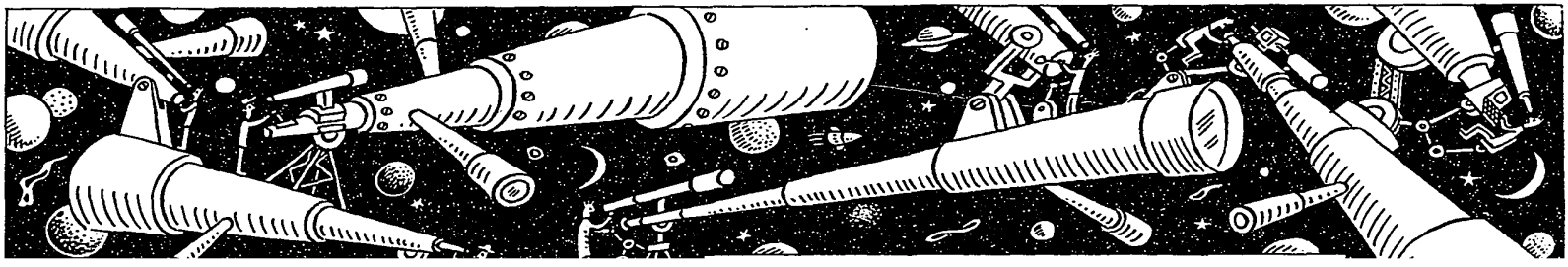
How We Got Lost in the Stars



COMING OF AGE IN THE MILKY WAY

By Timothy Ferris. Illustrated. 495 pp. New York: William Morrow & Company. $19.95.

By Marcia Bartusiak

FOR ancient farmers planting their first crops in the rich deposits of the Euphrates and Nile rivers, the heavens were almost touchable. "The gigantic Egyptian constellations hovered close over humankind," Timothy Ferris writes in "Coming of Age in the Milky Way," "as proximate as a mother bending to kiss a sleeping child." And by carefully keeping track of lunar cycles and stellar motions, clever observers came to recognize that there was power in knowing the stars, which allowed them to predict when to plant and when to harvest. Lusting to perfect this capability, astronomers of antiquity were driven to try to discern the true nature of the vaulted roof above them.

Over the centuries, the Egyptians' low-ceilinged sky expanded outward more than 10 billion light years, a size that the ancients would have found incomprehensible. "Coming of Age," aptly titled, chronicles this awakening of the human species to the vastness of our cosmos and shows us how each time the model of the universe was altered, tremors rumbled through

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Marcia Bartusiak, the author of "Thursday's Universe," is a freelance writer on astrophysics and astronomy.

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such realms as theology and politics. It is an exhilarating, wide-ranging journey that takes us from the shores of the Mediterranean, where the second-century astronomer Claudius Ptolemy fashioned his creaky celestial spheres, to modern-day research institutes where theorists contemplate this and other universes bubbling out of a quantum vacuum.

With his earlier books "The Red Limit" and "Galaxies," Mr. Ferris established a reputation as one of astronomy's poets laureate. With this work, 12 years in the making, he provides a perspective missing in most popular cosmology books, which lately have tended to highlight speculations of the present without reference to the many yesterdays of astronomy. It is a welcome and refreshing slant. Mr. Ferris, who teaches science writing at the University of California, Berkeley, is a master analogist who conveys his insights on the history of cosmology with a lyrical flair.

THE inauguration of humanity's passage into cosmological adulthood began in the fourth century B.C. at Plato's Academy, where the geometer Eudoxus surmised that the firmament was more than an inverted bowl through which the fires of the gods flickered. Anxious to craft a model that could make accurate predictions of celestial movements, Eudoxus envisioned the stars and planets as fastened to a series of invisible concentric spheres, with a motionless earth poised prominently in the center. Unfortunately, new astronomical findings failed to fit this design. "Thus began the phoenixlike cycle of the *science* of cosmology, where theories, however grand, are held hostage to empirical data that has the power to ruin them," Mr. Ferris writes.

