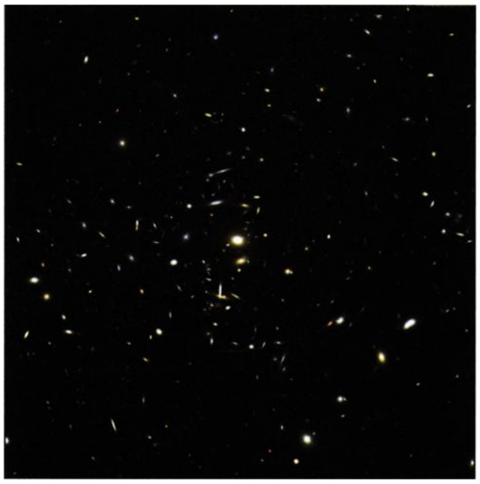
A Hot New Camera—and a Chilly Revival

Next week's service call to the Hubble Space Telescope should double the pleasure of astronomers. Not only will astronauts install a spiffy new camera, but they will resurrect an older instrument that sputtered to a premature shutdown.

Slated for rescue is the Near-Infrared Camera and Multi-Object Spectrometer (NICMOS). Installed in February 1997, NICMOS peered through dust at objects otherwise hidden from Hubble's view. But an accidental contact in the cooling system caused the camera's solid-nitrogen refrigerant to boil away, shutting NICMOS down by January 1999.

The daring fix looks and acts like the minirefrigerator in a college dorm room. "Refilling nitrogen in orbit isn't easy, so we figured out how to cool the camera mechanically," says project scientist Ed Cheng of NASA's Goddard Space Flight Center in Greenbelt, Maryland. The 90-kilogram cryocooler—built by Creare Inc. of Hanover, New Hampshire—will circulate compressed neon gas that expands within the existing NICMOS plumbing, driven by half-centimeter turbines whirling 7000 times per second. The vibration-free system should chill NICMOS to a frigid 70 kelvin for many years, Cheng says.



Sharp arcs. Large detectors in Hubble's new Advanced Camera for Surveys will capture stunning views of gravitationally distorted galaxies, this simulation predicts.

Expect hotter results from the Advanced Camera for Surveys (ACS), which astronauts will slide into the slot occupied by Hubble's last original instrument, the Faint Object Camera. Pictures from ACS will cover twice as much area on the sky as those from Hubble's workhorse, the Wide Field and Planetary Camera 2. Moreover, the camera's imaging chips are three to five times as efficient and its vision twice as sharp. Those gains will have a dramatic impact, says lead scientist Holland Ford of Johns Hopkins University in Baltimore, Maryland: "After 1 or 2 years in orbit, ACS will have detected more faint stars and galaxies than all of Hubble's previous instruments combined."

Astronomers will use ACS to survey wide patches of the distant universe. Such studies should write the book on how clusters of galaxies have evolved, Ford says. ACS images of the eerie distortions of space caused by massive clusters, called gravitational lenses, may reveal magnified images of the first galactic building blocks less than a billion years after the big bang. Further, surveys of the outermost solar system should expose a host of faint icy objects beyond Neptune and Pluto, within the poorly understood Kuiper belt. ACS also boasts a high-resolution camera for even sharper images of small patches, such as the cores of galaxies and dusty disks around young stars, and a detector for spotting ultraviolet light from hot stars, aurorae on Jupiter and Saturn, and other energetic objects. A small disk will block nearly all light from bright central sources for certain studies.

"Everybody and his brother wants to use this camera," says astronomer Richard Ellis of the California Institute of Technology in Pasadena. The competition is already fierce even by Hubble's stingy standards. In the first round of proposals for observing time on ACS, just one of every 20 requests made the cut.

–ROBERT IRION

violet scientists will hold a similar discussion in April at the University of Chicago. "We are thinking ahead more than a decade," says Robert Kennicutt of the University of Arizona in Tucson, who is helping to organize the Chicago meeting. But scientists hoping to rally support for a fast-track payload will be disappointed, Kennicutt warns: "This is not an effort to shoehorn a new mission into NASA's planning cycle."

Coming up with a cohesive plan is particularly pressing for researchers who use the ultraviolet and optical wavelengths that will not be a part of NGST's portfolio. Although smaller missions are on the drawing board, NASA has no plans right now for a major space telescope to serve their needs.

Meeting participants are expected to weigh the relative merits of exploring a range of scientific topics, including the nature of the intergalactic medium, the precise distance among galaxies, extrasolar planets, and the identification of fainter galaxies to understand galactic evolution. "It is real easy to define exciting problems," says Kennicutt. "It's more difficult to ask how many will still be cutting edge in a decade." Getting a firm grip on the scientific issues is vital, says Kinney. "Scientists tend to think in terms of facilities; from NASA's point of view, we need to know what science questions are important."

Researchers will also try to mesh their plans with the growing capabilities of ground-based telescopes. Those on the ground cannot compete with the cold and clear conditions of space when it comes to gathering infrared, x-ray, and ultraviolet wavelengths, and that fact is unlikely to change for a long time. But thanks to new technologies—such as adaptive optics—Earth-bound telescopes are starting to rival some of the best of Hubble's images in the optical realm. And ground observations are a lot less expensive.

"In some parts of the visible spectrum, there's not necessarily an advantage to a space telescope," Kennicutt says. But there is no consensus on when or whether those advances will equal or supercede space-based instruments. "There is a gray area when it comes to the visible, and [there is] quite a divergence of opinion," he adds.

For example, adaptive optics can monitor how the atmosphere distorts the image of a single bright star and compensate for the entire field by making minute adjustments to the mirror. The latest technique makes use of an artificial "star" created by a spot of laser light shot high into the sky. Recent pictures from the European Southern Observatory's Very Large Telescope atop Cerro Paranal, Chile, are even sharper than some Hubble images. But that clarity fades for wider fields.

Although some astronomers say wide-field optical imaging from space will retain an advantage over ground-based mirrors, the University of Arizona's Roger Angel says that ground-based technologies are catching up at telescopes such as the W. M. Keck Observatory atop Mauna Kea in Hawaii. At Keck, a series of lasers shot into the atmosphere allow researchers to adjust their mirrors to compensate for atmospheric effects over wider fields. Developing accurate lasers has proved problematic, but they are improving, says Angel. In fact, some ground-based astronomers soon expect to be able to capture images of extrasolar planets (*Science*, 25 January, p. 616). "The space-based guys always need to be looking over their shoulders," he adds.

Technology bridge

The outcome of this horse race between ground-based adaptive optics and space-based technologies will play a key role in NASA's decision on which missions to fund. "We need a hard-nosed discussion of the

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