

During lull at NASA, space science soars overseas

PRESIDENT BACKS US SPACE STATION AS NEXT KEY GOAL read the front-page headline of the 26 January *New York Times*. One might expect such news to ignite the excitement of grand new opportunities among the American space-science community—permanent, manned observatories, massive cosmic-ray experiments, regular sorties to the planets—but the reaction is, in fact, somewhat less enthusiastic.

NASA is in the midst of a transition from frequent space missions of relatively short duration to long-lived, sophisticated observatories and planetary orbiters that has resulted in a dearth of flight opportunities for space-science experiments. Many physicists and astronomers attribute the current drought to NASA's most recent expensive manned project, the Shuttle, and they hold a jaundiced view of what the next such project will bring. In fact, the Space Science Board of the National Academy of Sciences concluded last September, "There is no scientific need for this space station during the next 20 years."

The transition at NASA is occurring at a time when the European, Japanese and Soviet programs are continuing to grow. The situation in high-energy astrophysics (celestial observations above 30 eV) is particularly difficult for US experimenters. Europe, the Soviet Union and Japan each have at least one operating satellite in place, whereas the last US missions (HEAO-2 and -3) ended nearly three years ago. Three years from now, there will still be no opportunity for US scientists to observe in the x-ray or gamma-ray regimes while three new and considerably more powerful foreign missions (the German ROSAT, the Japanese ASTRO-C and the French-Russian SIGMA) will all be in orbit. Another more widely publicized example of this lull in US space-science activity concerns Comet Halley: Two Russian, one European and two Japanese satellites will intercept the comet during its once-in-a-lifetime apparition in 1985-86; plans for a US mission were scrapped several years ago.

What is likely to be the impact of NASA's emerging new roles as cargo

service and factory landlord (for the Space Station) on the future of US space science? What are the prospects for international cooperation in alleviating the current dearth of activity? And, finally, how are US university space-science groups going to "stagger across the desert of projects before us," as one senior physicist put it?

In recent conversations with several NASA officials and a number of leading space scientists both in the US and abroad, these questions emerge as the dominant themes in a concerned space-science community. The most serious and immediate problem cited by many of the scientists is the lack of ready access to space that the Shuttle was supposed to deliver. One senior NASA scientist summarized these concerns bluntly: "The amount of science being done by the Shuttle is a national disgrace." Geraldine Shannon, Washington representative of the Space Science Working Group, a consortium of universities interested in the health of the US space-science program, cited the related concern of declining funding for supporting basic research and technology activities at universities. "As these funds and opportunities decline, the university space-science research base, an important national resource, is eroding. For example, if the proposed FY 1985 planetary exploration budget is implemented, it will mean the certain dissolution of some university research groups." (See the NASA budget story on page 59.) Thomas Donahue, chairman of the National Academy of Sciences Space Science Board, estimates that current activity in data analysis and university-based research activities is "about \$100 million below the level required to support on-going and planned flight activity."

The lack of flight opportunities is also having a strong negative influence on the training of the next generation of space scientists. Rocket and balloon flights provide the chance for graduate students to build a new instrument, fly it, and analyze the data within the three-to-four-year timescale typical of dissertation research. But Shuttle payloads are far too rare and expen-

sive, and have such long lead-times that similar thesis projects are impractical. New satellite data are also rare. As a result, the number of students willing to go into space science is declining, and those few who remain often leave the field upon graduation. At Columbia University, for example, only one of the six most recent PhDs in high-energy astrophysics has stayed in the field.

Astrophysics. Currently, the foreign programs in high-energy astrophysics offer a marked contrast to this situation. Japan, for example, has been maintaining a series of small satellites for medium- and high-energy x-ray astronomy since early in the decade and has a firm commitment to continue this capability with increasingly sophisticated missions well into the 1990s. Japan's current satellite TENMA has been returning excellent spectral data on bright galactic x-ray binary sources from an array of gas-scintillation proportional counters. ASTRO-C, scheduled for launch in two years, will carry 5000 cm² of proportional counters, and be able to perform some of the experiments for which the American X-ray Timing Explorer was designed; XTE is not yet approved and could not be launched before 1990 at the earliest. A recent informal Japanese proposal for a joint x-ray telescope experiment in the early 1990s reportedly met with a cool reception at NASA headquarters.

