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Cosmology and the Writer

My title sounds faintly absurd, as if to suggest that cosmology may be the central problem for the aspiring writer. It might be more useful to discuss ecology for the respiring writer, tautology for the perspiring writer, or even theology for the expiring writer. Yet I do seriously want to explore the possible relations of writers and cosmology.

For earlier modern writers, from Baudelaire and Flaubert on, science was simply the enemy. Yeats felt a "monkish hate" for it because Huxley and Tyndall deprived him of the religion of his childhood, and Allen Tate made the case against Positivism in an impassioned lifelong polemic. Few writers now would take so extreme a view; science and technology have become so central to our lives that they must be taken into account. Still, I suspect that most writers feel a lingering suspicion, hostility, or at best indifference, toward science. They feel, as writers have always felt, that, admirable as its practical results may be, science doesn't deal with what is really most important. In *Paradise Lost*, the Archangel Raphael tells Adam that instead of wondering about celestial motions, he would do better to be "lowly wise" and cultivate his garden. In *Rasselas* Dr. Johnson portrays a learned astronomer who says, piously, "To man is permitted the observation of the skies, but the practice of virtue is commanded." However, it develops that after forty years of observing the skies the astronomer has come to believe that he is responsible for controlling the weather—a kind of madness oddly anticipating the great John von Neumann's conviction that computers would enable us to predict and control the weather. (This is the same von Neumann who thought reason required the United States to make a preemptive nuclear strike on Russia.) Blake's "The atoms of Democritus / And Newton's particles of light / Are sands upon the Red Sea shore / Where Israel's tents do shine so bright" is, I take it, another expression

of relative importance: even if true, the scientific vision is not what matters most.

As everyone knows who has read Stephen Hawking's *A Brief History of Time: From the Big Bang to Black Holes* (1988)—and almost everyone seems to have read or seen or heard that phenomenal best seller—exciting discoveries about the size, age, and beginning of the universe, as well as about the nature of matter and of mind, have been made within the past few decades. A very brief summary of the main points may be useful. The Big Bang, paradigm of modern cosmology, was first given this derisive title by its principal opponent, Fred Hoyle; but the undignified name has survived respectability. The paradigm was predicted by Einstein, but he inserted a cosmological constant to keep the universe static (and later said this was his biggest mistake). The Russian Alexander Friedmann did not make this mistake, and developed a theoretical model of the expanding universe; the American astronomer Edwin Hubble observed the red shift in distant stars and produced conclusive evidence in 1929 that the universe is expanding and that ours is only one of many galaxies. Further and final confirmation from a different kind of evidence was provided in 1965 by the discovery by Penzias and Wilson of uniform microwave background radiation and the identification of it as the residue of the original explosion. When the theory was thus doubly confirmed, scientists had to take the Big Bang seriously.

That the earth is not the center even of our solar system has not been news since Copernicus. The significant new point is that the Universe is not static, but expanding; its age therefore is intertwined with its size (to put it in layman's language; both are now established at about fifteen billion years or light-years). By reversing Hubble's expanding universe, we can go back to the initial space-time singularity of infinite density and temperature, some fifteen billion years ago. Interpreting the Big Bang is a fascinating challenge to scientists because it requires bringing together the two extremes of the macroscopic or large-scale structure of the universe governed by relativity theory and the submicroscopic world of subatomic particles governed by quantum theory. Many scientists hope that research in these areas, with the aid of such devices as the Hubble space telescope and

the Superconducting Supercollider, will result in a final theory explaining the relations of the four fundamental forces and encompassing both the vast universe now dealt with by relativity theory and the unimaginably tiny realm of the quantum.

