NASA Draws the Line at Servicing Hubble

The Hubble Space Telescope has done wonderful science, thanks to occasional shuttle flights that have kept it operating and upgraded its instruments. NASA has one more repair mission on the books for the 13-year-old machine, but astronomers have been pushing hard for a second rendezvous later in the decade. Last month, however, their high hopes were dashed.

Talk of a second mission is “superfluous” and “absolutely premature,” says NASA space science chief Ed Weiler, citing its high cost, delays in the currently scheduled mission, and an unexpectedly durable Hubble itself. The agency’s space science advisory committee, whose members represent all the disciplines involved in space exploration, agrees. “The real issue is the next mission,” says Andrew Christensen, chair of the panel. Those statements are a blow both to Hubble supporters and to a blue-ribbon panel that concluded in August that an extra flight could be scientifically worthwhile—if it could compete successfully with other NASA projects.

Launched in 1990 and first repaired in 1993, Hubble was slated to be serviced for the last time in 2004 and then returned aboard the space shuttle around 2010. That would coincide with the launch of the James Webb Space Telescope. But the servicing mission will be delayed until at least 2006, and possibly until 2008, because of the problems with the shuttle fleet, says Weiler. And a second flight would not come cheap. NASA now estimates that a second servicing mission would cost from $600 million to $1.2 billion, Weiler adds. The lower-end estimate would pay for doing basic maintenance, and the higher-end one for changing out a host of scientific instruments.

A seven-member panel led by Princeton University’s John Bahcall endorsed a second mission to provide Hubble with the instruments it needs to explore a fresh set of research questions. Such a mission, it added parenthetically, could be competed in the Explorer or Discovery programs, which fund small- and medium-class space missions (Science, 22 August, p. 1029).

That suggestion struck a nerve among other space scientists, however. NASA’s Sun-Earth Connection Advisory Subcommittee, for example, warned Bahcall in an 11 November letter that the Bahcall panel’s recommendation would subvert the Explorer program and have a “drastic negative impact” on solar research. On 17 November, Jonathan Lunine, an astronomer at the University of Arizona in Tucson, told the space science advisory committee at its meeting at Ames Research Center in Mountain View, California, that funding Hubble from the Discovery program would consume three to five other potential Discovery missions. That would represent a 5- to 7-year delay in the program, he estimated.

Bahcall panel members cried foul. In a 16 November letter to the same advisory committee, they insisted that their intent was merely to ensure a peer-reviewed competition with similar-sized missions while protecting existing projects. “We didn’t have firm cost estimates” for the servicing mission, adds Chris McKee, an astronomer at the University of California, Berkeley, who served on the Bahcall committee. The exact cost of the mission would depend on the extent and complexity of new instrumentation, but McKee acknowledges that a $600 million plus mission “would have a devastating effect” on other potential Explorer and Discovery missions.

One astronomer, who requested anonymity, accuses NASA of rallying the space science community against the additional Hubble mission by sending out e-mails last month alerting researchers to the issue. Weiler has long been critical of keeping Hubble operating past the time the James Webb Space Telescope is launched early in the next decade. But he insists that a second servicing mission could still be proposed as part of a competition next year.

Weiler says that delaying the scheduled repair mission may even have a silver lining: A later flight means a longer life for Hubble. In addition, scientists at the Space Telescope Science Institute in Baltimore, Maryland, believe that Hubble could carry out most of its missions successfully with other NASA projects.

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Mantle Dynamics

Mantle Plumes Both Tall and Short?

For 3 decades, researchers have been debating whether plumes of hot rock rise through Earth’s mantle. Geologists and geochemists have inferred deep plumes from traces left at volcanic hot spots such as Iceland and Hawaii. And some seismologists have suggested that they could glimpse a plume or two in their seismic “CT scans” of the mantle. Even so, plumes have stubbornly remained an appealing if unproven concept.

Now, as reported online this week by Science (www.sciencemag.org/cgi/content/abstract/1092485), a group of seismologists offers evidence of not one or two plumes but several. Some of them span the mantle 2900 kilometers from core to crust; others hint of a surprisingly shallow origin less than 1000 kilometers down.

These seismologists are confident that they’ve made a breakthrough in plume studies. “This is the first work that really confirms what [plume originator] Jason Morgan says,” says seismologist Raffaella Montelli of Princeton University, first of six authors of the paper. “We are providing visual proof plumes exist.” Other seismologists are more cautious. “I think it is fair to at least suspect that they are overinterpreting their data set,” says seismologist Barbara Romanowicz of the University of California, Berkeley. Until several technical questions are resolved, she says, “I think it is a leap of faith to claim a discovery” of dozens of plumes.

The Princeton report is getting a circumspect reception not just because of the startling number of plumes it claims. It is also introducing a new way of analyzing seismic waves that are combined to form an image of Earth’s interior. In conventional seismic tomography, seismic waves arcing through the mantle from earthquake to seismometer are considered to follow curved lines called ray paths. Where numerous ray paths traverse hotter than normal rock, the waves are slowed and an anomalously warm spot appears in the image.

But thin, warm structures—such as the supposed plumes—would be particularly difficult to image in the conventional manner. So Montelli and her colleagues—especially Anthony Dahlen and Guust Nolet of Princeton—developed an analysis that let them take into account how seismic waves actually travel, spread across a wave front rather than along a single line, or ray path (Science, 3 January, p. 35). By taking into account wave-front energy radiating into a ray path and washing out a slow signal, this “finite frequency” technique boosted the strength of signals from plume-like structures by 30% to 60% and more. They also combined the usual short-period waves with long-period waves, which sense temperature variations farther off their ray paths. That increased sensitivity to plumes missed by short-period waves.

The Princeton technique shows plumes beneath most classic volcanic hot spots. In addition to the two broad superplumes that everyone sees, beneath Africa and the South Pacific (Science, 9 July 1999, p. 187), the new method also shows narrow plumes rising off them, sometimes splitting before reaching the surface. Elsewhere, it shows lone plumes stretching from near the core-mantle boundary to the surface. But other plumes appear to rise from about 660 kilometers deep, the traditional boundary between the upper and lower mantle. A few hot spots, including Yellowstone, seem to lack plumes. And in a major surprise, the plumes beneath two of the most classic of hot spots, Iceland and Galápagos, begin at about 660 kilometers rather than at the bottom of the mantle as they had appeared to (Science, 14 May 1999, p. 1095).

But any mission might not even be feasible. Because Hubble flies in a different orbit than the space station does, the shuttle would have no safe haven in case it developed a problem such as the tile damage suffered by Columbia at launch. That’s a problem in NASA’s post-Columbia world.

For all those reasons, Weiler believes “there is no rush” for an additional Hubble flight: “My goal is a servicing mission by 2006.” For now, most of the space science community shares that near-term vision.

—ANDREW LAWLER