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978-0-521-78303-3 - Carl Sagan's Cosmic Connection: An Extraterrestrial Perspective

Carl Sagan

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Carl Sagan's Cosmic Connection

In 1973, Carl Sagan published *The Cosmic Connection*, a daring view of the universe that rapidly became a classic work of popular science and inspired a generation of scientists and enthusiasts. This seminal work is reproduced here for a whole new generation to enjoy. In Sagan's, typically lucid, lyrical style, he discusses many topics, from astrophysics and Solar System science, to colonization of other worlds, terraforming, and the search for extraterrestrials. He conveys his own excitement and wonder, and relates the revelations of astronomy to the most profound human problems and concerns: issues that are just as valid today as they were thirty years ago.

New to this edition are Freeman Dyson's comments on Sagan's vision and on the importance of this work, Ann Druyan's assessment of Sagan's cultural significance as a champion of science, and David Morrison's discussion of the advances made since 1973 and what became of Sagan's predictions.

CARL SAGAN was David Duncan Professor of Astronomy and Space Sciences and Director of the Laboratory for Planetary Studies at Cornell University. He played a leading role in the Mariner, Viking, and Voyager missions to the planets and briefed Apollo astronauts before their flights to the Moon. He helped to solve many mysteries in planetary science, from the high temperatures of Venus to the seasonal changes on Mars. For his unique contributions, he was awarded NASA medals for Exceptional Scientific Achievement and for Distinguished Public Service (twice), as well as the Tsiolkovsky Medal of the Soviet Cosmonautics Federation, the John F. Kennedy Award of the American Astronautical Society, and the Arthur C. Clarke Award for Space Education.

The *Cosmic Connection* was winner of the John W. Campbell Memorial Award for the best science book of the year, and Dr. Sagan was winner of the Klumpke–Roberts Prize, Astronomical Society of the Pacific, for the popularization of astronomy. Among Dr. Sagan's many other books are *The Pale Blue Dot*, *Comet* (co-written with Ann Druyan), *Contact*, *Shadows of Forgotten Ancestors* (co-written with Ann Druyan) and *The Dragons of Eden*, for which he was awarded the Pulitzer Prize. His Emmy- and Peabody-award-winning television series, *Cosmos*, has been seen by over five-hundred million people in more than sixty countries, and the accompanying book, also titled *Cosmos*, became the best-selling science book ever published in the English language.

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Carl Sagan's Cosmic Connection

An Extraterrestrial Perspective

Carl Sagan

produced by Jerome Agel

New contributions by
Freeman Dyson, Ann Druyan,
and David Morrison



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For Dorion, Jeremy, and Nicholas, my sons.
May their future—and the future of all human
and other beings—be bright with promise.

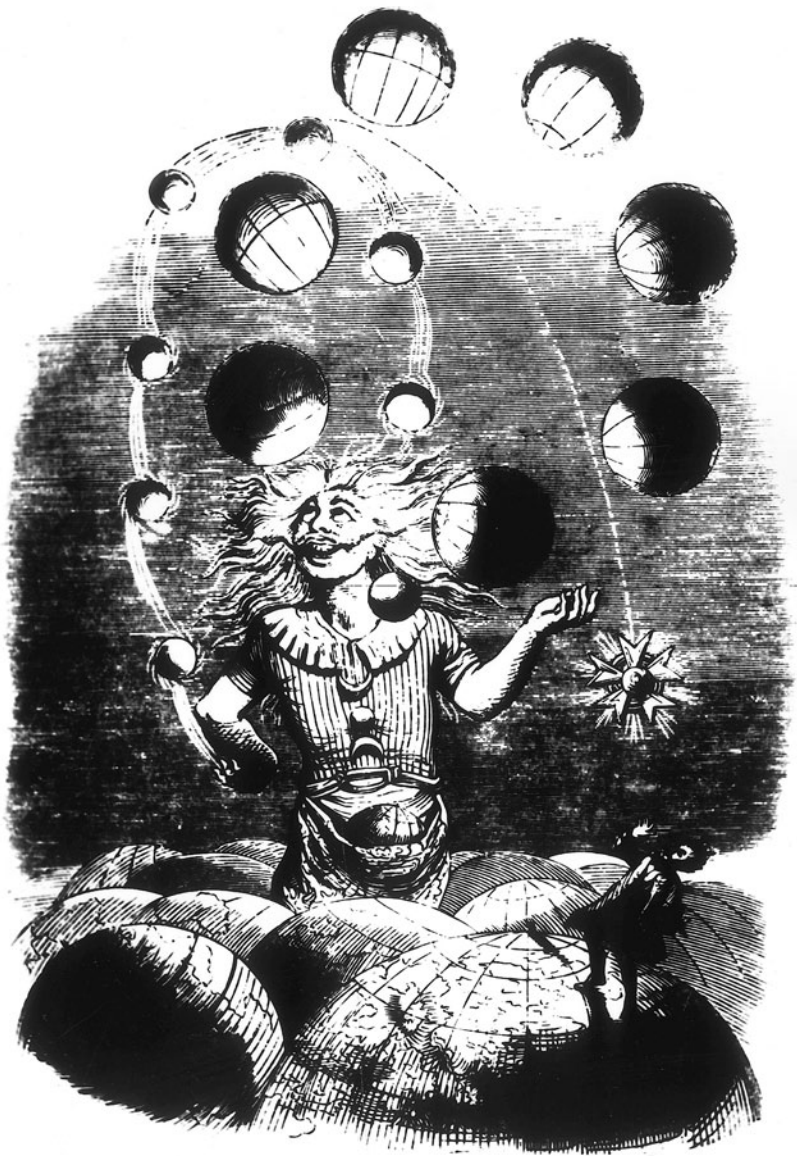
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"Les Mystères des Infinis" by Grandville, 1844.