I am neither a scientist nor a science and technology groupie (one of those who believe that literature and the book culture are doomed and the future belongs to artificial intelligence, holograms, and multimedia), but an intermittent student of the history and philosophy of science. (I find it comforting, by the way, that the word "scientist" was coined as late as 1840, by analogy with the word "artist"; before that practitioners of science were called merely natural philosophers.) I am not concerned in this essay with the speculative analogies between "creativity" in art and in science. Nor am I concerned primarily with the use of science as subject-matter for poetry or fiction, though this is a fascinating and amusing topic, and I confess that since childhood I have been an occasional addict of science fiction. My interest is in what the serious novelist or poet or playwright might gain from greater awareness of the recent developments in cosmology already mentioned and in biology, specifically neuroscience, the study of the brain in its relation to the mind.

Carl Sagan says in his Introduction to Hawking's *Brief History*: "This is also a book about God . . . or perhaps about the absence of God. . . . Hawking is attempting, as he explicitly states, to understand the mind of God." Sagan is here referring to Hawking's final paragraph, which suggests that if and when this final theory is discovered, "it should in time be understandable in broad principle by everyone, not just a few scientists. Then we shall all, philosophers, scientists, and just ordinary people, be able to take part in the discussion of the question of why it is that we and the universe exist. If we find the answer to that, it would be the ultimate triumph of human reason—for then we would know the mind of God."

In "A Brief History of *A Brief History*" (*Popular Science*, August 1989), Hawking remarks that if he had deleted this last sentence, as he almost did, it would have cut the sales of the book in half. Sagan's seizing on this point in his introduction shows his instinct for what will attract the popular mind; but Hawking seems to sense that this is a kind of deception. The

book is, of course, about God only insofar as God is identified with the physical universe, or as the clockmaker "to wind up the clockwork and choose how to start if off." (Clockmaker, however, is the wrong metaphor; the Big Bang would restore to God the thunder, to say the least!) But Hawking's sentence does suggest somewhat meretriciously a reconciliation of science and religion designed to appeal to the widespread yearning and therefore the enormous market for such reconciliations.

Freeman Dyson is like Hawking in being originally English and a renowned theoretical physicist; but in temperament and outlook he is a polar opposite. As to religion, he says, "I speak for myself alone. Any statement which attempted to express a consensus of scientists about religious and philosophical questions would miss the main point. . . . The voice of science is a Babel of diverse languages and cultures. . . . Many first-rate scientists are Christians . . . many are militant atheists, many are like me, loosely attached to Christian beliefs by birth and habit but not committed to any particular dogma" (*Infinite in All Directions*, 1988). He is rather scornful of extremes on both sides: the arrogant and old-fashioned "scientific materialism" of some biologists, and the claims to infallibility of some fundamentalists and Catholics.

Specifically, Dyson believes "that we are here to some purpose, that the purpose has something to do with the future, and that it transcends altogether the limits of our present knowledge and understanding . . . If you like, you can call this transcendent purpose God. If it is God, it is a Socinian God, inherent in the universe and growing in power and knowledge as the universe unfolds. Our minds are not only expressions of its purpose but also contributions to its growth." This is much like John Wheeler's concept of a "participatory universe," in which "the evolution of subsequent observers through the act of observing the universe creates a texture of meaning which becomes the universe."

The anthropic principle (which is respectfully rejected by Hawking and embraced as meta-science by Dyson) is fully considered in *The Anthropic Cosmological Principle* (Oxford, 1986), by J.D. Barrow and F.J. Tipler. The Copernican principle that man does not occupy a privileged position in the Universe must be qualified: "our location in the Universe is

necessarily privileged to the extent of being compatible with our existence as observers." It is not true that man is unimportant in view of the enormousness of space and time: "The Universe needs to be as big as it is in order to evolve just a single carbon-based life form." The Weak Anthropic Principle shows that "the observed structure of the Universe is restricted by the fact that we are observing the structure." Its size is not random but determined by the constants of nature. "The sizes of atoms, people, and planets are not accidental, nor are they the inevitable result of natural selection." The Strong Anthropic Principle is that the "Universe must be such as to admit the creation of observers within it at some stage" (i.e., it could not have been different).

