ESA SPACE SCIENCE REMAINS ON COURSE, DESPITE HIPPARCOS SETBACK

Last month's successful launching of the Hubble Space Telescope, a joint project of NASA and the European Space Agency, brings to an end a period that has been difficult for space science in the United States, Europe and the Soviet Union. The 1986 Challenger disaster, combined with an important Ariane launching failure later the same year, threw schedules for space science projects badly off. Working space scientists suffered, budgets and bureaucracies suffered, and public support suffered.

Anticipating the Hubble launch, and with it a revival of public interest in space science, PHYSICS TODAY paid a visit in Paris to Roger-Maurice Bonnet, the science director of ESA. He seemed a little older and a little more tired than he had during a similar visit four years before (see PHYSICS TODAY, August 1985, page 61), and thinking of the earlier visit he remarked wistfully that "those were more optimistic times."

Yet as he looked ahead in the course of the interview, Bonnet's spirits picked up. And by the end of the conversation he was on his feet, proudly producing from his pocket a reel, the shape and size of a carpenter's tape measure. It turned out to be film showing the final seconds of Giotto's intercept with Halley, taken by what ESA had billed as the "world's smartest camera." Holding the film up to catch light from Bonnet's office window, we watched with a vivid sense of being right there in the spacecraft as it closed rapidly on the potato-shaped black mass that we now recognize as Halley's nucleus. Spatial relationships and perception of depth changed rapidly as we veered past the core, as though we were in a sportscar racing past a piece of complex modern sculpture.

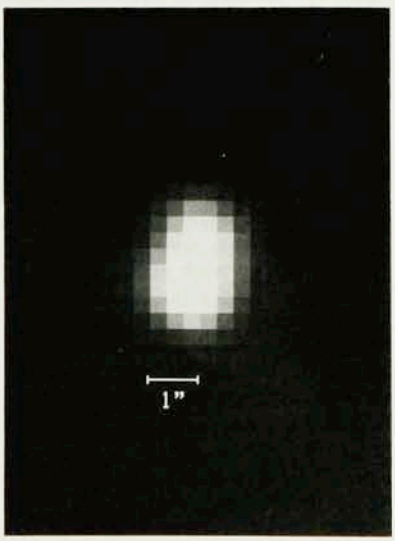
Delay costs

Assessing the overall costs associated with the launcher problems and delays of the late 1980s, Bonnet said that they resulted in extra expenditures of about $90 million not foreseen in 1985, when ESA's 11 member states agreed to increase funding for space science by 50% in the next five years. ESA's total annual budget averages about $200 million.

Assessing purely scientific costs and referring to Ulysses, the vehicle for ESA's Solar Polar Mission, Bonnet pointed out that the later you launch in the decade, the less high above the ecliptic you go—higher altitudes are more desirable because they permit more of the interplanetary medium to be observed. Ulysses now is expected to rise to only 70° above the ecliptic, as compared with 90°, as originally planned. The satellite, once scheduled to be launched in May 1986 from a US space shuttle with a Centaur booster, now is scheduled to go up in October this year with a modified, two-stage boosting system. It will observe the solar wind and interplanetary medium from the perspective of the Sun's poles.

Regarding Hubble, Bonnet thought that perhaps something had been gained from the delays, in that the team at the Space Telescope Science Institute in Baltimore had used the extra time to refine software.

As for ESA's experiments on the USSR's Phobos mission, which were prepared at the European Space Research and Technology Center at Noordwijk, in the Netherlands, they were unaffected by the failure of the last step in the mission—the effort to balloon-drop instruments onto the Mars moon. "The only thing wrong



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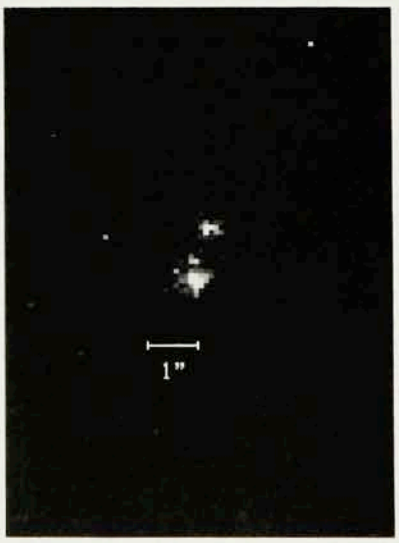

NASA/GODDARD SPACE FLIGHT CENTER

Portion of first Hubble photograph (right) from the Space Telescope's Wide Field Planetary Camera, showing a double star, was released on 22 May. The photo at left of the same region of the sky was taken at the Las Campanas Observatory in Chile. In the comparison shown here, two stars appear as one at ground-based resolution, but are cleanly separated by the Space Telescope. At this stage in the focusing and alignment of the Space Telescope, stellar images contain a small core of about 0.15 arcseconds in diameter and diffuse wings about 0.7 arcsec in diameter. Further alignment and focusing is expected to produce stellar images smaller than 0.1 arcsec with negligible wings.

with that mission, from ESA's point of view," Bonnet said, "was its name." It should have just been called a mission to Mars, he said, and then it would have been considered a resounding success.