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Foreword

Freeman J. Dyson, *Institute for Advanced Study, Princeton,
New Jersey*

I remember Carl Sagan telling with great gusto how he wrote his Pulitzer Prize-book, *The Dragons of Eden*. He had a publisher's deadline to write the book and a producer's deadline to do a film in Hollywood, and he had promised his family a trip across the United States, so he decided to kill three birds with one stone. He put the kids in the back of the car, put a tape-recorder in the front, and drove from Ithaca to Hollywood dictating as he went. He was speaking the last words of the book into the recorder as they arrived in Hollywood. This story may not be literally true, but to anyone who knew Carl it is quite plausible. Carl had an amazing fluency with words, an accurate memory, and sublime self-confidence. He was capable of composing a lucid and well-organized book on an unfamiliar subject in four days of driving, just as Mozart was capable of composing the overture of *Don Giovanni* while travelling in a coach two days before the first performance. Carl never claimed to be an artist comparable with Mozart, but he shared many of Mozart's qualities. He had personal charm, technical brilliance, and a robust sense of humor masking his underlying seriousness.

In the preface to this book, Carl says it was also partly composed in his car during a trip across the continent. Evidently the wide open spaces of America stimulated Carl's imagination. The book is full of anecdotes and digressions, but it has a serious underlying theme. The theme is Carl's vision of human space-explorers venturing out into the universe, following the great tradition of the sailors who ventured out into the oceans and began to explore the continents of this planet five hundred years earlier. But Carl was not only a romantic visionary; he was also a professional scientist. His professional life was devoted to understanding the planets with the tools of modern science. He knew

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that the acquisition of scientific knowledge about the planets must be done with robotic instruments before human explorers could make a useful contribution. He played a large role in the planning and execution of robotic missions to Mars and the other planets. His studies of the planets were solidly based in science, yet he was aware that science is not the main driving force of space exploration. Just as the terrestrial explorers in the fifteenth and sixteenth centuries were not much concerned with science, so Carl saw the outward movement of humans from this planet as an enterprise with wider aims than science. His vision, which he communicated in popular writings and in incomparable television performances, was space-exploring as a human adventure. He succeeded, more than anyone else of his generation, in giving science a human face. He saw the cosmic connection as an enlargement of the human spirit. He wanted everyone on Earth, not only the scientific elite, to feel connected with the cosmos.

Carl's vision as recorded in this book had two aspects, the long-range and the short-range. The long-range aspect was the awakening of mankind to an awareness of the majesty of the cosmos and the possibility of extraterrestrial life. The short-range aspect was a program of human activities in space to be pursued during the last three decades of the twentieth century. The book gives roughly equal emphasis to the two parts of the vision. But the outcomes for the two parts of the vision have been very different, as events over the twenty-seven years since the book was published show. The long-range part of the vision has been magnificently fulfilled, while the short-range part has failed miserably.

Carl intended this book to be read by two kinds of readers, those who already shared his vision and those who did not. His main purpose was to reach out and persuade the skeptics. If we who believe in the vision are to persuade the skeptics, it is important that we face honestly the fact that the short-range part of the vision failed. The believers must admit and understand the failure of the short-range vision, so that this failure will not cause the skeptics to reject the long-range vision. We

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must explain what went wrong, why the short-range vision failed, and why the long-range vision is still valid.

The main reason why Carl's short-range vision failed was that he put too much trust in fallible human institutions. He served three masters, NASA, Hollywood, and science, and believed that he could keep them working harmoniously together. He recognized no conflict between scientific integrity and political expediency. NASA would provide opportunities for human explorers to travel far and wide; Hollywood would educate the public; astronomers and planetary scientists would understand the cosmos; Carl would be a leader and guide in all three enterprises. He expected (see Chapter 23) international manned expeditions to the planets and self-sustaining colonies on the Moon before the end of the century. He expected at least one large telescope to be built and dedicated to a full-time search for extraterrestrial civilizations. The end of the twentieth century has now come and gone. There are no colonies on the Moon and no manned expeditions to planets. The dream of a rapid expansion of human voyages into the cosmos has faded. The International Space Station falls ludicrously short of Carl's expectations for a pioneering space venture. It is merely revolving in a low orbit around the Earth. It is a welfare program for the American and Russian aerospace industries, driven by mundane politics rather than by visions of cosmic connections.