According to Barrow and Tipler, most biologists believe that man is unique, intelligence "an incredibly improbable accident," not necessarily an advantage in natural selection; only astronomers and some physicists think there is intelligent life on other planets. It is "simply untrue that there is nothing special about the epoch in which we now live . . . We have shown at length that the epoch in which we live is very special in permitting the evolution of carbon life."

Modern cosmologists have no interest in the argument from design. In the first place, evolution is a sufficient explanation; in the second, the argument from design could prove at most only that God exists, not that he has any relation to mankind. Einstein, in spite of his talk about the Old One and God not playing dice and being subtle but not malicious, was and remained a thoroughgoing atheist and determinist. ("I believe in Spinoza's God who reveals himself in the harmony of all that exists, but not in a God who concerns himself with the fate and actions of men.") The Big Bang does suggest a God with thunder, but the fundamentalists who advocate teaching Creation Science are not happy with it, because nothing after the Bang fits the biblical account. Peter Caws says, "The so-called argument from design assumes intelligent planning, and a great many people attribute to the Creator the really superior, the practically infinite intelligence that would be needed to produce the marvels that we find on all sides in the natural world. But consider where we get the idea of intelligence: the only cases of it we know, in full-fledged form, occur among

human beings with functioning brains, and there is plenty of evidence that the intelligence really is linked to the brain. . . . " If intelligence depends on the existence of the brain, we can hardly say that the emergence of the brain depended on intelligence.

James Trefil, in a different way, demystifies the notion of "creation": "as seen by modern physicists, matter is just one more form of energy, a form which can be shifted around at will. Seen in this light, the creation of the universe is no more miraculous than the operation of an ordinary nuclear reactor. Both are just examples of the basic equivalence of matter and energy." At first, "the universe was a vacuum full of evanescent matter. Then, quite by accident, enough fluctuations occurred close enough together to trigger the process by which energy is drained from the gravitational field, and the process of runaway inflation started. . . . When the period of inflation was over, the Big Bang had begun and, as they say, the rest is history." He quotes another physicist as saying, "'The universe is simply one of those things that happen from time to time'" (*Reading the Mind of God*, 1989).

What has cosmology meant to aspiring writers in the past? How important has it been to them? While a systematic survey would be tedious, it may be worthwhile to look at a few examples. The Presocratics remind us that it was once possible to be simultaneously scientists, philosophers, and poets: T.S. Eliot was inspired by them, as were D. H. Lawrence, Allen Tate, and many others. Gerald Edelman takes his title from Empedocles for his latest book, *Bright Air, Brilliant Fire: On the Nature of the Mind* (1992).

Lucretius was, after the Presocratics, the first and greatest poet of cosmology. Though Lucretius was not much interested in science for its own sake, and expounded the doctrine of Epicurus, who was himself more philosopher than scientist, both used the atomic theory of Leucippus and Democritus as a scientific basis. Actually, Lucretius is not much concerned with the details of cosmology; his central points are that there is nothing out there but atoms and the void, and that eclipses are natural phenomena, not supernatural omens. While the gods do exist, they are not visible and have nothing to do with the

heavenly bodies or with human beings. There must be, he thinks, many inhabited worlds; earth and man are not unique.

He is a great advocate of science because he believes with total conviction that his gospel of scientific materialism will banish "this terror then, this darkness of the mind": fear of death and what lies after it: eternal punishment, hell, ghosts, the unknown. So he proclaims with passion that all passion is bad and that religion is the chief source of man's unhappiness (the reverse, we note, of the modern notion of religion as consolation). He sets out to prove that there is absolutely nothing out there but atoms and the void: no ghosts or spirits or gods (or rather, the gods do exist, but are completely indifferent to man).