Hipparcos

ESA's biggest disappointment of the last few years occurred last August, when the Hipparcos star-mapping satellite was launched more than a year behind schedule (due to Ariane problems) and its booster rocket failed—the first time the device had ever malfunctioned. The resulting eccentric, sub-geostationary orbit, with a perigee of 200 km and an apogee of 36 000 km, left the satellite vulnerable to damage from radiation and thermal effects. In particular, its solar arrays, detectors, lenses and computers were badly exposed to radiation as it crossed the Van Allen belts.

The situation turns out to be much less dire than originally feared. Making use of stabilization thrusters, controllers have managed to raise the satellite's perigee from 200 to 500 kilometers, and its lifetime in space is now estimated at more than 30 months. The satellite originally was intended to transmit data continuously to a single ground station, so that it would complete its survey in two and a half years. Instead, controllers have activated three additional stations that each take data intermittently, and together the four stations are expected to provide a large proportion of the data originally desired.

According to Hamid Hassan, the project manager in Noordwijk, data recovery is about 70%, taking ground-station outages and Van Allen outages into account. At that rate, it should take the satellite about three years to accomplish what was planned for two and a half. Costs will be higher, of course, but Hassan says that ESA's science program committee has reacted positively to requests for more funds.

Bonnet describes the Hubble and Hipparcos missions as complementary. Hubble provides accurate measurements of relative positions between faint objects within a few arcminutes of one another. Hipparcos measures position and proper motions of stars in a global frame, yielding greater accuracy in the measurement of positions among widely spaced objects. It also will produce an absolute scale for the measurement of luminosity, according to Bonnet.

Michael Perryman, the project scientist for Hipparcos, elaborated for us on the complementarity of Hubble and Hipparcos. Because Hipparcos obtains measurements only down to a magnitude of about 12, the data it is gathering for 120 000 stars are unconnected with quasars. But in a special program designed for Hipparcos, Hubble will observe about 50 pairs of stars in the Hipparcos catalog and will measure their relative positions with respect to quasars. Thus the Hipparcos data will be put in a extragalactic framework.

To obtain completely satisfactory measurements taking account of instantaneous positions, movements through space and effective movements with respect to the Earth's rotation around the Sun, Hipparcos needs to make repeated observations of the same stars. PHYSICS TODAY asked Perryman how much the overall value of the Hipparcos project would be reduced if the lifetime of the satellite turned out to be much shorter than currently anticipated. He said that the satellite needs about a year for motions and about 18 months for distances. Observing the sky twice a year, the telescope already has produced its first batch of positional data.

Horizon program

Giotto, Hipparcos, Europe's contribution to Hubble, and Ulysses all originated in a process, going back to the 1970s, in which ESA periodically called for prososals from scientists in its member states, reviewed the proposals and selected one or two for implementation. Another major project that came out of that process is the Infrared Space Observatory, a 60-cm telescope with a lifetime of about 18 months that now is scheduled for launching in 1993. In spring 1996 or a year later, when NASA is hoping to send the Cassini mission to Saturn, ESA will piggyback with a probe to the moon Titan (the Huygens mission).

In addition to those projects, ESA adopted in 1985 an ambitious longer-term program called Horizon 2000, which has four "cornerstones." That program has remained pretty well intact through thick and thin (see the article by Ian Axford in PHYSICS TODAY, May 1988, page 42). Furthest along is the Solar–Terrestrial Program, which calls for the simultaneous launch of four identical satellites to study the interaction of the solar wind and the Earth's magnetosphere (CLUSTER), and the Solar Heliospheric Observatory (SOHO), an observatory that ESA plans to launch in conjunction with similar observatories planned by the United States, Japan and the USSR. Bonnet said that SOHO is scheduled for 1995–96 but has recently been delayed by six months to accommodate changes requested by NASA.

Further off in the Horizon 2000 program is a Far-Infrared and Submillimeter Space Telescope, and still further an attempt to retrieve material from a comet nucleus.

ESA outlook

Bonnet emphasizes that everything depends on sustaining the program of 5% annual increases in funding for space science that ESA's 11 member governments adopted in 1985. In 1988 ESA had to reassess its plans at the insistence of Great Britain, and after some grumbling, Britain agreed to continue supporting the programmed increases, but only for three years, and only if the program were given a formal review.

That review was done by a committee chaired by Klaus Pinkau, head of the Max Planck Institute for Plasma Physics in Garching, West Germany, and the findings were favorable on the whole. The committee recommended liberalizing ESA's contracting rules to free the agency from the requirement that all contracts must be divided among member countries in strict proportion to their contributions to the ESA budget. Savings from such a reform plus savings from modifying internal agency procedures would enable the agency to meet the goals adopted at the beginning of 1985 and to go ahead with planned 5% annual increases in its science budget from 1992 to 1994.

This October Jean-Marie Luton will succeed Reimar Lüst as director general of ESA. A French geophysicist who graduated from the Ecole Polytechnique, Luton currently is director general of France's National Center for Space Studies, or CNES. Luton did research in planetary geophysics for CNRS from 1964 to 1971, when he was loaned to the Ministry of Industrial and Scientific Development to work on space policy. He joined CNES in 1974, and in 1987 he was named director of space programs in the department of space and strategic systems for Aerospatiale, France's aerospace company. His appointment as ESA director general seems destined to further strengthen the agency's ties with France's aerospace establishment, which is easily Europe's strongest and already the dominant force in the European Space Agency.

Lüst, also a geophysicist, will move to Hamburg this fall to become head of the Max Planck Institute for Meteorology.

—WILLIAM SWEET