MEETING BRIEFS

New Instruments Shed Light On Astronomy's Future

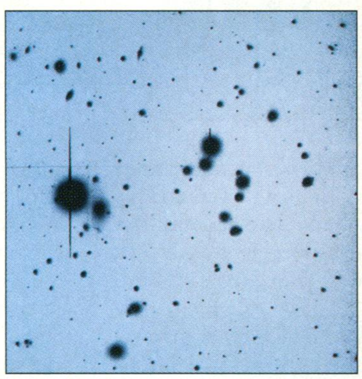
KONA, HAWAII–The snowy 14,000-foot summit of Mauna Kea, with its bevy of powerful telescopes including the just-completed Keck, provided an appropriate backdrop for a recent ocean-side gathering of astronomers and engineers to discuss "Astronomical Telescopes and Instrumentation for the 21st Century." Last month's meeting was organized by the Society of Photo-Optical Instrumentation Engineers, and included a status report on liquid mirror telescopes, discussion of a space observatory that may make optical and x-ray astronomers best friends, and a modest proposal to cover the globe with a network of small, automated telescopes.

Telescopes Turn Liquid

Astronomers have long had a delightful daydream: telescope mirrors made of spinning pools of liquid. Such mirrors have tantalized stargazers with the potential for enormous telescopes, because a pool of a reflecting liquid—mercury, for instance—can be constructed at a much lower cost than the millions of dollars needed to cast, grind, and polish large glass mirrors. As in all daydreams, however, there was a catch. Until the last decade, a telescope needed to move in order to track objects across the sky and produce a clear image; in a liquid mirror, such movement would destroy its required surface shape. The dream was deferred.

No longer. This January, after a decade in which Ermanno Borra at Laval University in Quebec has been testing prototype mirrors in the lab and cheerleading the concept, the first liquid-mirror instrument designed for astronomical research debuted on the outskirts of Vancouver, Canada, as Paul Hickson of the University of British Columbia told the meeting. (Last year, the University of Western Ontario began using a liquid mirror to capture the faint reflection of laser beams bouncing off the atmosphere. That scheme wasn't intended for astronomical observation; it was designed to probe the composition of the atmosphere.) The key advance making this instrument a reality was the 1982 invention of a computerized light sensor that could digitally compensate for Earth's rotation and allow tracking of astronomical objects from an immobile telescope.

In both Canadian instruments, the mirror is a shimmering 2.7 meters in diameter, made from a few gallons of liquid mercury, spun into a 2-millimeter layer by a rotating Kevlar container. The forces of the spin and gravity mold the mercury into a parabolic shape, well suited for focusing light. Indeed, in February, the Vancouver mirror produced spectacular images of some of the universe's most distant and faint galaxies, says Hickson. This reflecting pool is also cost-effective: The telescope ranks among the world's top 20 most powerful optical instruments yet cost only $200,000 to build. A comparable-size solid-mirror scope might cost millions. Keck, the world's largest with an effective 10-meter aperture, totaled more than $70 million.



P. HICKSON

Reflections of the future. One of the first images of galaxies *(left)* produced by a telescope with a liquid mirror was released last month. The mirror *(right)* is on a scope located near Vancouver, Canada.

In spite of the beautiful images coming from Vancouver, hard-mirror devotees such as Roger Angel of Steward Observatory at the University of Arizona, a pioneer in solid-mirror technology, maintain that the liquid approach has major caveats. One drawback is the relatively small field of view a parabolic mirror provides. Another problem with the technology is that, since tilting a liquid mirror would ruin its shape, they're limited to imaging objects directly overhead. "The huge drawback...is you can't point the damn thing," says Angel.

