cultural-historical-archaeological emphasis on the Old World that has served to avert our eyes and minds from the quite wonderful achievements of early New World peoples.

All in all, it is ironic that our modern society, housed in closed-in urban cubicles, isolated from land and sky, otherwise-informed but hardly able to distinguish a planet from a star has so little familiarity with the movements of the heavens that we are surprised that Indians of a millenium or more ago had a quite detailed awareness of them. The surprise, it is fair so say, is that we are surprised.

A new interdisciplinary field of research called archaeoastronomy (or sometimes astroarchaeology) has evolved in the past five years or so to bring to bear a variety of talents and perspectives to the study of native American astronomy.

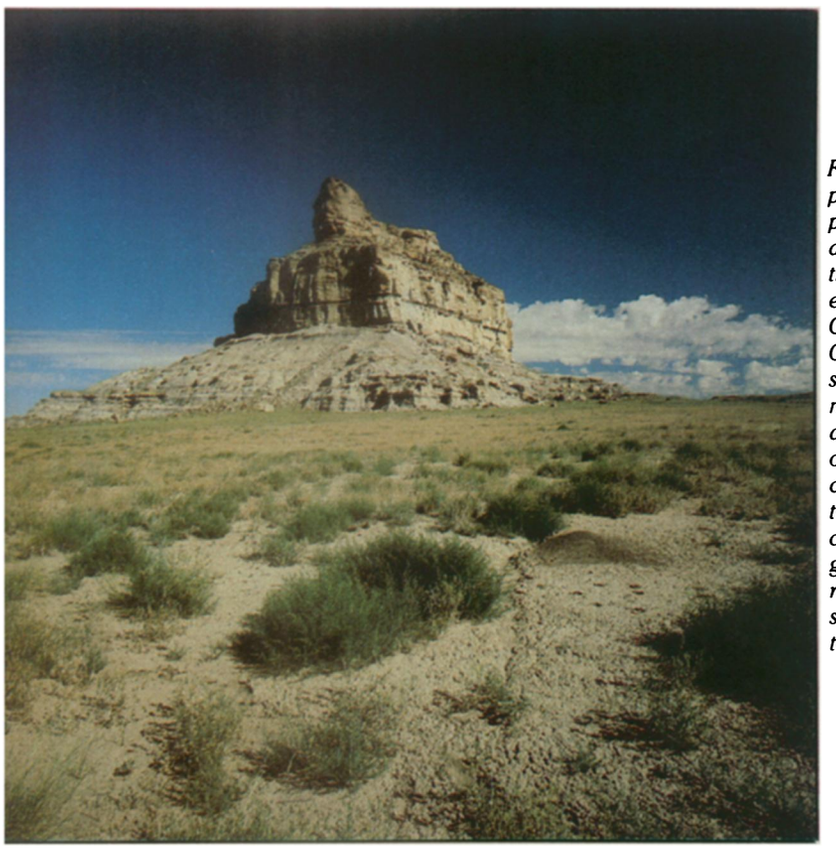
Former SCIENCE NEWS *Editor Frazier, who now lives in New Mexico, has tromped through Chaco Canyon a number of times. For this article he visited the Fajada Butte site with the researchers in May and June.*

The sun, the moon and the brighter planets and stars all figured in the early astronomies. Sunrise and sunset at the equinoxes, solstices, and zenith passage dates were marked in order to determine dates and periods of agricultural, ceremonial and civic importance. In the Caracol of Chichen Itza, notes astronomer Anthony F. Aveni of Colgate University, is a building incorporating precisely those horizon-based Venus alignments that could have served to reckon exactly the planet's 584-day period and eight-year cycle. Astronomer John A. Eddy has shown that the Big Horn Medicine Wheel in north-central Wyoming was very likely built to mark the summer solstice sun and certain bright stars of midsummer dawn (Sirius, Aldebaran and Rigel) and was in use 200 to 700 years ago. NASA astrophysicist John C. Brandt and colleagues, including astronomer Stephen P. Maran and Ray A. Williamson, in 1975 reported several sites in northern Arizona thought to contain rock-art petroglyph records of the A.D. 1054 supernova. Since then they have expanded their list of possible western records of the supernova to more than 15, including examples from New Mexico, Utah, Texas and Baja California. Williamson, a St. John's College astronomer now involved with research on Pueblo archaeoastronomy in the U.S. Southwest, has identified several prehistoric sun-watching stations or observing sites in and around Chaco Canyon National Monument in northwestern New Mexico and Hovenweep National Monument on the Colorado-Utah border. Jonathan Reyman, an Illinois State University anthropologist, has reported evidence that exterior corner windows at Pueblo Bonito in Chaco Can-



yon may have been aligned to the winter solstice sunrise.