Aristarchus of Samos, 1,700 years before Copernicus, put the sun at the center of the universe, but no one listened. Instead, building on Eudoxus' concept, Ptolemy enmeshed the heavenly bodies in a maze of ungainly epicycles, wheels within wheels, that held humanity in a dark millennium of delusion. If this is really how God had built the universe, a medieval monarch once drolly commented, then He might have had some better advice. The estimated width of Ptolemy's universe, with the stars fixed at the boundary, was no larger than earth's orbit.

Some perceived Ptolemy's labyrinthine scheme as existing only in thought, merely a useful device for predicting eclipses and occultations. One is reminded that quarks, now believed to be the basic units of matter, were similarly considered unreal when they were first imagined.

The bondage of Ptolemy was at last broken during the Renaissance, when empirical inquiry became the norm of science and when the discovery and exploration of the New World led to great advances in stargazing for navigational purposes. And two fortunate supernovae — one in 1572, another in 1604 — strongly hinted that the structure of the cosmos was not immutable, as the ancients believed, but changing and evolving.

Mr. Ferris wipes away the myths of that era too, replacing them with well-researched and engaging stories. Galileo, the con artist, turns a spyglass upon the heavens and lets his superiors think that he, rather than Dutch lens makers, invented the telescope. Urbane and egocentric, Galileo also snubs his less cultured contemporary, Johannes Kepler. "That, alas, is vanity," Einstein said. "You find it in so many scientists."

Galileo deserves the benefit of the doubt; Kepler's credentials did look shaky. A man of social ineptitude whose clothes were often food-stained, he once made a living casting horoscopes for unappreciative European princes. Yet in time Kepler would be described by Kant as "the most acute thinker ever born." After years of frustrating calculations, he flung open the doors of cosmic space with one seemingly simple discovery: the planets do not orbit in circles, long considered God's perfect form, but in ellipses. That was the realization upon which Sir Isaac Newton would forge his momentous law of gravitation.

Newton himself is a paradox. Generally viewed by history as the voice of detached reason, he was a student of alchemy and biblical prophecy. Remote, terribly absent-minded and rude, Newton invented the calculus while he was still an undergraduate, but he refused to publish it for 27 years for fear of the public attention it would bring. "As a man he was a failure," Aldous Huxley wrote, "as a monster he was superb." His scientific masterpiece, the "Principia," might never have been written except for the dogged and persistent prodding of Edmund Halley, of comet fame. As if with one monumental stroke of the pen, Newton proved that motions everywhere, in the heavens and on earth, are described by the same set of physical laws. The universe moved with clocklike precision.

This is not to say that Mr. Ferris presents us with a book of anecdotes. To the contrary, he allows us to view humanity's growing cosmic awareness — the result of either plodding effort or serendipity — as the consummate human adventure, in which intellectual genius is fed by both jealousy and friendship, and scientific progress is measured as much by failures as by triumphs.

Children in elementary school dutifully learn that the earth is 93 million miles from the sun. What they are not taught is the extraordinary effort put forth in the 17th and 18th centuries to ascertain that simple fact. Scores of explorers from Siberia to the South Pacific, sometimes in the midst of seafaring battles and epidemics, had to time carefully the passage of Venus or Mercury whenever it orbited in front of the solar disk. While the planet, silhouetted against the blazing sun, provided a sort of surveyor's stake out in space, the widely separated transit timers on earth served as the base for this celestial triangulation. Mr. Ferris relates how William Wales timed one of these rare transits of Venus from the Canadian tundra, enduring horseflies, mosquitoes and a winter so severe that a half-pint of brandy would ice over in just five minutes. As another observer noted, "Liquor gives us the necessary strength for determining the distance of . . . the sun."

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In the present century we took the greatest leap of all. Our home galaxy, the Milky Way, was discovered to be but one among billions of other galaxies spread throughout the gulfs of space. Aided by astronomy's newfound comprehension of the chemistry of the stars, the astronomer Edwin Hubble — who had also been a Rhodes scholar and a boxer — recognized that the Andromeda nebula and other spiraling objects in the sky were separate island universes. The cosmos, cozily centered on us for so long, opened up a millionfold. More startling, the galaxies were racing away from one another in a marathon of cosmic proportions. Hubble considered this vision so radical, in fact, that he actually resisted the idea for many years; he preferred to speak of his data as simply "velocity shifts."