Early in the history of the space station, I shared with Carl an unhappy experience. We were both members of a committee advising the Office of Technology Assessment (OTA), which was an organization supposed to provide technical advice to the US Congress. The committee met three days to assess the scientific value of the proposed space station. We met in idyllic surroundings. If my memory is accurate, we met at Airlie House, in Virginia, a country estate converted into a conference center where private discussions could be held. We listened while experts from NASA and the aerospace industry described forty-eight scientific experiments that they proposed to do on the space station. After the experts departed, the committee debated the

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merits of the experiments. We decided that forty-six of the experiments could be done better without the space station, for a variety of reasons. Two of the experiments were studying the effects on human physiology of living on the space station. These were the only experiments that could not be done more conveniently or more accurately or more cheaply without the space station. We concluded that the scientific justification for the space station was illusory. On the last afternoon of the meeting, we began drafting a report summarizing our conclusions. But at that point, one of the OTA staff members who had organized the meeting intervened. He said, "I am sorry, you don't understand. You don't get to write the report. We get to write the report." He thanked us for our services and adjourned the meeting. Later, we learned that the OTA staff had sent a report to Congress expressing conclusions directly contrary to ours. Meanwhile, Congress had voted, and the space station program was approved.

Carl's disappointments in his dealings with NASA and Hollywood were like Mozart's disappointments in his dealings with the Archbishop of Salzburg and the Emperor of Austria. Carl and Mozart were creative spirits, both dependent on patrons, both impatient with the formalities that patronage demands; both took it for granted that the patron should continue to give them unqualified support. To both, it came as a bitter disappointment when the patron withdrew support or imposed conditions that limited freedom.

Nevertheless, at the same time as Carl's short-range visions were frustrated, his long-range vision thrived. He founded and led the Planetary Society, bringing scientists and ordinary citizens together to promote the long-range goals of exploration and education. The Planetary Society became a powerful voice in Washington, giving political support to publicly funded space missions. It also became an important source of money for privately funded observations searching for extraterrestrial intelligence. For three decades, Carl was the preeminent voice of science speaking to the broad public. In television shows and films and books, he used his gifts as a performer to dramatize the excitement of exploring and the joy of discovery. He was a great

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preacher. He knew how to spice his gospel of cosmic connection with stories and jokes so that he did not seem to be preaching. His audiences came to his performances to be entertained and went away converted.

Toward the end of his life, Carl won an important battle with NASA. He persuaded the space agency to turn the camera on one of the Voyager spacecraft back toward Earth, after it had finished its examination of the outer planets and was speeding away from the solar system, far beyond Neptune. The camera was turned back as Carl had requested, and took a picture of Earth from the depths of space. The picture was transmitted by radio to receivers on Earth and carefully reconstructed. Earth appears as a barely visible pale blue dot in front of a background of distant stars. The image of Earth as a pale blue dot became an important part of Carl's message. Carl used it as a theme of television programs and as the title of a book. The pale blue dot is a symbol of the smallness and the fragility of our planet in the immensity of the Universe. This little dot contains the whole of human history, all our passions and struggles and loves and hates. With that picture, Carl made clear to all mankind the smallness of the squabbles that currently divide us and the greatness of the destiny that may one day unite us. *That* is the long-range vision that Carl proclaimed.

This book is a record of short-range visions that failed and of long-range visions that remain alive. It records the dreams of a young man at a particular moment in history. It is a monument to a great man who succeeded, in spite of failures and disappointments, in changing our view of our planet, changing the way we think about the universe.

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Carl Sagan: A New Sense of the Sacred

Ann Druyan

Every one of us is, in the cosmic perspective, precious. If a human disagrees with you, let him live. In a hundred billion galaxies you will not find another.

Carl Sagan, *Cosmos*

Join me in my mind's eye for a scene I have imagined many times. We are floating down past the sooty rooftops of the Bensonhurst section of Brooklyn in the spring of 1941. As we descend, the express train from Manhattan shocks us with its Doppler roar, barreling past us along the elevated tracks that doom broad 86th Street below to perpetual shadow. Among the sidewalk tumult of shoppers and peddlers, we find a slender woman striding purposefully with a young boy firmly in hand. She is dressed in an inexpensive but stylish outfit, impeccably coordinated gloves, hat, shoes and matching purse; the sole perquisite of her husband's hand to mouth pattern cutting job in the ladies garment industry. She holds herself high; her expression, implacable. This is the face etched by her father's cruelty and the death of her mother when she was only two. It's the face she wears with everyone but her husband and this boy. It's her dare to the world to get in her way.