Chaco Canyon, now an arid, isolated area of prehistoric Indian ruins, was once a major center of Pueblo Indian culture. Six thousand persons lived there in a thriving, highly organized society. The canyon functioned as a trade distribution center for other Anasazi settlements throughout the area. An intricate system of roadways and line-of-sight communications was established linking outlying areas with it. Its major phase of occupation was from A.D. 950 to 1150, during which time Pueblo Bonito, the largest prehistoric Indian dwelling in the Southwest, was built. Many insights about early Pueblo Indian life are coming out of recent archaeological research in Chaco Canyon.



Fajada Butte's powerful presence dominates the southern entrance to Chaco Canyon. The solstice marker, accessible only by climbing through a chimney guarded by rattlesnakes, sits high atop the butte.

Williamson has called the sun-watching sites and stations in Chaco Canyon and elsewhere solar observatories, realizing that the term is partially misleading, and he classifies them into several types. Included among them are structures used solely for gaining information about such things as the motion of the sun or to determine a calendar (type 1) or structures built using knowledge of astronomical positions so that certain phenomena become obvious, such as the sunlight at winter solstice sunrise passing through a particular small window and illuminating markers on an opposite wall (type 2). Other types include buildings whose alignments along east-west or north-south lines were based on astronomical knowledge.

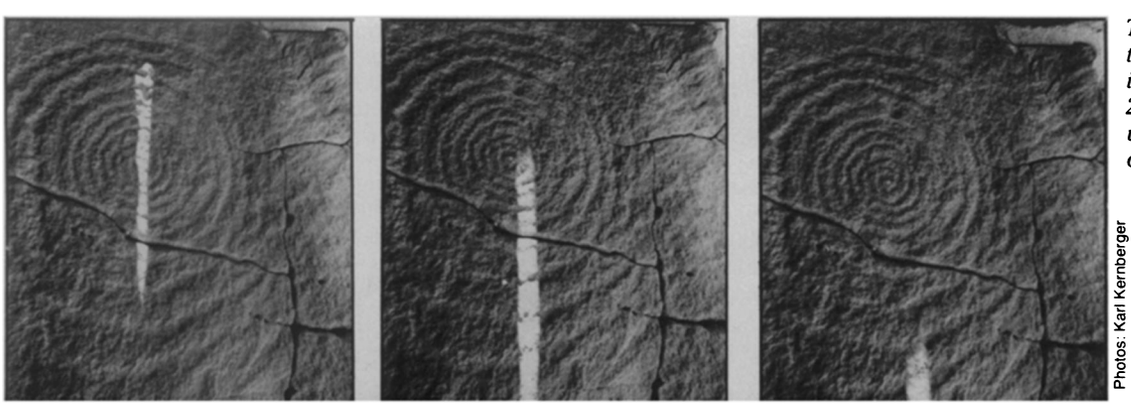
Possible type 1 stations at Chaco Canyon include several natural locations that are marked by sun glyphs and may have been horizon observing stations. One near the Wijii ruins at the east end of Chaco Canyon, for instance, has a white painted sun at the top of an ancient stone stairway. A narrow rock chimney is off 500 meters to the east-southeast in the exact direction of winter solstice sunrise. The chimney is just a few minutes of arc narrower than the apparent diameter of the sun, so an observer stationed in front of the sun glyph and sighting through the chimney would have an excellent and very accurate device for determining the exact date of the winter solstice.