Dante's cosmos is Ptolemaic, but traditionally and theologically symbolic. From earth (with Hell at the center) we rise through water, air, and fire to the three infrasolar spheres of the Moon, Mercury, and Venus, representing inconstancy, ambition, and love, imperfect versions of the theological virtues of faith, hope, and charity, imperfect because in the shadow of the earth. After the Sun we encounter Mars, Jupiter, and Saturn, representing the cardinal virtues of fortitude, justice, and temperance. Then come the fixed stars, representing the Church Triumphant, the Crystalline or Primum Mobile, representing the angelic orders, and the Empyrean, which contains the Trinity, the Virgin, angels, and saints, but is really beyond space and time, and is where all the spirits really are.

Milton's universe is similar, but looser and not static; it is not complete to begin with, but much of it is under construction during *Paradise Lost*, in response to events in the poem. Hell is prepared for the fallen angels as they fall; they build Pandaemonium for themselves. When Satan flies to the newly-created World (Milton's term for the whole Ptolemaic cosmos), he sees it hanging by a golden chain from Heaven, which is in size like the moon compared to the smallest star. Satan travels through the traditional Ptolemaic spheres of the World to reach Earth at its center. Later, Adam inquiring of celestial motions is given a lecture by Raphael explaining why the Earth, though smallest and farthest from Heaven, may nevertheless be the most important of these bodies. The archangel then advises Adam to concern himself with more important things; it doesn't really

matter, he says, whether the Sun or the Earth is center. (He does, however, remark that the Ptolemaic cycles and epicycles are needlessly complicated, and gives a broad hint that the Copernican theory may well be true: "What if the sun / Be center to the World, and other stars / By his attractive virtue and their own / Incited, dance about him various rounds?") After Adam and Eve sin, Sin and Death build a broad causeway from Hell through Chaos to the World.

The doctrine opposite to Lucretius', that the design of the universe proves the existence of a Designer, is exemplified by Addison's ode, "The spacious firmament on high," with its thesis that the heavenly bodies proclaim "The hand that made us is divine." But even in Addison's day, the contemplation of the Newtonian cosmos often led—as in Pope's Essay on Man—to minimally consoling thoughts: yes, the design proves the existence of a designer, but not that the designer cares anything for man. The clockmaker god can't intervene in his clockwork. The worst error of human pride, Pope says, is to think the universe made for man, or his world the only one or the most important. Like many other theodicies, Pope's Essay on Man denounces anthropocentrism as the worst manifestation of human pride, an attempt to upset divine order by breaking the great chain of being.

The most effective poetic uses of cosmology in later poetry have been based on images derived from Dante or Milton. For example, George Meredith's great sonnet, "Lucifer in Starlight," which revives Milton's Satan, restores him to his prelapsarian status as Lucifer, and launches him on a flight around the modern world: "On a starred night Prince Lucifer uprose. / Tired of his dark dominion swung the fiend / Above the rolling ball in cloud part screened, / Where sinners hugged their spectre of repose." But he is defeated by the laws of modern science: "He reached the middle height, and at the stars, / Which are the brain of heaven, he looked, and sank. / Around the ancient track marched, rank on rank, / The army of unalterable law."

Similarly, William Empson (who took a Cambridge First in Mathematics as well as in English—surely the only poet who ever did so?), evokes the Dantean cosmos in "Legal Fiction," fusing it with modern real estate law: "Law makes long spokes

of the short stakes of men . . . / Your rights extend under and above your claim / Without bound; you own land in Heaven and Hell; . . . / Your rights reach down where all owners meet, in Hell's / Pointed exclusive conclave, at earth's centre / . . . And up, through galaxies, a growing sector. / . . . the lighthouse beam you own / Flashes, like Lucifer, through the firmament. / Earth's axis varies, your dark central cone / Wavers, a candle's shadow, at the end."

