

MANNED SPACE EXPLORATION: THE ONLY GAME IN TOWN?

Journey into Space: The First Thirty Years of Space Exploration

Bruce Murray

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Reviewed by Ronald E. Doel

When the space shuttle Challenger exploded 75 seconds after liftoff on 28 January 1986, the event ended not only the lives of the seven crew members on board, but also confidence in NASA's predictions that the shuttle represented the most efficient and low-cost means available for reaching space and promoting space research. Since that tragedy, space researchers have again confronted a fundamental problem of science policy: To achieve maximum scientific results, what is the optimal mix of manned and instrumented flight? Although scientists typically prefer unmanned probes—in part because scientists retain greater autonomy over their development and operation—many believe that unmanned spacecraft are far more vulnerable to funding cuts and cancellations than manned missions. Nor is this issue new. As historian David H. DeVorkin argues in his recent book *Race to the Stratosphere* (Springer-Verlag, New York, 1989), political and institutional needs have influenced the debate over manned versus unmanned flight since the 1930s.

Bruce Murray's memoir, which covers his involvement in planetary missions over the past quarter century, seeks to examine this issue and the way US science policy decisions have influenced solar system exploration. Murray is well positioned to write

such a book. Well respected for his work in planetary geology, Murray also earned a reputation as a firebrand for his forceful criticisms of NASA's leadership of planetary exploration. In 1966, for example, Murray coauthored an article in *Science* sharply opposing NASA's plans to explore Mars using a single, ultrasophisticated spacecraft called Mars Voyager. Instead, Murray advocated a succession of smaller predecessors. Congress subsequently killed the Mars Voyager program.

Murray remained an outspoken critic of NASA headquarters between 1976 and 1982, when he directed the Jet Propulsion Laboratory, the agency's leading center for unmanned solar system research. Murray used the post as a bully pulpit—although ineffectively—to challenge the reluctance of NASA administrators to fund new planetary missions in the 1970s and early 1980s. In 1979 he cofounded with Carl Sagan the Planetary Society, a privately funded advocacy group for planetary exploration. Murray also led the protracted effort to establish a US mission to Halley's comet, which Reagan Administration officials killed in 1981. By the mid-1980s he returned to teaching and research at Caltech.

Murray's thesis is that in the early 1970s NASA administrators, obsessed with finding an institutional mission to replace that provided by Apollo, promoted the shuttle and planned space station as the agency's new *raison d'être*. Although billed as a promising means for expanding American capacity to launch planetary probes, the shuttle program, Murray argues, instead decimated such efforts. The main flaws of the shuttle policy, publicized during the Rogers commission inquiry into the Challenger disaster, are now familiar. In 1972 President Richard Nixon approved development of the reusable space shuttle as a means of replacing conventional rockets. Shortly thereafter James Fletcher, then NASA's

chief administrator, required that all new unmanned space missions be launched with the space shuttle, thereby eliminating the fleets of Atlas, Titan and Centaur rockets formerly used to boost unmanned satellites into orbit or towards planetary destinations. Increasingly behind schedule and confronted with growing backlogs of commercial, civilian and military spacecraft awaiting launch, shuttle officials pushed their unrealistically optimistic flight schedules up to—and then beyond—the threshold of reliable performance. Despite the painful evaluations that followed the 1986 tragedy, both the shuttle and the space station have retained their high priority status within NASA. Shuttle cost overruns have been paid for by funds once set aside for solar system exploration. In addition, the few planetary missions scheduled to fly have been delayed by frequent shuttle postponements. As a result, planetary scientists, along with their colleagues in astrophysics, continue to face limited funds for new missions and further delays in the launch dates for completed spacecraft.

Murray is not the first to tell this story. Nevertheless, his highly personal account is one of the most compelling and convincing indictments yet to appear of NASA's stewardship of solar system exploration. A confirmed believer in the scientific and cultural significance of planetary exploration, Murray devotes the first part of this book to recounting his involvement in the pioneering Mariner missions to Mars in the 1960s, the Mariner 10 mission to Venus and Mercury in 1974 and the Voyager mission to the outer planets in the 1970s and 1980s, all of which he regards as triumphs of the American space program. In describing more recent mission proposals that he and other planetary scientists have presented to NASA—the Galileo mission to Jupiter, the Ulysses solar mission and the Halley intercept mission—

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Murray tells a more somber tale. He uses all three cases to illuminate what he terms the intrinsic incompatibility of the shuttle program with the needs of unmanned planetary exploration.

Murray is particularly effective, for example, in chronicling numerous shuttle problems that delayed the Galileo launch seven years, from 1982 to 1989. During that interval, he notes, NASA officials came to identify the Galileo craft (rather than the shuttle) as the "problem," and blamed the costs for redesigning Galileo to fit the altered shuttle and for reducing the funds available for planetary exploration. This perverse confusion of means with ends, hardly unknown in large bureaucratic organizations, is a theme that Murray explores effectively.