Manmade structures also appear to have been used as solstice markers. Casa Rinconada, one of six known Great Kivas in Chaco Canyon, has two sets of wall niches positioned so that sunlight passing through the northeast window illuminates one particular niche for four or five days at the summer solstice. Pueblo Bonito, according to Williamson, exhibits at least two solstice alignments. Several rare corner doorways, for instance, afford an excellent view of the winter solstice sunrise. Pueblo Bonito is a large, D-shaped, multi-story, 800-room apartment-type dwelling. Its axis of symmetry is on a north-south line. "What we and others have found so far," says Williamson, "indicates that the Anasazi had a considerable range of sophisticated astronomical knowledge and practice."

Some of the particular evidence reported for solstice sunrise and sunset markers is controversial, and caution against overzealous speculations is necessary. But it is not disputed that paleo-Indian sun watchers did undoubtedly make such solar observations. Their modern-day counterparts at Pueblo villages in the Southwest still do.

In fact, most village-dwelling Indians in New Mexico and Arizona conduct their major ceremonial activities according to a precise determination of the summer and winter solstices. A prominent leader of the Hopi Indian tribe of northeastern Arizona described for SCIENCE NEWS modern-day solstice-watching activities. A Sun-Watcher peers through a small window in a kiva or clan house and checks a point on the horizon each day. Sunlight shining through the window shines on the opposite wall where markers have been placed to track the path of the sun. Then the Sun-Watcher informs the Hopi priesthood of the impending solstice and the ceremonies are planned and appropriate clans informed. Religious activities are not confined to Sundays but are practiced daily in a harmonizing of natural and supernatural beliefs. Overall is the need to maintain all possible ways to gain life-sustaining crops, just as with the Hopis' ancestral clan relatives of Chaco Canyon.

Many technical details of these procedures are discussed in an interesting recent paper by Stephen C. McCluskey of West Virginia University, "The Astronomy of the Hopi Indians," in the JOURNAL FOR



Time sequence taken at five-minute intervals on June 21, 1978, shows vertical movement of dagger.

Photos: Karl Kernberger

THE HISTORY OF ASTRONOMY: 8 (1977, pp. 174-195.)

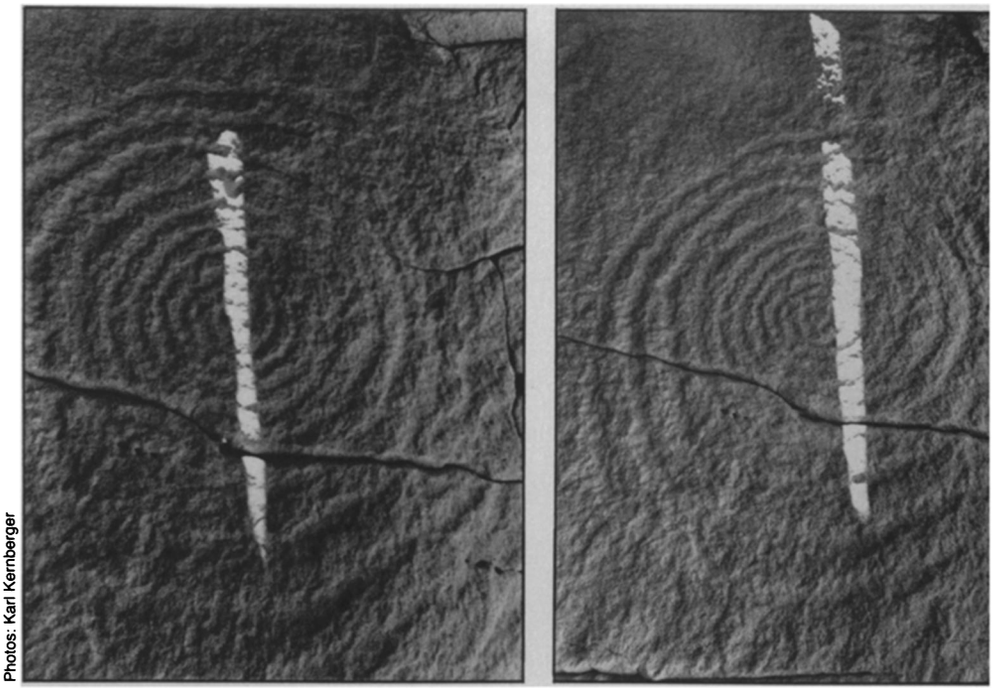
Colgate's Aveni has observed that New World civilizations shared a horizon-based system of astronomy, in marked contrast to the pole-oriented Chinese astronomy and the ecliptic (zodiac)-based Babylonian system. A horizon-marking system is capable of delineating a period in the calendar with remarkable accuracy, and, up to now, all proposed and confirmed solstice markers in Chaco Canyon and elsewhere in the American Southwest have been horizon (sunrise or sunset) markers. This has been true of both summer and winter solstice markers.