Empson's "To an Old Lady" may well be the only good poem based on astronomy (more or less modern in this case), and specifically on the possibility of space flight to another inhabited planet of the solar system (it would have to be specifically Mars). The old lady, who appears to be a relative of the poet, lives in another, older, world of time, customs and manners; it may be observed but not invaded. "Ripeness is all; her in her cooling planet / Revere; do not presume to think her wasted. / Project her no projectile, plan nor man it. . . . / Our earth alone given no name of god / Gives, too, no hold for such a leap to aid her; . . . / No, to your telescope; spy out the land; / Watch while her ritual is still to see, ... / Stars how much further from me fill my night, / Strange that she too should be inaccessible, / Who shares my sun. He curtains her from sight, / And but in darkness is she visible."

Empson's "The World's End" is one of the few successful poems about Relativity, contrasting its cosmos with the Miltonic and with extravagant Romantic imagery: "'Fly with me then to all's and the world's end / And plumb for safety down the gaps of stars' . . . / Alas, how hope for freedom, no bars bind; / Space is like earth, rounded, a padded cell; / Plumb the stars' depth, your lead bumps you behind; / Blind Satan's voice rattled the whole of Hell. / . . . Apple of knowledge and forgetful mere / From Tantalus too differential bend. / The shadow clings. The world's end is here. / This place's curvature precludes its end."

Most other poems about Einsteinian space are essentially jokes, like Cummings' "Space being (don't forget to remember) Curved / (and that reminds me who said o yes Frost / Something there is which isn't fond of walls) / an electromagnetic (now I've lost / the) Einstein expanded Newton's law preserved / conTinuum (but we read that beFore) of Course life being just Reflex you / know since Everything is Relative or / to sum it All Up god

being Dead (not to / mention inTerred) / LONG LIVE that UPwardlooking / Serene Illustrious and Beatific / Lord of Creation, MAN: . . . ." MacLeish's "The End of the World" is similarly a joke, if a grim one: in the middle of the circus "Quite unexpectedly the top blew off: / And there, there overhead, there, there, hung over / Those thousands of white faces, those dazed eyes, / There in the starless dark the poise, the hover, / There with vast wings across the canceled skies, / There in the sudden blackness the black pall / Of nothing, nothing, nothing—nothing at all."

Yeats is the only poet whose use of astrology has been really effective; this is so because he believed in it deeply, and his belief gives a magical power to poems about time and myth, such as "Leda," "The Second Coming," and many others. The astrological meanings are not explicit, but submarine, just below the surface; the reader does not have to be aware of them to get the effect of mingled fear and exultation: that vast and mysterious significances are in question, events of tremendous importance are happening.

Other visionary poets, like James Dickey in *The Zodiac*, affirm the ultimate analogy, or identity, of the poetic imagination and the divine power that created the stars; but for them, too, the astrological zodiac offers much better imagery for the purpose than scientific cosmology. Dickey also wrote a good poem on the Apollo moon-landings, again using mainly classical mythology.

Refusing to be intimidated by traditional sublimity, Auden could say cheerfully, "Looking up at the stars, I know quite well / That for all they care, I can go to hell," and Robert Penn Warren that the stars are "only a backdrop for / The human condition" and the sky "has murder in the eye, and I / Have murder in the heart, for I / Am only human. We look at each other, the sky and I. / We understand each other."

Robert Pack in his poems based on the books of Heinz Pagels, *Before it Vanishes, A Packet for Professor Pagels* (1989), suggests an implicit comparison to Dante. Pack usually imagines Pagels as a kind of guide-companion, like Virgil to Dante, or as a friend (like Lucretius' Memmius) whom he is addressing; but the tone is mostly comic. Pack's book prefaces each poem by a quotation from Pagels: the poem then tells a story or presents a scene that

parallels or contrasts to the passage from Pagels. The plan is brilliant, but, except for the dramatic ending when Pack bids farewell to Pagels, who has fulfilled his own premonition of falling to his death while mountain-climbing, the poems tend to be no more than pleasant or mildly amusing.