Historians will wish that Murray had explored with similar thoroughness the difficulties he faced administering JPL. Although JPL took on more and more military research under Murray's directorship as a means of securing its institutional survival, the opposition Caltech faculty gave to this reorientation is only partially portrayed. At one point Murray also defended the Galileo mission to members of Congress in terms of its inherent contributions to military technology, without commenting on the implications—indeed, the irony—of justifying such a program under the banner of defense. Yet one appreciates Murray's attempt to footnote important documents and sources, including historical articles he has consulted in preparing his arguments.

It is in the book's final section, however, that Murray advances his most controversial argument. Here Murray turns from chronicler to advocate: To reinvigorate scientific exploration of the solar system, Murray writes, NASA should commit itself to a new Apollo-style program aimed at placing humans on Mars in the first decades of the following century. This concept, which Murray developed with Sagan and other leaders of the Planetary Society and articulated publicly in 1986, calls for a joint US-USSR undertaking to Mars, an approach calculated to reduce costs and—considering Soviet expertise in the study of weightlessness and space biology—reduce the time required to prepare such a mission. Murray argues that such a venture, by providing a vision and focus to NASA more fruitful than that embodied in the shuttle and space station, would serve to return scientific exploration of the solar system to past levels of greatness. To put it another way, manned

exploration has become the only game in town.

Murray's argument (written before recent events in eastern Europe and the end of the Cold War) has gained its share of adherents. President George Bush this May endorsed this plan by announcing that the US should commit itself to sending human expeditions to Mars by the year 2020 to support "a sustained program of manned exploration of the solar system and the permanent settlement of space."

Yet one wonders if Murray has fully absorbed the lessons his own memoir provides. Given his claim that a program of manned planetary exploration would strengthen *unmanned* planetary science, it would have been exceedingly helpful had Murray examined the history of lunar science within the Apollo program. In fairness, it must be noted that Murray had little personal involvement in lunar research during the Apollo period. Yet it is precisely this comparison that has greatest relevance to Murray's argument. Recent historical studies suggest that the science-Apollo interface was often tenuous. Many scientists complained bitterly in the late 1960s that lunar science was largely confined to meeting engineering goals, illustrated by the cancellation of the final seven Rangers and the last ten Surveyor missions once practical objectives were met. Of course, complaints are a normal part of a healthy, growing field, and as NASA scientists have frequently argued, far less lunar science would have been accomplished had Apollo never come about. Nevertheless, it is clear that the relationship between science and the Apollo program was deeply troubling to lunar scientists.

Also largely missing from Murray's account is the Hubble Space Telescope, the most expensive scientific instrument constructed to date. As Robert W. Smith points out in *The Space Telescope* (Cambridge U.P., New York, 1989), Hubble's mission was expanded in the 1970s to include solar system research in order to gain support for it from planetary scientists. Indeed, the Space Telescope gained a strong constituency of scientific supporters despite its unmanned design. Unfortunately Murray is silent about what implications Hubble's development may hold for future policy decisions for planetary science.

Even if the causes Murray ascribes to the "brief golden age" of planetary exploration do not all withstand later scrutiny, his narrative illuminates planetary science policy through its

formative years. The societal pressures that cause Murray and other major figures of American science to champion manned flight as the only means to fund one of this century's most visible fields of science, although an unintended lesson, are no less worthy of our attention.

Exploring Complexity: An Introduction

Grégoire Nicolis and

Ilya Prigogine

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Any regular reader of the magazine *Mosaic*, published by the National Science Foundation, could get the impression that nonlinearity and complexity are a major theme of NSF-supported research. Unfortunately there does not yet exist a Federal patron to sponsor this burgeoning and promising field of research. Many, including this reviewer, believe the newly forming spectrum of ideas loosely called "complexity" to be uniquely rich in its promise of deep insights that elude the standard reductionist methodology of physics. Having been midwife to the formation of the Los Alamos Center for Nonlinear Studies (1980), the Santa Fe Institute (1984) and the University of Arizona's Center for the Study of Complex Systems (1986), I am keenly aware of both the promise and the difficulties of the subject.

Recently the scribes of nonlinearity have produced a large number of books of all sorts on the subject. Since few agree on what the "subject" really is, it is not surprising that no single text captures more than a fraction of the intellectual menu. A glance at the proceedings of the first Santa Fe Complex Systems Summer School, *Lectures in the Sciences of Complexity*, edited by Daniel L. Stein (Addison-Wesley, Redwood City, Calif., 1989), gives an indication of the vast interdisciplinary territory being opened up. It has to attract attention therefore, when a major work appears from the "Brussels School" of Ilya Prigogine, in collaboration with one of his brilliant associates, Grégoire Nicolis. It is, after all, the work of this group that played a key role in founding important aspects of the subject now known as complexity.

Many physicists of my acquaintance disapprove of certain aspects of the style of the Brussels School. To them the vision seems too grand, and as in the case of this book, the equation-to-word ratio is somewhat