Now there is intriguing observational evidence of a unique marker in Chaco Canyon, one that indicates *noon* on the day of summer solstice. Its configuration may possibly indicate a sophisticated understanding by the ancient peoples of Chaco Canyon of the interplay of light and shadow on and by different curved and angled surfaces to achieve the observed effect. This probable noon solstice marker is causing considerable stirrings of interest among the small community of astronomers and archaeologists who know about it.

The origin of the feature as a solstice marker most probably dates back 800 to 1,000 years ago to the classic, or Bonito, phase of occupation of the canyon. But the beginning of our awareness of the role it may have played dates back to only a little over one year ago. In late June of 1977, Anna Sofaer, a Washington, D.C., artist with a deep interest in Indian rock art and an intense fascination with Southwestern astroarchaeology, happened to be near the top of a sandstone promontory in Chaco Canyon known as Fajada Butte studying some of the abundant petroglyphs that mark its upper reaches. The difficult-to-climb butte rises about 430 feet above the arid canyon floor. Rattlesnakes guard its upper ledges. The butte has an excellent view in all directions, but previous workers had failed to find any indication of solstice markers anywhere on it.

Just below the upper ledge of the butte on the east side are three upright slabs of rock. Their faces are perpendicular to the rock wall against which they lean. They are quite large, about nine feet high, six feet wide and a foot thick. While Sofaer was examining a carved spiral petroglyph hidden in the shadows on the wall behind the slabs, she was surprised to see a narrow beam of light suddenly begin moving vertically down through the spiral to the right of its center. The dagger-shaped beam was created by the passage of sunlight down through the small opening between two of the three slabs of rock. The time was shortly after noon, eight days after summer solstice.

Sofaer photographed the phenomenon. With the suspicion that the slab-and-petroglyph combination might be a noon solstice marker, she vowed to return this year with equipment and colleagues to help prove or disprove the hypothesis. She soon linked up with Volker Zinser, a Washington architect whose professional training at the Technical University in Berlin had thoroughly acquainted him with the sometimes unusual effects of light and shadow caused by the interplay of different curved and angular surfaces. Also joining the group was Rolf Sinclair, a scientist on the staff of the National Science Foundation, who has a strong interest and background in early astronomy.



Photos: Karl Kernberger

Dagger's movement between June 21 and July 21 suggests that it will move to the far right of spiral by winter solstice.

Zinser was able to explain theoretically that a horizontally moving source of light (the sun) would, when partially cut off by certain curved surfaces (the tops of the rock slabs), produce a downward-moving vertical beam of light on a vertical surface (the cliff and the spiral petroglyph on it).

Sofaer and Zinser returned in mid-May 1978 with photographic and measuring instruments to do some preliminary work prior to summer solstice in June. Again, shortly after noon, the dagger of light moved vertically down through the spiral, to the right of center, just as it should some weeks prior to solstice. Rough calculations indicated that at summer solstice on June 21, the dagger might well pass vertically right through the center of the 15-inch spiral.

They also identified the particular curved surfaces at the top and rear of the second and third slabs that were responsible for cutting off the sunlight at noon to form the downward-moving light pattern. It looked as though some relevant portions of the curved surfaces had been worked by humans, their edges ground into shape, but that was impossible to confirm. Two geologists examined the setting and determined that the slabs of rock had come from the cliff face above and slightly off to the side of their present location. They could not rule out the theory that the slabs had fallen into their exact present upright position (whether they did or did not is not crucial to the hypothesis), but there was some sign that the right-most slab, possibly at some time in the past had been propped up from beneath. Zinser and Sofaer also used an electric light that night to simulate the position and motion of the sun at solstice time. The simulation produced the precise downward-moving dagger bisecting the spiral.