She clutches the hand of her seven-year-old son, who, though tall for his age, is having a hard time keeping up with her. Why are we following them? They are so completely ordinary. Not just to us, but to everyone around them. No money in the bank; no status; no connections. The multitude they move among pays them no attention, unaware that this day these two are setting forth on a cosmic journey. It will traverse an incomprehensible expanse of space and time, impacting events on this world and others. Even at our remove of sixty

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years in the future, we know only slightly more than the unconscious bystanders of Bensonhurst that afternoon. The ultimate consequences of the journey begun this day may not unfold for a billion years, possibly culminating somewhere far, far away, in another part of the galaxy, with the decryption of a message found aboard an ancient derelict spacecraft by beings exotic beyond all imagining . . .

And it all begins with a question posed by the boy: What are the stars? He asks his parents and anyone who might possibly know. The family and friends want to help; they can't. They can offer nothing more satisfying than "they're lights in the sky, kid". The boy wants to know what they really are. His mother has virtually no formal education, but she is a reader and she loves him madly, so they set out on their quest.

We follow them up the steps of the Brooklyn Public Library and inside. Standing before the librarian's desk, the boy turns to his mother, hoping she will speak for him. She gives him a look that tells him he must find his own words. He has a severe facial tic with a complex but unvarying routine. He has to wait it out before finally stammering a request for a book on the stars. The librarian nods knowingly and disappears. She returns with a book on Hollywood. Momentarily stymied, he recovers and explains that he means the stars in the sky . . .

Fade to the blackness of the vast interstellar ocean. Out of the darkness, a delicate, spindly Voyager spacecraft, moving at 38,000 miles per hour, zips by us on its beeline to a billion years from now. This far from home, there is no sunlight to dazzle off the golden disc that protects its precious cargo of music, images, emotions, ideas; a trove of earthly culture. From out here, the Sun looks exactly like what it really is, just another star.

* * *

His was no idle, detached curiosity. It had little in common with the abstract, platonic diversions favored by the gentlemen of the academy. For Carl Sagan, it was the permanently revolutionary method of science, with its systematic and unblinking questioning of authority

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and dispassionate testing of all hypotheses, that promised the greatest prize of all – a deeper understanding of who, what, when and where we are in space and time. He wanted to know the cosmos as it really was. He was completely free of the spiritual narcissism that demanded a central place in the universe for him and his kind. (Indeed, to get some idea of how advanced he was in this regard, see under “Chauvinism” in the index of this book.)

If science was resented by some for devastating our species’ self-esteem, then our civilization, he reasoned, would only be as healthy as our capacity to come to grips with our actual circumstances. There could be no comfort in clinging to childhood fantasies of centrality. To him, the fact that we *did* science was a hopeful sign that we were ready to attain some maturity as a species.

Of equal importance was his conviction that the dream of a democratic civilization dependent on science and high technology, was absent widespread scientific literacy, hollow. He held that this was also a prescription for disaster. Science and high technology were penetrating the fine structures of nature and taking us to other worlds. Would we stand back, he wondered, clueless and powerless, as these ancient sanctuaries were sacked for the short-term interests of the few? Global public science literacy could not come a moment too soon. His adult life was a relentless forty-year campaign of scientific research and public education to demystify scientific processes and insights.

He wanted to tear down the walls that separated science from society, knowing that both communities would benefit as a result. He respected the public and believed that if what science did were widely understood, support for science education and research would grow. The public reacted with enthusiasm. The scientific community was ambivalent.

The Roman Catholic Church, a famously rigid hierarchical structure, requiring unquestioning adherence to its orthodoxies, recognized in the 1960s that if it were to survive, it had to conduct its rites in the spoken language of the people. How ironic that the scientific com-

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munity, the most powerful, explicitly anti-authoritarian, engine of radical change the world has ever known, was, even thirty years later, still punishing members of its own priesthood who would divulge its mysteries to the uninitiated. The very word "popularizer" is redolent with contempt and tellingly there is no other word I know of besides the non-specifically scientific "educator" or "communicator."

To get an idea of just how deep this anti-democratic bias runs, let's do a thought experiment. Professor "X" was generally acknowledged as a pioneer in more than one area of scientific investigation, published five hundred papers in scientific journals (including thirty-seven in *Science* and thirty in *Nature*), and consistently played a leading scientific role over four decades in NASA's spacecraft exploration of the solar system. All this while directing a university laboratory and editing an international scientific journal. During this same period he taught at some of the most respected universities on the planet. Many of his former students are among the most distinguished space scientists of this generation. The question is: Was Professor "X" a "real scientist?"

If Carl Sagan's vita ended there, he undoubtedly would've been spared the frequent belittling of his scientific standing, an injustice that even after his death continues as a plodding backbeat to the first two attempts at full length biography. His transgression was to also write, co-write or edit thirty-one books and 1380 articles, and to give countless public talks, radio and television presentations, including the world's most successful science television series, as well as co-founding the largest public space-interest organization on Earth. All of the above was aimed at engaging public awareness of and respect for the scientific enterprise.

