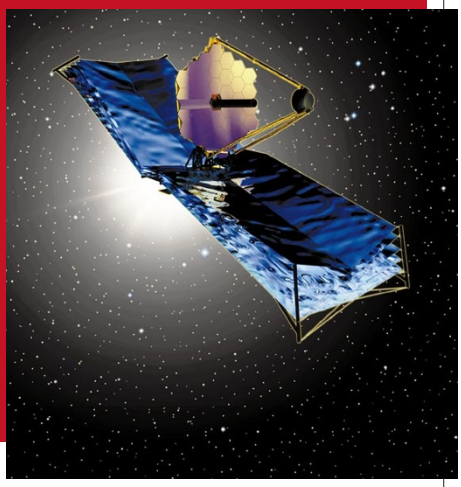
Torn between a rock and a high place

As astronomers mull over the merits of large versus smaller ground-based telescopes, another — equally contentious — debate is taking shape. Which will provide the best value for money: orbiting successors to the Hubble Space Telescope, or ground-based titans with mirrors of up to 100 metres in diameter? The answer may depend on whether adaptive optics, which eliminates the distortion caused by atmospheric turbulence (see main story), can be applied to the huge ground-based telescopes that are now on the drawing-board. "Adaptive optics is the single critical-path technology that has to be proven. And without high-quality wide-field adaptive optics, it is probable that, ultimately, there is no future for astronomy on the ground," says Gerry Gilmore, an astronomer at the University of Cambridge.

Applying the technology to monsters such as the European Southern Observatory's proposed 100-metre OverWhelmingly Large (OWL) telescope poses a formidable challenge, not least because it will require supercomputers hundreds of times faster than current models. But if the technical obstacles can be overcome, OWL could provide images of individual stars within galaxies so far away that the light started on its journey to Earth when the Universe was a quarter of its current age. It could also observe planets orbiting around other stars in our Galaxy. Such performance would exceed by an order of magnitude that of the 8-metre Next Generation Space Telescope (NGST, right), which NASA, in collaboration with the European Space Agency and Canada, plans to launch around 2009, for about the same projected cost of US$1 billion.

Indeed, the huge costs of getting large mirrors into space — not to mention the technical difficulties — mean that space telescopes will be unable to compete at wavelengths that can be studied from the ground, if the issue of adaptive optics can be cracked. Space telescopes also have the disadvantage that their instruments cannot readily be updated. "You are always flying old instrumentation," says Piero Benvenuti, who is coordinating European planning for the NGST.



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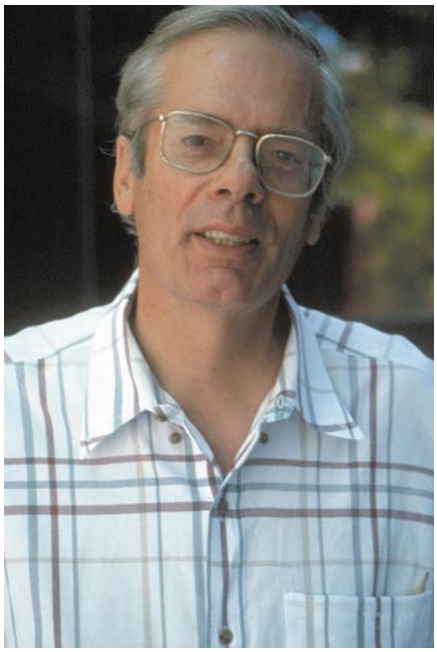
telescope's primary mirror is reflected. The technique's power was demonstrated when the 3.6-metre Canada-France-Hawaii telescope on Mauna Kea produced images of the galaxy NGC 7469 that matched the resolution of those from Hubble[3].

Last year, the technology was applied successfully at Keck II[4], and the first adaptive optics images from Gemini North, an 8.1-metre telescope at Mauna Kea, were released last month. The technique is now central to the planning of all the main large-telescope projects.

Some astronomers believe that combining large mirrors with adaptive optics will make many small telescopes obsolete. "In my opinion there are too many small observatories that now are too expensive," says Lodewijk Woltjer of the Haute-Provence Observatory in France. "You can't expect to keep doing what you used to do and at the same time start up new things."



Mirror man: Roger Angel's work is helping to drive the development of ever-larger telescopes.

The French government seems to agree. Last year, it decided to stop core funding to telescopes smaller than two metres. Only strong protests by astronomers prevented the telescopes from being shut down. But in the absence of central government funding, observatories now have to seek alternative income. Stressing their value for training astronomy students, some telescopes are now being funded by individual universities or local authorities. The Pic du Midi Observatory high in the Pyrenees, meanwhile, has opened its facilities to 'scientific tourists'. "We now have only two national telescopes in France, one at Pic du Midi, the other at Haute-Provence," says Roland Bacon, director of the Lyon Observatory, who is seeking alternative finding for his observatory's 1-metre telescope.

In Britain, smaller telescopes are also coming under financial scrutiny, as the UK Particle Physics and Astronomy Research Council negotiates terms for Britain to become a member of the ESO. An announcement on whether Britain will join is expected soon. And depending on the precise terms of any membership deal, Britain might have to stop funding some smaller telescopes, such as the 4-metre Anglo-Australian Telescope at Siding Spring in New South Wales and some members of the Isaac Newton Group of Telescopes on La Palma.

Meanwhile, the ESO is itself threatening to axe some of the smaller telescopes on its site at La Silla in Chile unless other organizations offer to take them over. "ESO is involved in facilities that are beyond the capabilities of a single country," says Piero Benvenuti, an astronomer who works for the European Space Agency but is based at the ESO. "If a small telescope is only there for historical reasons, ESO should discontinue its use."

The same questions surround many of the telescopes run by the US National Optical Astronomy Observatories — in fact, some of the organization's smallest telescopes are already being transferred to consortia of universities. "There is a lot of hand-wringing about what to do with our national observatories," says Roger Angel, whose work on mirror technology at the University of Arizona in Tucson is helping to drive the development of ever-larger telescopes.

Small scopes take a stand

Some astronomers who use or work at the observatories now coming under threat feel that small telescopes are getting a raw deal, particularly as the costs of keeping them open are not huge. "A new telescope may cost US$5 million a year to run, and the small telescope will cost US$50,000," says Helmut Abt of the Kitt Peak National Observatory in Arizona.

There are also fears that politics and egos are being allowed to dominate over a reasoned assessment of the scientific merits of the different telescope sizes. "Many of the people who are in senior positions have been using large telescopes," says Richard Ellis, an astronomer at Caltech who is himself involved in a proposal to build a 30-metre device called the California Extremely Large Telescope. "In the political arena, the large telescopes get a lot of attention; they always get prominence in the newspapers. The