On the basis of what they had learned, Sofaer and Zinser presented a paper ten days later at the meeting of the American Rock Art Research Association in Oregon and made plans to return to Fajada Butte at summer solstice in June.

They were not disappointed. Shortly after noon on solstice day, June 21, the now-familiar dagger of light appeared and began moving vertically downward through the spiral. This time it passed not to the right of center but precisely through the center of the spiral. Four different kinds of cameras recorded the sequence. The hypothesis of passage of the light through the spiral's center on the day of summer solstice had been proved.

To summarize, the investigations have demonstrated that the light formation is dramatically vertical at solstice time, is centered in the spiral in its descending movement at solstice time, remains consistently shaped in downward-pointing dagger form, is created by doubly curved surfaces, and maintains its primarily perpendicular motion at solstice for a significant length of time (about 35 minutes).

Say Sofaer and Zinser: "This solar construct is unique among archaeo-findings

reported to date: as a midday solstice recording process utilizing a device of great geometric complexity and precision."

How much of what they call this "unique solar marking construct" was intentionally created is a difficult question. It is theoretically possible that the whole thing is a coincidence: that the slabs fell exactly into their upright position with their top surfaces curved just right so that the vertical beam of light was created at noon and that some ancient Indian carved the spiral on the wall behind them without realizing that the light bisected the spiral at summer solstice. That seems a bit farfetched.

Or perhaps the rocks fell precisely into their present place and the Anasazi noticed the light beam they created and carved the spiral to mark the beam's location at solstice. That's possible.

Or perhaps the rock slabs fell only somewhere near where they are now and were placed into their present position by the Anasazi, who propped them up and adjusted them and ground down their upper curved surfaces to just the right curvature so that the vertical beam was created at noon. Then they carved the spiral in the appropriate position.

There is no way at this time to prove conclusively which of these scenarios is right. The documented observations and the context of the find among other solstice markers in and around Chaco would seem to argue against the coincidence possibility. Whether the upper curved surfaces of the slabs have been worked by humans is not totally clear. The sandstone is soft and erosion has obscured any definite signs. Archaeologist R. Gwinn Vivian visited the site June 22. He says he saw evidence that the very tops of the slabs at one of two particularly relevant areas might have been modified, but he cannot be certain of it. "I wouldn't want to say that definitely they have been modified, but understanding the slabs as a whole, it does look as though they could have been." Vivian is probably as familiar with Chaco Canyon as anyone. He grew up there (his father was the Park Service archaeologist there in the 1930s and 1940s). He is now associate director of the Arizona State Museum in Tucson, a division of the University of Arizona.

Vivian says he has been a skeptic about some previous claims of solstice markers in Chaco, and this one still requires further study. "But it is rather interesting that that light goes smack down through the middle," he says.

Anthony Aveni, who is editor of the recent book *Native American Astronomy,* has also expressed interest in the find and is encouraging further observations. So are other archaeoastronomers.

Sofaer, Zinser and Sinclair intend to continue the research. Observations of what happens at noon throughout the year need to be made for comparison. Also, a second beam of light created by the gap between the first and second slabs moves vertically downward, too. It passes through a smaller, less distinct spiral petroglyph to the left of the main one. Its significance as a possible solar marker needs to be explored.

Already they are exploring with Park Service officials and with W. James Judge, director of the Chaco Center on the campus of the University of New Mexico, ways to continue the studies while protecting the fragile site from damage by investigators or careless backcountry hikers. The difficulty of reaching the site and the requirement of permits for hiking in Chaco should discourage casual visitors. "I think that it has some considerable significance," says Vivian, "and it should be protected."

The marker is not only fragile, it is subtle, and that is part of its majesty.

As the researchers conclude: "The natural appearance of this solar construct and its integration with the surrounding environment makes man's role perceptible only through a most careful examination of *all* the dynamics operating to form the significant solar markings."