So what use can modern cosmology be to poets? Most poems inspired by it, aside from some of those mentioned, tend to be essentially jokes or light verse at best. The Big Bang is unimaginable, as is quantum reality; they can be represented only in numbers and mathematical structures. Astronomical distances—light-years, parsecs, astronomical units—are beyond the human scale; we cannot really imagine them. The only cosmologies that work for the human imagination are symbolic, and the greatest are those of Dante and Milton; later poets have been most effective when they have alluded to or played off these in some manner.

What, then, have the new discoveries in cosmology to offer the aspiring fiction writer? Not much more than they offer the poet, I fear. No one, to my knowledge, has written well about the Big Bang, Black Holes (though the concept of total negation swallowing even light would seem to have interesting metaphorical possibilities), Cold Dark Matter, the Inflationary Universe; nor, on the other hand, about the submicroscopic world of quantum reality. It is hard to see how anyone could. Both these extremes are beyond the human imagination; it is probably a mistake even to try to imagine them. As Caws puts it, "Everything we have learned about science suggests that away from the normal macroscopic center of things we can't form a perceptual model of it at all. We have grown up in what I call the 'flat region'—and we need to go off into space . . . to conclude that it is round. So in the direction of the very large, the very fast, the very distant, the very small, we can only have mathematical models of how it really is."

Certain other areas of science, such as biology and physiology, have much more promise: they can be used in what is perhaps the basic enterprise of most serious science fiction: defining the human. The assumption of many advocates of Artificial Intelligence that the mind is nothing more than a computer, and hence that computers can eventually become intelligent and conscious in the same sense as human beings,

has been the basis of much entertaining SF. But recent studies of the brain such as those of Gerald Edelman and narrative case histories like those of Oliver Sacks have shown just how different the human brain is from a computer. At the same time that they eliminate scores of robots, androids, and superhuman computers from the possibilities of fiction, these books should be stimulating to good writers. They make clear how individual and far from mechanical human memory and perception are; as natural products of evolution, the brain and mind belong to biology rather than to physics.

The older naturalism that was the most obvious effect of a "scientific" viewpoint and dominated such novelists as Hardy, Zola, and Dreiser tended to produce a picture of human life that might be drab and depressing, but was at least solid and realistic. The alarming trend now is the opposite: in pop culture unrestricted fantasy seems all the rage, as in Broadway musicals, TV shows like "Quantum Leap" and films like *Back to the Future*, and innumerable movies about minds transposed between children and adults or men and women. Apparently pop-psych books encouraging sexual fantasy as a good thing, South American magic realism, comic books and animated cartoons, and the ever-expanding technical possibilities of movies and TV have contributed to this phenomenon; but the basic source seems to be a vague notion in the popular mind that relativity and quantum theory, together with the uncertainty principle and speculation about alternative universes and time travel, have made it impossible to tell what is real. Tributaries like New Age thought, the mysterious East, and UFOs all flow into this river, where the Dancing Wu Li Masters practice the Tao of Physics and quantum healing takes care of health. All this might seem to be harmless liberation of the child within us, but what it tends to produce, both in visual media and in fiction, is an increasing reliance on spectacular special effects to get and retain the audience's attention.

The fact is what it has always been: that nothing in a story is interesting for more than a casual moment unless the audience believes it, unless the characters are recognizably like us in essential ways and their predicaments, desires, loves and hates can be related to our own. Fantasy must be limited: if there are no limits to the strange powers of Superman or telepaths or

omnipotent aliens, there are no rules to the game and therefore no interest (at least to those beyond the age of six). A sense of reality, a suspension of disbelief, is as necessary as ever to producing a successful narrative: not gritty realism or depressing naturalism, necessarily, but a sense that the characters are people like us in situations we might conceivably be in. Otherwise, the reader cannot identify with the character.