Meanwhile, in the theorist's corner, Einstein was redefining the very notion of space, time and gravity. As Mr. Ferris so engagingly puts it, "the force of gravitation disappears and is replaced by the geometry of space itself. . . . What we call gravi-

tation is but the acceleration of objects as they slide down the toboggan runs described by their trajectories in time through the undulations of space. The planets skid along the inner walls of a depression in space created by the fat, massive sun; galaxies rest in spatial hollows like nuggets in a prospector's bowl."

The discoveries of Hubble and Einstein ultimately led to a cosmic model, impishly entitled the "Big Bang," that shapes astronomers' thinking today just as Ptolemy's spheres shaped that of medieval scholars. For George Gamow, one of the Big Bang's earliest advocates, the image of space and time emerging from a primordial explosion billions of years ago provided a vast playground for his prolific ideas. The gadfly astronomer Fred Hoyle, on the other hand, considered it a fraud. Fortunately for astronomy, his unsuccessful attempts to dethrone the Big Bang concept led to his showing how the basic elements of life, such as carbon, calcium and oxygen, are forged inside stars. Such are the ways of science.

Mr. Ferris reminds us that, as humanity's sense of space expanded, there was also an appreciation for the antiquity of earth. The industrial revolution, which spawned steam-driven engines and pumps, allowed miners to dig ever deeper into the earth, exposing vast layers of geologic strata. As though they were pages in an ancient tome, Darwin read those layers handily. Darwinism, Mr. Ferris points out, was a time bomb: "For species to have evolved to their present-day diversity through the slow workings of random mutation and natural selection required that the duration of the past be much longer than the six thousand or so years suggested by the Bible." And with the discovery of radioactivity — timekeepers set the very day certain elements were forged in the belly of a star — physicists revealed a universe that was billions of years old.

In its final chapters, "Coming of Age" plunges inward to the submicroscopic world of quarks and electrons. Physicists have taken a zoo of particles and related them to one another in an elegant fashion. Mr. Ferris has good reason to shift his focus: It is in the Big Bang that physics' pursuit of symmetry among the forces of nature joins hands with cosmology's search for the origin of the universe. "It was a shotgun wedding, one that married two very different disciplines," the author writes. "Cosmologists tend to be loners, their gaze fixed on the far horizons of space and time and their data tenderly garnered from trickles of ancient starlight; none will ever touch a star. Particle physicists, in contrast ... are by tradition hands-on students of the here and now, inclined to bend things and blow up things and take things apart."

Since "Coming of Age" covers centuries of cosmological history in less than 500 pages, the 20th century becomes a blur of astounding revelations, which include quantum mechanics, the expanding universe, antimatter, general relativity and the possibility of other spatial dimensions. We certainly gain an appreciation for the wealth of discovery in our era, especially when it is set against the more glacial pace of classical Greece, but at the expense of certain detail. Here the reader gets only a taste, appealing as it is, not the full course.

IN his hurry at the end, Mr. Ferris also tends to use much of the technical jargon of the modern-day specialties, without effectively translating their meaning into laymen's language. And while a chapter on the search for extraterrestrial intelligence is included (a topic curiously out of place), other favorite astronomical stories are missing. For instance, only one paragraph is devoted to the wonderful tale of Arno Penzias and Robert Wilson stumbling in the 1960's upon the fossil echo of the Big Bang with their radio telescope at Bell Labs, a discovery upon which most of modern cosmology is based. Even Mr. Ferris acknowledges the limitations of his chosen format. "Economy," he confesses in his preface, "is a jealous god."

However, the richness and texture of Mr. Ferris's overall presentation, especially when he is dealing with astronomy's origins and its memorable historic figures, far outweigh the book's feverish denouement. "The act of exploration alters the perspective of the explorer," he notes. A reading of "Coming of Age in the Milky Way" does likewise, transporting us from the far reaches of intergalactic space to the Lilliputian domain of subatomic particles. This trek through cosmology's archives is a splendid one indeed. □