

All hail the Keck ten-meter telescope project

I write, in some excitement, first thoughts after a press conference in Pasadena on 3 January. The W. M. Keck Foundation is proposing to grant \$70 million to the California Institute of Technology for construction of the world's largest optical telescope, ten meters in aperture, on Mauna Kea, Hawaii. (See page 71.) It will be a long time before the true importance of the announcement can be properly evaluated. This, possibly the largest private gift in the physical sciences, comes to a privately supported institution, already operating the 200-inch Hale telescope on Palomar Mountain, a radio and a solar observatory, and soon a submillimeter telescope.

The telescope will be operated and used jointly by astronomers and physicists of Caltech and of the University of California. Much remains to be completed in this complex arrangement: a design review; an inter-university financial, scientific and operational agreement; and a joint nonprofit corporation to construct and operate the telescope. The Keck family has long associations with Caltech. The W. M. Keck Foundation, whose president Howard B. Keck is a Caltech trustee, provides the money. The observatory and telescope are to be named in honor of his father, William M. Keck, a pioneering oilman. In rough outline, Caltech supplies most of the initial capital, and the University of California pays for operation until the investments are equalized. It is an imaginative plan.

But there were other than financial reasons. The University of California has long held a leading place in astronomy, with teaching and research departments at four campuses. Its Lick Observatory, headquartered at the University of California, Santa Cruz, has a 120-inch as its major instrument, serving the entire California faculty at all its campuses. Lick is affected by city lights, and only skill in instrumentation keeps it in the forefront. Because the California group has long needed more photons, astronomers and physicists, led by Jerry Nelson of the Lawrence Berkeley Lab, have been planning a new large telescope. Mauna Kea (where the University of Hawaii has an established site) is as nearly ideal as any earthbound location. The Nelson telescope design is innovative—a mosaic of 36 quite thin hexagonal mirrors; interacting sensors provide information rapidly to maintain the parabolic figure. Now that the money is available, can we foresee the effects of this surprising, enormous, private investment?

Like high-energy physics, astronomy is an intrinsically expensive science; faint objects send us expensive photons. Integrating four times longer for the same result with a 5-meter telescope is not a solution. Even with the relative luxury of access to Palomar by a limited number of observers, we found no substitute for collecting area. Technological advances were not enough

for the problems that could be addressed. Recent gains in quantum efficiency brought detectors, such as the charge-coupled device near to theoretical limits, and little more can be expected from sensor technology, except increased area. (CCD's are now 12 mm square, with fewer than 10^6 pixels.) My colleagues working on faint quasars, or looking at clusters of galaxies at large redshifts, or searching for nonluminous matter, continuously demand more photons. Rare or distant objects are faint. A program that would take four years with the 5-meter is almost never started; with the 10-meter, it becomes possible in a year. The goals now attainable are far more ambitious than our past dreams. We need spectra and velocities, stellar contents and compositions, of many galaxies at redshifts z larger than 1; present spectra at $z = 1$ are largely photon noise. Quasars become rare for z above 3; their light traverses intervening hydrogen clouds, which may have primordial composition. The unknown details of galaxy evolution for values of z between 1 and 2 will illuminate early history.

The Space Telescope complements the 10-meter telescope: Without atmospheric limitations, it should have higher angular resolution but far fewer photons (smaller area), and about the same duty cycle. It has ultraviolet sensitivity whereas the 10-meter will be excellent for the infrared. New auxiliary instruments on a ground-based telescope permit quick response to changes in sensor technology and costs are lower than in space.

The project faces many engineering challenges: Figuring the off-axis segments of the paraboloid requires innovative methods. The focal ratio is fast and the curvatures are steep. The tube length and the dome are surprisingly small, making the telescope economical compared to a scaled-up 200-inch. The altazimuth drive needs to be precise, to use the excellent seeing. Operating a very large telescope on Mauna Kea, at 13 600 feet, is difficult but the instruments are computerized. Will remotely controlled observing be feasible? The auxiliaries for the 10-meter will need to be (at least conceptually) designed soon. I wish I were younger!

This has indeed been an extraordinary, surprising event; I remember the depth of public involvement with the 200-inch project, and with science, when Hale's great vision of the 200-inch project encountered a similar farsighted response within the Rockefeller Foundation. Fifty years later, a large private gift to science emphasizes its intrinsically cultural value. As Howard Keck explained, it will "... help to discover how we and the universe began." Although the Federal government's support of science must continue to be on a much greater scale than private support, society's rewards for this support are not only practical but ennobling. President Reagan sent a message to the presidents of Caltech and the University of California, and to the Kecks. It ended with: "... and I offer my best wishes for a New Year that has started off with a truly Big Bang."

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