Science, then, might help the fiction writer define the limits of imaginable reality and of the human as opposed to imaginable other forms of life. It may be immensely stimulating to the imagination. It might also improve his sense of fact, though the example of Thomas Pynchon makes this somewhat dubious: Pynchon's considerable knowledge of science does not prevent him from constantly blurring the line between fictional reality and fantasy, a blurring which reaches an extreme in his latest novel, *Vineland*. In *Gravity's Rainbow* (1973), Pynchon made the most impressive use of science and technology that any recent novelist has achieved—not primarily cosmology, perhaps, but involving concepts like entropy and relativity, as the title suggests. As with such other novelists as Don DeLillo, however, Pynchon's obsession with paranoiac conspiracies prevents any sharp definition of reality.

But science is fictionally workable in such novels as Michael Crichton's *Jurassic Park*, where genetics, biology and paleontology provide a means that is just barely possible theoretically (cloning from DNA found in the blood of fossilized mosquitoes preserved in amber to resurrect dinosaurs and other creatures of the Jurassic era) to make an interesting novel of suspense and contemporary social satire (wicked scientists, unscrupulous entrepreneurs who wish to profit from the greatest of all theme parks). Alan Lightman's *Einstein's Dreams* has, somewhat surprisingly, become a best seller; it is a well-informed fantasy based on Einstein's biography, imagining dreams Einstein might have had based on his theories of time and conversations he might have had with his friend Besso. But it isn't really a novel at all.

Perhaps the best SF novel yet written is Ursula Le Guin's *The Dispossessed*, which involves cosmology only insofar as it is set on an earth-like planet with an inhabited moon—inhabited by all the idealistic radicals who have been exiled there. It is a fine

novel, but the science is primarily anthropology, sociology, and politics. Carl Sagan's recent novel, *Contact*, is about contact with extra-terrestrials through wormholes (theoretically barely conceivable), and Richard Powers' *The Gold Bug Variations* (1991), is a brilliant novel about a scientist and more centrally about science itself. It deals mainly with the discovery of the genetic code; its characters are a female reference librarian, a male molecular biologist who did early research on DNA, his female lover, and a dilatory young male art historian. The real subject, however, is the four-part structure of everything from the intertwining two couples to Bach fugues to the double helix of DNA and the four-part harmony of the universe.

Stephen Weinberg's notion of a final theory, justifying the need for a Superconducting Supercollider, is almost as arrogant as Hawking's assertion that final theory would reveal the Mind of God. Weinberg, in an editorial in the *New York Times*, professes exactly the same aim as Lucretius: final theory would banish such superstitions as Astrology and Creationism. But Weinberg also makes the sweeping statement that science provides the only truth man can attain, so should be sought for its own sake. No one nowadays would deny the immense importance of science and technology in our daily lives nor the impossibility of understanding the modern world without understanding them; but the claim of exclusive validity for scientific truth is fortunately now rather unusual.

The greatest physicists have had no delusions of omniscience. Newton described himself as "like a boy playing on the sea shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, while the great ocean of truth lay all undiscovered before me." Einstein said, "Out yonder there was this huge world, which exists independently of us human beings and which stands before us like a great, eternal riddle, at least partially accessible to our inspection and thinking."

As Peter Caws says, "It is not so much that a Newtonian paradigm has been displaced by an Einsteinian one . . .—indeed, Newton *hasn't* been displaced, except at the remote fringes of conceptual possibility—it's rather that Newton never covered even his own domain in the way Laplace thought. Newton could give a complete account of how two massive

bodies would interact in an otherwise empty universe, and the whole success of Newtonian science has consisted in pretending that real events can be represented as aggregates of independent pairwise interactions. . . . But Newton couldn't, and science still can't, give a complete account of how *three* massive bodies would interact, even in an otherwise empty universe.

"If science can't even solve the three-body problem in mechanics, its most elementary branch, how can anyone ever have thought that it could mirror the whole of nature? . . . The assumption that total discursive adequacy was what science claimed (rather than being what some immoderate scientists and their admirers claimed) has obscured the genuine lesson that science has to teach" (*Yorick's World*, 1993).