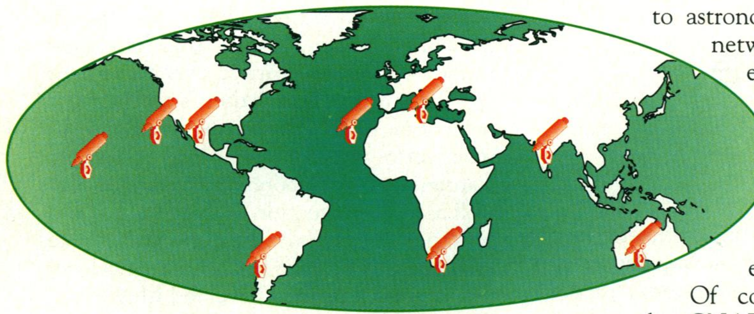
Borra and Hickson respond that there is no desperate need to aim their mirrors anywhere but overhead: Earth's movement brings enough sections of the sky into view overhead to keep their immobile telescopes busy. "It's very well suited for a variety of scientific projects that don't involve pointing. For survey projects, it's ideal," asserts Hickson, who is planning to use the Canadian telescope to map the large-scale structure of distant galaxies. Other targets, which are faint and thus demand the light-gathering power of a large mirror, will be distant quasars, variable stars, supernovae, and galaxies, he adds.

The developers of liquid mirrors do admit they are still polishing their craft, particularly when it comes to size. Solid mirrors have not come close to breaking the 10-meter barrier, but some believe liquid mirrors 10, 20, or 30 meters or more in diameter loom ahead. "We don't know if there is any fundamental limit," says Hickson, who is seeking money for a 5-meter mirror next. One potential roadblock may be that as mirrors get bigger, their outside rims rotate faster, and there may be a point at which the liquid spins so fast it produces wind turbulence, disturbing the air and lowering image quality.

Such questions have long been theoretical but now, at last, scientists have a working telescope to evaluate in their efforts to find answers. "Many astronomers are watching us closely," says Hickson. Even the hard-mirror bunch are playing with the technology. Angel and colleagues are developing a telescope that combines a glass mirror with a large—but very economical—liquid reflector. Concludes an optimistic Borra, "The technology is very young and the sky, it can be said, is still the limit."

Buying Time: A Buzz About a GNAT

Astronomers keep running out of time, specifically observing time on telescopes. Take Roger Culver, a lone astronomer with one low-quality telescope at Colorado State University. At the moment, Culver just can't compete with the big boys at places like the University of California, which runs a num-



Scoping out the globe. Astronomers would like a worldwide network of automated telescopes. The network should allow researchers to get more observing time.

ber of its own powerful telescopes. But soon he may be able to, thanks to a very down-to-earth development: a new non-profit organization designed to alleviate a painful crunch in telescope observing time.

The organization is called GNAT, Inc., which stands for Global Network of Astronomical Telescopes, and it hopes to dot some of the world's best observing sites with small but sophisticated automated optical telescopes that would be operated at long distance by computer. "You can have access to good telescopes at good sites. It allows people such as myself, the have-nots, to get into the game more," says an excited Culver.

Indeed, getting more astronomers into the game, and keeping entry fees down, was one of the ideas that set off GNAT Inc.'s founders, Eric Craine of Western Research Co., and David Crawford and Mark Giampapa of the National Optical Astronomy Observatories (NOAO). Only a select group of astronomers, they say, have easy and bountiful access to high-quality instruments at sites where weather and visibility are favorable. NOAO, which is supposed to serve the whole community, can accept perhaps just 1 in 5 research proposals before its instruments are booked. Even then, astronomers might be budgeted for only a few nights a year.

Discussed for many years, the idea of a GNAT has been given new practicality by the recent advent of automated observatories—a small number are now in operation around the world and at least two U.S. companies now manufacture them. GNAT, Inc.'s plans call for placing a dozen small automated telescopes at six excellent observing sites, such as those in Chile, South Africa, Australia, and Hawaii. The telescopes would be connected to a central computer network running on specially developed software that would allow far-flung astronomers, dialing in through the Internet, to plan and gather data from automated observing runs.

This type of remote-control observation would also have a major educational impact, suggest GNAT fans. For instance, says Culver, his students could have real-time access to astronomical data from the network and gain experience doing modern data analysis for ongoing cutting-edge research projects instead of working on dry, artificial classroom exercises.

