BACKGROUND BOOKS

ASTRONOMY

Human beings have long endeavored to form a coherent picture of the universe—as much of it as any age could fathom—and of man's place in it.

That picture began to take shape during the end of the Ice Age, perhaps as long as 30,000 years ago, according to Evan Hadingham in **Early Man and the Cosmos** (Univ. of Okla., 1985). Moving with ease from Eskimo moonwatchers to Pueblo Indian sunwatchers, he provides a colorful chronology and comparisons of a dozen primitive skywatching societies.

Two similar treatments, James Cornell's **First Stargazers** (Scribner's, 1981), and **Astronomy of the Ancients** (MIT, 1981), edited by Kenneth Brecher and Michael Feirtag, expand on astronomy's archaeological aspects. In addition to describing ancient Egyptian and Babylonian astronomy, Cornell explains the relevance of specific ancient observatories in the Far East and Africa; Brecher's and Feirtag's collection of eight essays by leading archaeoastronomers focuses on such matters as the first scientific instruments and the medicine wheels of the Plains Indians. Providing a close look at particular cultures, **Native American Astronomy** (Univ. of Tex., 1979), edited by Anthony F. Aveni, and **At the Crossroads of the Earth and the Sky: An Andean Cosmology** (Univ. of Tex., 1981) by Gary Urton suggest that the term "primitive" does not always fit early societies.

The invention of specialized tools, such as telescopes, has played a crucial role in the evolution of astronomical knowledge. Focusing on the relationship between theoretical and technical advances in astronomy, Cornell's Martin Harwit, in **Cosmic Discovery: The Search, Scope, and Heritage of Astronomy** (MIT, 1984), shows how theories and instruments tend to improve together. Using charts and graphs, he demonstrates the rapid progress in astronomy since World War II, noting, among other things, the major astronomical discoveries by people not trained as astronomers—physicists, chemists, engineers, and even theologians.

What are those discoveries? By far the best way to comprehend the majesty of the cosmos, and to understand what astronomers have found, is to see what they see. **The Cambridge Atlas of Astronomy** (Cambridge, 1985), edited by Jean Audauze and Guy Israël, provides 432 pages of color photographs, charts, and diagrams of objects millions of light years from Earth. Included: Venus's landscape, Jupiter's moons, the Magellanic Clouds, gaseous nebulae, clusters of galaxies, neutron stars, and pulsars. **The Cambridge Photographic Atlas of the Planets** (Cambridge, 1982), edited by Geoffrey Briggs and Fredric Taylor, and **Colours of the Stars** (Cambridge, 1984) by David Malin and Paul Murdin, supply greater detail.

Many of these spectacular images are products of recent journeys into space. Indeed, **Astronomy from Space: Sputnik to Space Telescope** (MIT, 1985), edited by James Cornell and Paul Gorenstein, provides 10 essays by research astronomers on such topics as exploration of the Moon, ultraviolet and x-ray charting of the sky, the geology of the planets, and the future of space astronomy. Wallace Tucker's and Karen Tucker's **Cosmic Inquirers** (Harvard, 1986) describes the difficult technical labor that goes into designing and carrying out big expensive projects, such as the construction of the Very Large Array in New Mexico or the launching of the Ein-

stein X-Ray Observatory.

The fruits of these and other large-scale research projects are well illustrated (240 pages of color plates) in **The New Astronomy** (Cambridge, 1983) by Nigel Henbest and Michael Marten. Equally useful summaries are Paul W. Hodge's **Galaxies** (Harvard, 1986), James Elliot's and Richard Kerr's **Rings: Discoveries from Galileo to Voyager** (MIT, 1984), and Wallace Tucker's and Riccardo Giacconi's **X-Ray Universe** (Harvard, 1985).

Closer to home, **The Milky Way** (Harvard, 1941, 1981) is Bart J. Bok's and Priscilla F. Bok's classic anatomy of our galaxy, which Ovid in the *Metamorphoses* called "the Palatine of the Great Sky." This streak across the night sky, composed of the light from millions of distant stars, can best be viewed in the United States and Europe, the Boks note, "in the late summer on a moonless night an hour or so after sunset."

Skywatchers may also spot a shooting star. Known technically as "meteoroids," according to Robert T. Dodd in **Thunderstones and Shooting Stars: The Meaning of Meteorites** (Harvard, 1986), they continually bombard the Earth, ranging widely in size and kind from small pieces of "fluffy dust" to 100,000-ton chunks of metal.

Despite the recent leaps in knowledge about the universe and its origin, most astronomers (like most scientists) maintain that the more they learn, the more they realize they do not yet know. Hence **Revealing the Universe: Prediction and Proof in Astronomy** (MIT, 1982), edited by James Cornell and Alan P. Lightman. Thirteen scholar-essayists consider not only such matters as "the mystery of the x-ray burst sources" but also various unanswered questions now facing astronomers: Are there more than nine planets in the solar system? In what form is the universe's "hidden mass"? And could the theory of stellar evolution be wrong?

Such questions form a seemingly endless chain. In fact, physicist Werner Heisenberg observed in **Physics and Philosophy: The Revolution in Modern Science** (Harper, 1958) that "natural science does not simply describe and explain nature; it is part of the interplay between nature and ourselves; it describes nature as exposed to our method of questioning."

Astronomers utilize a specific method of questioning, one that focuses on *how* cosmic events occur. As to *why* they occur—the bigger picture—those questions fall under the rubric of "cosmology," what astronomer Edward R. Harrison calls "the science of the universe." In **Cosmology** (Cambridge, 1986), Harrison notes that cosmologists deal with such matters as the large-scale structure of the universe, its distant and receding horizons, the interplay of cosmic forces, and the nature of space and time. But, whereas "most sciences tear things apart into smaller and smaller constituents, for the purpose of examining the world in progressively greater detail . . . cosmology is the one science devoted to putting the pieces together into a 'mighty frame.'"