Having recently completed a successful six-year gamma-ray mission called COS-B, the astrophysics program at the European Space Agency is currently limping along with the partially functioning EXOSAT satellite. However, the German soft x-ray telescope ROSAT is on schedule for a late 1987 launch and, with an x-ray sensitivity exceeding that of the Einstein Observatory, this project will be a major step forward in high-energy astrophysics research. After completing a six-month all-sky survey, 50% of the telescope time will become available to US proposers for the study of individual targets. As a collaboration with the British, however, ROSAT will also carry an Extreme

Ultraviolet telescope that may preempt much of the science planned for the oft-delayed NASA Extreme Ultraviolet Explorer (EUVE) which, after seven years in the pipeline, is now scheduled to fly in the same time frame. Likewise, the French-Russian collaborations on GAMMA-1 and SIGMA may achieve some of the scientific objectives of the US Gamma Ray Observatory before the GRO launch date of late 1988.

In the ir-optical-uv band, NASA's Space Telescope is clearly the premiere mission of the decade. Although plagued by delays and cost overruns (PHYSICS TODAY, November, page 47), ST is now scheduled for launch in mid-1986.

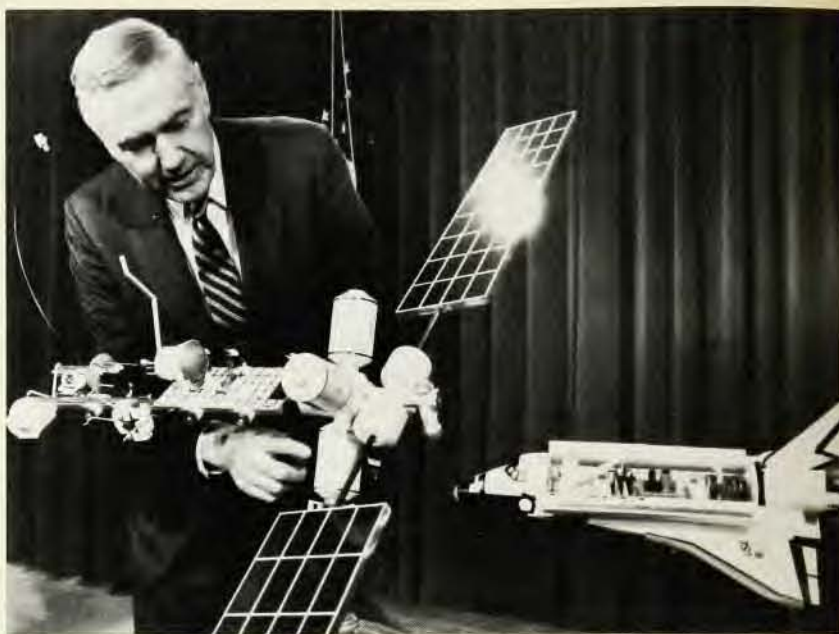
Once in orbit, it is expected to produce valuable data for the rest of the century. NASA is planning to start development shortly of the second generation of Space Telescope scientific instruments. These (one or two) instruments would be installed in orbit a few years after the original ST launch, to replace one or more instruments that might have failed or would by that time have lower priority.

By supplying one of the focal-plane instruments, the solar panels, and staff support at the ST Science Institute in Baltimore, ESA has bought a share of ST observing time for European astronomers. ESA's next solo mission is HIPPARCHOS, an astrometry satellite scheduled for launch in 1987. Its future astrophysics plans include the Infrared Space Observatory, on which construction is expected to begin in a few years.

Meanwhile, NASA is considering a successor to last year's Infrared Astronomy Satellite (IRAS) dubbed SIRTF, and the two agencies appear close to an agreement to develop a joint uv mission called Columbus. In addition, Australia and Canada are negotiating with NASA on a joint enterprise called Starlab—a wide-field, 1-meter optical telescope for the Shuttle.

The Gamma Ray Observatory, planned for launch in 1988, will investigate the highest-energy astrophysical processes with four instruments covering the gamma-ray energy range from about 200 keV to 30 GeV. In this first broad-spectrum survey of gamma-ray sources, NASA had originally planned for two years operation but is considering a longer lifetime.

Trends. The foreign effort today is reminiscent of the American program during the 1970s—what appears now as the golden age of space-science research in the US. During that decade, more than a dozen satellites devoted to astrophysics alone were launched, opening new windows on the Universe in the ultraviolet (Copernicus and the International Ultraviolet Explorer), x-ray (Uhuru, SAS-3, HEAO-1 and 2, the



Model of a manned space station is exhibited by NASA administrator James Beggs late in January, after the President endorsed the space station, despite opposition from US space scientists and many others.