It's hard to think of any other field in which such a person would be thanked by colleagues for so protean a labor of love with disparagement and even, on occasion, exclusion. Why? Some of the animus stemmed from his public stands on the nuclear arms race, the ballistic missile defense scam, and inadvertent climate modification, including global warming and nuclear winter. Others were discomfited by his

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efforts to extend the range of scientific investigation to subjects once thought scandalously outre, such as the search for extra-terrestrial life and intelligence. However, this would seem to contradict a widespread and unflattering myth about him: Carl Sagan as the ruthlessly ambitious careerist.

If it was “careerism” that motivated him, surely he wouldn’t have turned down three dinner invitations to the Reagan White House. That’s the equivalent of landing on Boardwalk for careerists. This was the man who consistently rejected opportunities to be co-opted by the rich and powerful. Instead, he was the young postdoc who lectured at the all-black college in Alabama in early 1963, years before there was any large-scale organized white commitment to end American apartheid. His typically apt choice of topic, the search for intelligent life on Earth, must’ve had special pungence to that audience, at that place, in that time – and he maintained that commitment over the years. He was the world famous scientist who consistently went where careerists generally only venture for the photo opportunity. The media knew nothing of his trips to the inner-city kindergarten, the pep rally for the district’s teachers on the day before school started and the ceremonies to naturalize new citizens; all to share his love of science and to encourage the questioning of authority. No careerist would have resigned from the Air Force Scientific Advisory Board and voluntarily surrendered his top security clearance in protest over the American war against Vietnam. A careerist would have played the game to get tenure at Harvard, and believe me, if that’s what Carl Sagan had been about, he would’ve kept his controversial head down and done it brilliantly. A careerist would have welcomed the lucrative offers for commercial endorsement instead of turning down every single one of the hundreds that were offered.

We were inseparable, in love and work, for twenty years. Although we had passionate disagreements, there was not a moment of that time that I did not consider myself the most fortunate person to be with him. Some of the hurt and indignation you hear in my voice is undoubtedly due to my bias. But I claim there’s more to it than that. It

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has to do with a deeper issue, the tragic disconnects between heart and brain, goodness and knowledge, skepticism and wonder, that have afflicted our civilization for the time of its first story, Genesis. The unmistakable message of our expulsion from Paradise is that happiness can only be achieved in a state of thoughtless obedience and ignorance. Now that our civilization rests so heavily on the lever arm of science and high technology, this ancient cultural dysfunction enters its acute stage.

Scientific biography is symptomatic in its Oberammergau-like two dimensionality. We are told Einstein was a lousy husband. Why do we find this kind of information so satisfying? It relieves us from the daunting burden of comparison with his achievement and it affirms the inverse square law between scientific genius and the capacity for love. In this cultural atmosphere, the life story of a scientist becomes little more than a harvest of resentments from the insecure and unrequited.

To me, Carl's integrity, kindness, gentleness and courage were every bit as off-scale as his intellect. In our twenty trips around the Sun together I never once recall him saying anything that he didn't believe was true. In fact, the only surviving element of his severe childhood facial tic was a telltale twitching of the nose that was always triggered by the need to refrain from speaking his mind so as not to wound another person. I invite the reader to scour his mountain of published work to find a single betrayal of anyone who had ever entrusted him with a confidence, or one mean-spirited passage meant to settle a score. This, from a man who never shrunk from taking a public stand on the great issues of his day. He was incapable of keeping his mouth shut about a matter of principle when it was in his own self-interest to do so. How do we square the notion of him as a "driven careerist" with his consistent lifelong pattern of choosing a course that was, to say the least, problematical for his career?

"Activist" is the right word. However, it, too, has its negative connotations in science. The legitimate fear is that the scientist will distort science, subordinate it to political imperatives. Lysenko, Mengele, and

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Teller come to mind for good reason. However, the critical question is which comes first. If political aims drive the science, the science will inevitably be tainted. However, if scrupulous science results in conclusions with serious implications for our future, what is the ethical response? What should we expect from the scientist who grasps a danger brought about by science? Should he/she hide silently and safely behind the protective wall? Most of the rest of us are scientifically illiterate. We can be conned. All governments lie and few of them have ever demonstrated a concern for the future beyond the next election. If the scientists must refrain from activism, or even public education, how can we hope to successfully avert these dangers?

Carl's childhood coincided with a brief historical moment when science could do no wrong; it was stainless, clean, like the glass and steel of the futurism it inspired. By the time he was eleven, that aura had turned to the rubble of Nagasaki. Through the ensuing arms race, which in its late stages employed more than half of the world's scientists, the good scientist all but vanished from the popular imagination and was replaced by an archetypical enemy of the people, evil and insane.

A family trip to the movies to see the latest sci-fi blockbuster was inevitably marred by Carl's squirming. It tormented him to see how riddled with errors the "science" was. Hollywood loved the jargon of science because it added to the reality of the experience. However, film makers and audience alike were so alienated from science that there was no perceived need to get it right. Nobody else seemed to notice. Equally painful to Carl was the depiction of the scientist. You know him. He's the one who's willing to destroy everything that is precious to the rest of us in the pursuit of his ungodly, monomaniacal research. Carl would start to shift uncomfortably in his seat. He didn't want to spoil it for the kids, but it was almost more than he could bear. The nose would start twitching wildly.