It is worth noting that, though the assertion has been made often and confidently for more than three centuries that there are many planets orbiting other suns, no planet outside our solar system has yet been detected; the unseen companion of Barnard's Star is the best candidate so far. The appropriately named Hubble space telescope that is now in orbit will, it is hoped, eventually settle the question. It is also worth noting that, though QED is the most successful branch of modern physics in that it is the basis of accurate prediction and operation—it is the basis of the whole electronics industry, among many other things—nobody really understands it.

For me, at least, SF has lost most of its attraction as its favorite themes have been ruled out as contrary to fact: it is now definite that no intelligent life exists in our solar system, and no planet, much less a habitable one, has been discovered yet anywhere else. If any are discovered they will certainly be too distant for any communication other than radio. UFOs unfortunately do not exist. The strong probability, like it or not, is that man is unique in the universe. So the central theme of much SF—encounter with alien life-forms—is no longer plausible. As James Trefil and Robert Rood say in their fascinating debate, *Are We Alone?* (1981): "Since the Copernican revolution the main thrust of science has been to make the assumption of mediocrity seem more and more reasonable. The earth is not at the center of the universe, but revolves around the sun. The sun is a single star in a galaxy of ten billion stars, and the galaxy itself is only one of millions in the universe. Darwin showed us

that humanity has been created in the same way as other animals, and Freud showed us that there is more of the primitive in our nature than we might have thought. It seemed that the more we learned about ourselves, the less special we became.

"Now, for the first time in five hundred years, things seem to be going the other way. During the past two decades, the more we have learned, the more we can see the earth as something special." The earth is a planet in the system of a single G star; is in the narrow band about that single G star where water will neither boil nor freeze for the billions of years necessary to produce life; has a large moon, which means there are large and variable tides, leading to numerous tidal pools; and the tilt of the earth's axis is just enough so that, in conjunction with the influence of the other planets, periodic changes in the climate occur. "Although the probability of any one of these features being present on a planet may not be impossibly small, the probability that all four will be present at the same time is. So maybe the earth *is* special, after all." On this particular bit of rock, circling this particular sun, "all of the millions of factors happened to work themselves out so that the first fragile molecules had enough time to form complicated chains, and these chains were given just the right amount of protection to form single living systems, and these living systems changed their environment in just the right way so as to narrowly escape twin catastrophes and put oxygen into the atmosphere. This in turn allowed life to emerge onto land, and since the planet's orbit was just right, the weather changed, forcing the apelike creatures on the African savannah to build tools, fashion shelters, and start to think about the world around them."

"If I were a religious man," concludes Trefil, "I would say that everything we have learned about life in the past twenty years shows that we are unique, and therefore special in God's sight. Instead I shall say that what we have learned shows that it matters a great deal what happens to us. We are not the snail darters of the galaxy—one more life form whose ultimate fate is of little moment in the grand scheme of things. If we succeed in destroying ourselves, it will be a tragedy not only for the human race but for the entire galaxy, which will have lost the

fruit of a fifteen-billion-year experiment in the formation of sentient life."

Writers can learn more about human nature from such humane scientists as these, and perhaps have their consciousnesses expanded by awareness of the new cosmology. But if what finally emerges is that man and his earth are unique in the universe, this is no surprise. Writers have always known that man (and woman) are unique on this earth. We share much, but not everything, with the animals; what writers have always explored with most fascination is what is not shared.

Auden mythologized the human realm as that of Clio, Muse of History, overlapping with but distinct from the realm of Dame Kind, or Mother Nature. In the light of this distinction, Hawking's title—*A Brief History of Time*—is a misnomer: time, in the cosmological sense, has no history; history pertains only to what has human significance. The Big Bang is noise, part of nature; what is peculiarly human is language or silence. Awareness of recent cosmology, then, may be of some help to the aspiring writer in his central enterprise of exploring what it is to be human and defining the boundaries of his unique domain.