OSO series, and so on), and gamma-ray (SAS-2, HEAO-3) regimes. A series of spectacular solar-system missions—the Pioneer and Voyager flybys of the outer planets and the Viking lander on Mars, to name a few—testified to the robust health of the US scientific program. For the most part, however, these experiments were conceived and approved during the Apollo era when expansive budgets for the manned space effort buoyed the scientific component of the NASA program. In the latter half of the decade, in an environment of declining Agency budgets and large cost overruns on the Space Shuttle, commitments for new missions slowed.

Joseph Burns of Cornell University, current chairman of the Planetary Division of the American Astronomical Society, recently summarized the past trend in solar-system exploration: "thirty-two missions in the 1960s, eleven in the 1970s, and two in the 1980s. The Venus Radar Mapper, recently approved, is the first new start in seven years." He went on to say that the Shuttle had been "of no utility at all" for solar-system research and that "Space Telescope won't make much difference in the planetary game."

The history of the astrophysics program in the Shuttle era is also rather grim. Back in the late 1970s, Announcements of Opportunity for Spacelab and other Shuttle payloads were issued from NASA headquarters, resulting in literally hundreds of proposals for space-science experiments. Roughly thirty were selected for various definition and development stud-

ies, but only a handful remain as active projects, and the level of "activity" is sometimes very low: Of the three x-ray astronomy experiments on the OSS-2 pallet, for example, it is now anticipated that half of one will fly sometime in the next few years, with the others added incrementally over the remainder of the decade. One of the projects still on track is the Astral program, a series of missions composed of a grouping of shuttle-based optical-uv instruments, starting with a flight coinciding with the Comet Halley appearance in the spring of 1986.

In the Agency's defense, Stephen Holt, chief of the Laboratory for High-Energy Astrophysics at NASA's Goddard Space Flight Center, pointed out that the fraction of the total Agency budget devoted to space-science missions has held constant for the past 20 years. "Therefore, the total budget for space sciences actually increases when NASA begins a new development program like the Shuttle or the proposed Space Station." To its credit, NASA in the FY 1985 budget has begun to acknowledge the importance of complete scientific analysis of the data collected from spacecraft by allocating about \$10 million for the guest-investigator program of data analysis for IRAS. For the decade of the 1980s, according to NASA Chief Scientist Frank McDonald, NASA plans to have launched about 14 space-science missions, some of which could be considered space applications rather than space science: the Solar Mesospheric Explorer, the two Dynamics Explorer missions (magnetospheric and upper

magnetospheric studies), Solar Maximum Mission, IRAS, Active Magnetospheric Particle Tracer Explorer, EUVE, Cosmic Background Explorer, GRO, ST, Galileo Jupiter Orbiter and Probe, Venus Radar Mapper, the Upper Atmosphere Research Satellite and half the cost of the International Solar Polar Mission.

In addition, McDonald highlighted two other telling points regarding the US space-science program in the mid-1980s: First, there is "the increasing diversity; it is difficult to balance the needs of each community" (x-ray astronomers and planetologists must now compete with oceanographers, upper-atmosphere researchers and geophysicists, among others, for satellite missions); second is the "move toward very large observatories" (ST, Galileo, and GRO are in the \$½- to \$1-billion category, and it is clear that only a very few such satellites can be built each decade).

Cheaper projects. In response to the current situation, the Solar System Exploration Committee, a group of NASA and university scientists, decided last year to break with the trend toward ever-larger and more sophisticated projects. Instead, they recommended the creation of a multipurpose "Planetary Observer" vehicle that could be used to address a set of specific scientific questions in the course of a large number of \$200-\$250-million missions. An optimal schedule of one launch every two years is envisioned for this program over the next two decades. The first such mission, the Mars Geochemical/Climatological Observer, appears as a new start in the FY 1985 budget, although the Agency carefully avoided committing itself to an ongoing Planetary Observer program. McDonald told us, "The solar-system community now has an ideal opportunity to demonstrate the viability of cost-conscious planetary science."