He knew that popular culture was not the problem, but merely the messenger, a reflection of widespread perception. It wouldn't be enough to start writing movies about good, humane, conscientious,

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decent scientists. The burden to change was not on Hollywood alone, but also on the uncommunicative and completely self-absorbed scientific community. It was those impenetrable walls that insulated them and created an ideal culture medium for the growth of public mistrust. The walls had to come down.

In some sense, his arrests for non-violent civil disobedience at the Nevada Nuclear Test site after Gorbachev's unilateral moratorium on nuclear testing, his briefing of the Central Committee of the USSR, the US Congress and the Pope on the possible climatic consequences of nuclear war, his early and frequent sounding of the alarm on global warming, and his indefatigable combat against the hydra of the Star Wars missile defense scheme (whose many heads have grown back once again, only this time, lamentably, in a world without a Carl Sagan) were a scientist's acts of redemption.

"Redemption"? It's a word from the vocabulary of the soul and it brings us to what is, perhaps, the toughest and most dangerous wall to scale: the one that divides the scientific from the sacred. It is here, I believe, that his influence on our civilization will be most profound and lasting.

It is claimed that science has nothing morally or spiritually to tell us. Remember the Earth revealed to us by the *Voyager* spacecraft taking one last look from out past Neptune. Not the *Apollo* frame-filling Earth, but the Earth that is a single pixel in the context of the vast cosmos. This is the Earth that Carl Sagan made us see; "the pale blue dot". Stare at this image of our tiny planet in its larger context and do your best to remain a militant nationalist, a zealot willing to drench this tiny mote in blood, or a capitalist who places the bottom line above all. Is this piece of scientific evidence really value free, lacking in moral and spiritual implications?

Carl Sagan's respect for the foundational significance of religious tradition is evident throughout his work. He was a lifelong scholar who frequently surprised the faithful in debate with his encyclopaedic knowledge of their sacred texts. His initiatives to unite the communities of science and faith in defense of the environment continue to

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flourish and produce results. His writings are enriched by epigrams from the world's religious traditions. What is "A Transitional Animal", the first chapter of *The Cosmic Connection*, but an attempt at a new Genesis; an account in biblical cadence of local cosmic evolution, the reconstruction of our origins made possible by the diligence, fearlessness and continuity of the generations of science. It is informed by and strictly bound to verifiable reality; neither perfect nor eternal, but always subject to revision, an endless search.

The tone evokes the Old Testament, but the content declares a radical bifurcation. *The Cosmic Connection* is not only a demolition kit aimed at the weight-bearing structure of the wall, but also a revelation of a spiritual and ethical perspective made possible by its collapse. The epigram that begins my essay is a moral statement. It is essentially "Thou Shalt Not Kill" but without the authoritarian "because I say so" of the original commandment. Not fear-based. A moral imperative derived from the accreted evidence of more than one scientific discipline. Rather than damning us for our curiosity, as is the case in Genesis, we are presented with a bounty of discoveries made possible by our naturally human need to know, when methodically focused and disciplined. Rather than a separately created race of overseers, appointed to crack the whip over the rest of nature, we are interwoven into its much more ancient and surpassingly intricate fabric.

In *The Cosmic Connection*, Carl envisions a new concept of human progress, the extension of our "identification horizon", the category of beings whom we are willing to treat as we wish to be treated. The pioneering insight that expands our sphere of fellowship may come in the form of a perspective-shifting epiphany. I'm thinking of Herman Melville's prescient "I don't get it" tone of voice, asking "Why don't the Tahitians send missionaries to New Bedford?" Or, as the taking up of an unpopular cause, as in Frederick Douglass' extrapolation from his own experience of voiceless enslavement, that his struggle must be for the emancipation of women, also. Sometimes it is a radical innovation in a scientific approach, as in Jane Goodall's commitment to study the lives of our closest relatives in their natural environment rather than,

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as had always been done before, as uprooted prisoners, many of them, doing grim life in solitary. Each of these insights is another brick removed from the wall that divides us from each other and blocks our view of nature's glorious immensity.

For him, this shift in ethical perspective was a natural by-product of science. To discover what the stars really are, how big and old the universe might be, to behold the exquisite interconnectedness of life on Earth and to trace its origins all the way back through cosmic evolution, had revolutionary spiritual and ethical implications, unanticipated by our pre-scientific western religious traditions. It wasn't going to be enough to merely update the textbooks. (Although, there are those who aren't even willing to go that far.) This radically changed understanding of who, when and where we are, called for new psalms, new moral imperatives and most urgently, a new sense of the sacred. How could it not?

In the final pages of *The Cosmic Connection*, Carl introduces the image of humans beings as "starstuff", a theme he returned to when we collaborated with astronomer Steven Soter to write the *Cosmos* television series. We are starstuff. You, me and everybody. Not the failed clay of a disappointed Creator, but, literally, down to every atom in our bones, the ash of stars. "Starstuff pondering the stars; organized assemblages of ten billion billion billion atoms considering the evolution of atoms; tracing the long journey by which, here at least, consciousness arose." (*Cosmos*, Random House, 1980, p. 345).