Of course, all this costs money, but GNAT boosters contend it's pocket change compared to the millions spent on a single Keck. Automated telescopes, they say, require little on-site maintenance or monitoring. By placing them near existing observatory sites, astronomers could also take advantage of infrastructure already in place. Moreover, placing a large single order for automated telescopes should drive down the cost per instrument because of economies of scale, says Crawford.

Another significant cost-saving measure is to keep the telescope design simple, with one basic detector, rather than designing each telescope with specialized components that most astronomers won't need. "If you keep the telescope kind of generic, let it do 80% to 90% of what people want, you can bring the cost way down," contends Crawford. And most important, these modest 1-meter mirrors equipped with modern light-gathering computer chips can still equal, for many tasks, the performance of the largest telescopes a few decades ago. "There's a lot of very good and fundamental astronomy that can be done on these small scopes," says Culver.

Crawford and his colleagues calculate that a full GNAT could be up and running for less than $5 million, with operating expenses of $1.2 million a year. At the moment, says Giampapa, "we're looking at avenues of private funding." The group is also trying to sign up a slew of universities as partners. "We see this network building up in a series of layers and evolving over time," explains Craine.

Though the trip from plans to reality could prove a long one, astronomers like Culver applaud the birth of GNAT, Inc.: "If you don't dream, you don't get anything done. Now we're getting out of the dreams and into the nitty-gritty."

Optics and X-rays: A Marriage Made in Heaven

They may not be as cliquish as status-conscious teenagers, but different subgroups of observational astronomers still talk mostly among themselves. For instance, investigators who primarily use ground-based optical telescopes to study the cosmos with visible light often have little to do with high-energy astrophysicists, who must study x-ray sources such as binary star systems using space-based detectors. It's an unfortunate cultural gap, scientists say, since optical observations can enhance the understanding of some of these still-mysterious objects. And at the Hawaii meeting, researchers described an up-and-coming space observatory from the European Space Agency (ESA) that may soon give the two groups more to chat about.

The 3-ton orbiting instrument, dubbed XMM (X-ray Multi-Mirror Mission), is a sophisticated x-ray space observatory with an optical twist: It will carry a 30-centimeter optical telescope aligned with three x-ray scopes. Now under construction and slated for a 1999 launch, the $30-million project will be "the first true multiwavelength observatory in space," says Pennsylvania State University astronomer Scott Horner, a member of the United States–United Kingdom collaboration working on the optical monitor.

The capacity for simultaneous x-ray and optical viewing will come in very handy for observing several puzzling astronomical phenomena. One of them is an unusual type of binary star system that emits large sporadic bursts of x-rays a few times a day, according to Jeffrey McClintock of the Harvard-Smithsonian Center for Astrophysics. The bursts last only a few seconds and are immediately followed by an optical flash. The flash is caused by the x-rays striking a disc of material lying around one of the stars. By using XMM to observe the input energy—the x-rays—and relating this energy to the brightness and duration of the subsequent optical flash, McClintock believes he and other astronomers can glean clues to the composition and size of these discs.

In the past, making these x-ray and optical comparisons has been almost impossible. Ground-based optical observatories are often booked solid a year ahead of time, making it difficult to capture images of an x-ray source that's suddenly exhibiting unusual variability. "We can rarely follow up within months," laments Richard Griffith, an astronomer at John Hopkins University and a mission scientist for XMM. By the time an optical scope can be trained on an object, its behavior may have changed enough to render any comparison with the earlier x-ray data meaningless. Coordinating simultaneous observations between ground- and space-based instruments is likewise a scheduling nightmare. "It's much easier to have an optical scope aboard [the x-ray observatory]," says Horner.

Optical data should also help astronomers pin an ID on x-ray sources they've been unable to categorize. So when XMM reaches orbit, optical and x-ray astronomers can expect to be in touch much more often.

–John Travis