The nonmonumental quality of this solar construct reflects the profound beauty of ancient Pueblo architecture — characterized by the Indians' sensitive integration with nature, light and patterns of the solar cycle. □

Astronomical Readings

Recent Astronomy Books that have been of Special Interest to SCIENCE NEWS readers

THE ATLAS OF MERCURY — Charles A. Cross and Patrick Moore, foreword by Sir Bernard Lovell—Crown, 1977, 48 p., photographs and drawings, $10. From the best of the Mariner 10 photographs a new chart of Mercury is presented. The photographs showing the most important characteristics are further enlarged and experiments carried out by Mariner 10 are discussed with earlier observations from earth-based telescopes. [1]

THE CAMBRIDGE ENCYCLOPAEDIA OF ASTRONOMY — Simon Mitton, Ed. — Crown, 1977, 495 p., color & b&w photographs and drawings, $35. Draws together many remarkable discoveries and presents them in context through a series of themes rather than by an alphabetical listing. Mirrors the interests of active astronomers without ignoring the achievements of classical astronomy. The text is complemented by many diagrams and photographs. [2]

EVOLUTION OF STARS AND GALAXIES — Walter Baade, ed. by Cecilia Payne-Gaposchkin —MIT Pr, 1975, 321 p., graphs & charts, paper, $5.95. An edited compilation of this famous astronomer's 1958 lectures at Harvard. Although some of the information is outdated, most of the material is sufficiently basic so as to be useful today. The book conveys a historical image of one of this century's finest observational astronomers. [3]

THE FIRST THREE MINUTES: A Modern View of the Origin of the Universe — Steven Weinberg — Basic Bks, 1977, 198 p., photographs, diagrams, tables, $8.95. Writing for the inquiring layman, particle physicist describes the course of events at the genesis of the universe, with emphasis on the new understanding that has grown out of the discovery of the cosmic microwave radiation background. [4]

GUIDE TO MARS — Patrick Moore — Norton, 1977, 214 p., illus., $9.95. Traces our knowledge of Mars throughout history and gives an account of Mars as it is believed to be today. New findings are coming to light all the time, but it does seem, according to the author, that we have learned the basic essentials of the red planet. [5]

IN SEARCH OF ANCIENT ASTRONOMIES — E. C. Krupp, Ed. — Doubleday, 1978, 300 p., photographs and drawings, $10. An attempt to present to the general reader a balanced perspective of the field of archaeoastronomy by the Director of the Griffith Observatory in Los Angeles. [6]

THE MOON BOOK — Bevan M. French — Penguin, 1977, 287 p., illus., paper, $4.95. What we have learned from the Apollo program about our closest neighbor in space by a NASA scientist who is head of extraterrestrial materials research in the Lunar and Planetary Program. [7]

THE RED LIMIT: The Search for the Edge of the Universe — Timothy Ferris, introd. by Carl Sagan — Morrow, 1977, 287 p., photographs, $10. About 20th-century astronomers and their major discoveries. Title refers to the finding that if a galaxy was receding, its light waves would shift toward the red end of the spectrum, leading astronomers to the discovery of the expanding universe. [8]

SPACE AND TIME IN THE MODERN UNIVERSE — P. C. W. Davies — Cambridge U Pr, 1977, 232 p., diagrams, $14.95; paper, 6.95. Modern science has discovered situations in which space and time can change their character so drastically that remarkable and unexpected phenomena occur. This book examines them for the "scientifically inclined" laymen or scientists from other fields. [9]

SPACE-TIME TRANSIENTS AND UNUSUAL EVENTS — Michael A. Persinger and Gyslaine F. Lafrenière — Nelson-Hall, 1977, 269 p., diagrams, $9.95; paper, $5.95. Written by a psychologist and his research assistant with the help of computer technology, this book is a study of unusual events. Its purpose is to encourage thinking about the limits of our concepts and the boundaries of man. [10]

UNTIL THE SUN DIES — Robert Jastrow — Norton, 1977, 172 p., illus., $8.95. Examines the forces that have shaped human beings and created the power of human intelligence. Considers the prospects for intelligent life on other planets in this solar system and elsewhere in the cosmos. [11]