The underlying scientific insights are, of course, the work of many others, most pivotally, Charles Darwin. However, the coherent expression of this science-based, rigorously skeptical, yet awe-filled perspective belongs to Carl. He used his gifts to touch multitudes of the previously alienated among all ages and cultures, giving us the soaring spiritual high that is science's overarching revelation – our oneness with the cosmos.

Carl Sagan understood that tacit intellectual public acceptance of the claims that science makes, though devoutly to be desired, would not be sufficient. He grasped that our future depended on whether or

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not we would take this new universe revealed by science to heart and make its methods for testing reality our way of thinking. "YOU ARE HERE" read the little sign on the appropriate arm of the Milky Way Galaxy in the first slide of his lectures. What haughty compartmentalism can long withstand that reality, once we take it within?

* * *

When I imagine the hunt for the truth about the stars that began for him in earnest with his mother, Rachel, on that day in Brooklyn, I always go in for a long, tight close-up of his small hand in hers. There's the original connection that potentiates all others. A child's question is honored and a loving grown-up joins in the quest for an answer. In that commitment the gateway to the universe may be found; to becoming what Carl Sagan envisioned we could become: Conscious, wise, compassionate, energetically curious, eternally skeptical, immune to the manipulations and intimidations of the powerful; free of the walls that imprison and divide us; awe-inspired by the beauty of an ever-broadening identification horizon, welcoming of its expansion; no longer stunted by the old primate hierarchies, but instead, proud of our capacity to care for each other and to discern our tiny, utterly decentralized place in the fabric of nature, space and time; secure enough at last to embrace the wonder inherent in this reality, awakened to our responsibilities as a link in the generations past and future, at peace with our self-knowledge, alert to a heightened and consequential sense of the sacred; long-term thinkers, solid citizens of the planet and the cosmos; as Carl was; fully alive, completely connected.

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Preface

When I was twelve, my grandfather asked me—through a translator (he had never learned much English)—what I wanted to be when I grew up. I answered, “An astronomer,” which, after a while, was also translated. “Yes,” he replied, “but how will you make a living?”

I had supposed that, like all the adult men I knew, I would be consigned to a dull, repetitive, and uncreative job; astronomy would be done on weekends. It was not until my second year in high school that I discovered that some astronomers were paid to pursue their passion. I was overwhelmed with joy; I could pursue my interest full-time.

Even today, there are moments when what I do seems to me like an improbable, if unusually pleasant, dream: To be involved in the exploration of Venus, Mars, Jupiter, and Saturn; to try to duplicate the steps that led to the origin of life four billion years ago on an Earth very different from the one we know; to land instruments on Mars to search there for life; and perhaps to be engaged in a serious effort to communicate with other intelligent beings, if such there be, out there in the dark of the night sky.

Had I been born fifty years earlier, I could have pursued none of these activities. They were then all figments of the speculative imagination. Had I been born fifty years later, I also could not have been involved in these efforts, except possibly the last, because fifty years from now the preliminary reconnaissance of the Solar System, the search for life on Mars, and the study of the origin of life will have been completed. I think myself extraordinarily fortunate to be alive at the one moment in the history of mankind when such ventures are being undertaken.

So when Jerome Agel approached me about doing a popular book to try to communicate my sense of the excitement and importance of these adventures, I was amenable—even though his suggestion came just before the *Mariner 9* mission to Mars, which I knew would occupy most of my waking hours for many months. At a later time, after discussing communication with extraterrestrial intelligence, Agel

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and I had dinner in a Polynesian restaurant in Boston. My fortune cookie announced, "You will shortly be called upon to decipher an important message." This seemed a good omen.

After centuries of muddy surmise, unfettered speculation, stodgy conservatism, and unimaginative disinterest, the subject of extraterrestrial life has finally come of age. It has now reached a practical stage where it can be pursued by rigorous scientific techniques, where it has achieved scientific respectability and where its significance is widely understood. Extraterrestrial life is an idea whose time has come.

This book is divided into three major sections. In the first part I try in several ways to convey a sense of cosmic perspective—living out our lives on a tiny hunk of rock and metal circling one of 250 billion stars that make up our galaxy in a universe of billions of galaxies. The deflation of some of our more common conceits is one of the practical applications of astronomy. The second part of the book is concerned with various aspects of our Solar System—mostly with Earth, Mars, and Venus. Some of the results and implications of *Mariner 9* can be found here. Part Three is devoted to the possibility of communicating with extraterrestrial intelligence on planets of other stars. Since no such contact has yet been made—our efforts to date have been feeble—this section is necessarily speculative. I have not hesitated to speculate within what I perceive to be the bounds of scientific plausibility. And, although I am not by training a philosopher or sociologist or historian, I have not hesitated to draw philosophical or social or historical implications of astronomy and space exploration.