Two other new NASA programs promise to provide truly low-cost (\$1 million) access for other space scientists. The widely publicized "Get-Away Specials" (GAS cans), in which anyone can buy a ride in the Shuttle, are being adapted for use in astronomy. A pair of ultraviolet background experiments are now being constructed, and a general-purpose data-recording and support can for space-science payloads is being developed at the Goddard Space Flight Center. The GAS can is not useful for most astronomy projects, though, because it cannot point to a celestial target, but simply scans the sky as the Shuttle goes through its maneuvers.

However, the second program, dubbed SPARTAN, does offer an exciting new opportunity for instrument development flight tests that produce real

scientific returns. Essentially, a SPARTAN experiment is a rocket payload that is dumped overboard when the Shuttle gets on orbit and is then retrieved about 40 hours later when the mission is complete. Three experiments are under development and, says Edward Weiler (head of the astronomy section at NASA headquarters), "The FY 1985 augmentation for the program will send SPARTAN on its way." The European Space Agency has a similar goal in mind with its EURECA program. Following up on its manned, billion-dollar Spacelab contribution to Shuttle science, ESA had decided, according to an announcement last year, to "embark on the development of a family of free-flying, retrievable platforms for missions of duration exceeding that allowed by the Shuttle" (meaning several months). A late 1987 launch of EURECA 1, primarily a microgravity research mission, is anticipated. Such a program would dovetail nicely with the exposure durations available in other formats: for example, about 10⁵ seconds for a Spacelab (manned) experiment, about 3 × 10⁵ sec for a SPARTAN payload, about 10⁷ sec for a EURECA flight, and more than about 10⁸ sec for free-flying satellites.

Management. Programs such as the Planetary Observer and SPARTAN are at opposite ends of what many scientists would like to see as a spectrum of opportunities for the use of "creative management" in developing a balanced, productive space-science program. In fact, the "management" issue was a recurring theme in many of our conversations with university and NASA scientists and administrators. NASA's Weiler called the search for cheaper and more frequent access to space the major outstanding "management challenge" the Agency faces. Some of those outside the Agency claimed that much of NASA's best management talent had been lost over the past five years and that, with a few isolated exceptions, the Centers had become middle-level management entities that simply buy engineering, software and science while the scientists in the universities starve.

There is widespread feeling that the scientists themselves should take a

large role in managing future space-science missions and that, if this were done, the cost of programs now in the planning stages might be substantially reduced (AXAF was frequently cited in this context). These sentiments were echoed by George Keyworth, the President's Science Adviser, in his keynote address to the January meeting of the American Astronomical Society in Las Vegas. Acknowledging that we had "sacrificed space science to Shuttle tiles," he called for the Space Science Board to set up a committee to study the question of space-science management and the university-NASA-industry relationship. This committee could consider ways to stimulate small (less than \$10 million) and medium-sized (about \$100 million) programs in which the principal investigator or scientist would endeavor to produce maximally cost-effective payloads for NASA delivery to orbit. Direct NASA management would be reserved for very large projects that need what one scientist called "the army-type approach." The committee would also work toward framing recommendations to ensure the health of the university space-science community, addressing what Keyworth labeled "the critical problem" of graduate-student training.

Thus, while NASA works to generate enthusiasm for its latest big manned project and moves slowly toward the completion of its three large-scale space-science projects for the 1980s (ST, GRO and Galileo), US scientists are looking to their foreign colleagues for new data and to the Agency for some fresh ideas to reinvigorate smaller programs and reduce the cost of larger ones. The few new starts in the last two years are encouraging, and Donahue emphasizes that "it is important to maintain this rhythm over the next decade while the Space Station is being developed." For most, the Space Station does not conjure up images of a great leap forward in space-science research. But there is some hope that, with a healthy NASA, the US will continue to spend a reasonable amount of energy and dollars on pure research, what one scientist called "the crowning achievement of the American space program." —DAVID HELFAND

What now for Sakharov and Orlov?

In one of the ironies of history, the seven-year jail sentence for Yuri Orlov, the accelerator physicist who was imprisoned in 1977 for slandering the Soviet regime, was to come to an end on 10 February, the same day Moscow announced the death of Yuri Andropov, who ran the KGB at the time of Orlov's arrest and trial. It so happened

that Orlov's wife received a telegram on 9 February from the labor camp at Perm saying that the physicist had been transferred three days before into "the custody of the MVD," the Russian initials for Ministry of Internal Affairs, which oversees the police and penal institutions. Orlov is now starting the second part of his sentence, a five-year