The astronomical discoveries we are in the midst of making are of the broadest human significance. If this book plays a small role in broadening public consideration of these exploratory ventures, it will have served its purpose.

As with all ongoing work and especially all speculative subjects, some of the statements in these pages will elicit vigorous demurrers. There are other books with other opinions. Reasoned disputation is the lifeblood of science—as is, sadly, infrequently the case in the intellectually more anemic arena of politics. But I believe that the more controversial opinions expressed here have, nevertheless, a significant

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scientific constituency. I have purposely introduced the same concept in slightly different contexts in a few places where I felt the discussion required it. The book is carefully structured, but, for the reader who wishes to browse ahead, most chapters are self-contained.

There are far too many who helped shape my opinions on these subjects for me to thank them all here. But in rereading these chapters, I find I owe a special debt to Joseph Veverka and Frank Drake, both of Cornell University, with whom over the past few years I have discussed so many aspects of this volume. The book was composed partly during a very long transcontinental trip in a very short automobile. I thank Linda and Nicholas for their encouragement and patience. I am also grateful to Linda for drawing two handsome humans and one elegant unicorn. And I am grateful to the late Mauritz Escher for permission to reproduce his "Another World" and to Robert Macintyre for the human figure and star field in Part Three. Jon Lomberg's paintings and drawings have been a source of intellectual and aesthetic excitement for me, and I am grateful to him for producing many of them especially for this book. Hermann Eckleman's careful photographic reproductions of Lomberg's work have facilitated their appearance in this book. And I thank Jerome Agel, without whose time and persistence this book would never have been written.

I am indebted to John Naugle of NASA for showing me his file on public response to the *Pioneer 10* plaque; the Oregon System of Higher Education for permission to reproduce some ideas from my book *Planetary Exploration*; the Forum for Contemporary History, in Santa Barbara, for permission to reproduce a portion of my letter distributed by the Forum in January 1973; and Cornell University Press for permission to reprint a fraction of my chapter "The Extraterrestrial and Other Hypotheses" from *UFO's: A Scientific Debate*, edited by Carl Sagan and Thornton Page, Cornell University Press, 1972. I am also grateful to those who have granted me permission to reproduce in Chapter 4 their remarks on the *Pioneer 10* plaque. The evolution of this book through many drafts owes much to the technical skills of Jo Ann Cowan, and, especially, Mary Szymanski.

—CARL SAGAN

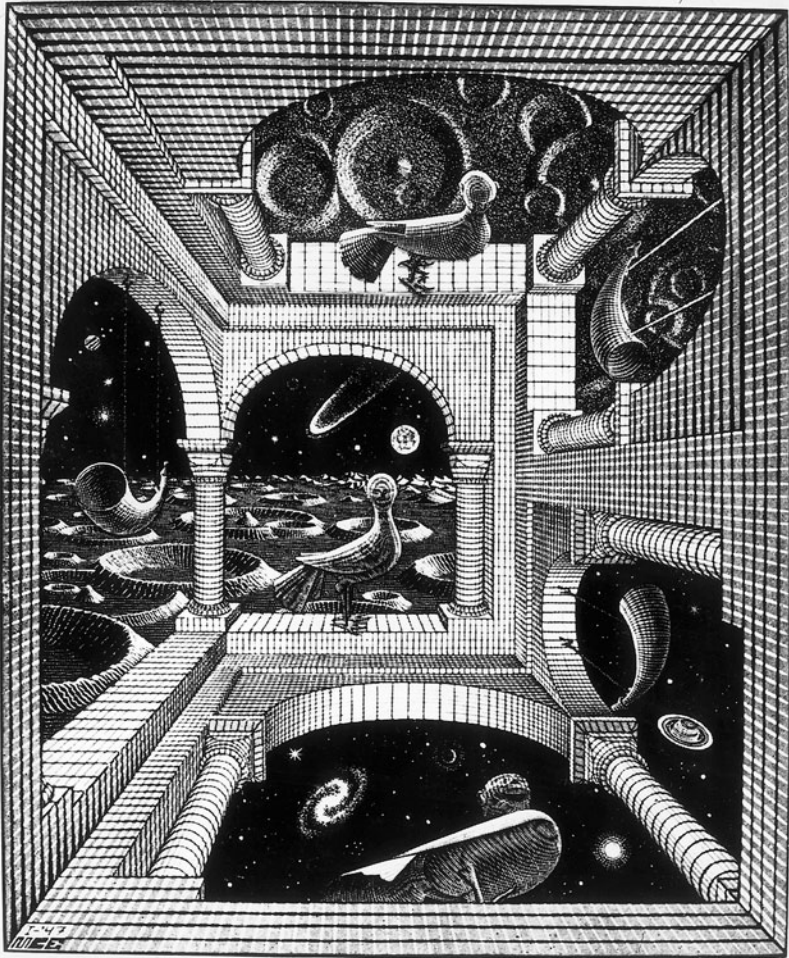
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"Another World" by M. C. Escher.