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For Immediate Release

May 23, 1989

Color/B&W Available

GIANT TELESCOPE ARRAY WILL USE

OPTICAL TROMBONE TO GIVE ASTRONOMERS

"A NEW PERSPECTIVE ON THE UNIVERSE"

Scientists from two Georgia universities are seeking a total of $10 million to build a seven-telescope stellar interferometer which would provide resolving power more than a hundred times better than any existing telescope.

The facility would allow astronomers to more readily observe such celestial objects as binary stars -- and to detect planets in other solar systems. Design and prototype testing has been completed under a $260,000 National Science Foundation grant.

"A long baseline optical interferometer would be a revolutionary leap forward in fundamental observational astronomy," said Dr. Harold McAlister, astronomer at Georgia State University and principal investigator in the project. "Such an instrument could literally furnish a whole new perspective on the universe."

Over the centuries, astronomers have built larger and larger telescopes in order to see fainter and fainter objects. But because of image degradation caused by the Earth's atmosphere, larger conventional telescopes don't always provide better images. Optical interferometer technology -- similar in principle to that used in radio astronomy -- offers one means of compensating for that degradation.

In an interferometer, a pair of telescopes relays a commonly intercepted wave front of light to special beam-combining optics. When the two beams are brought together, they interfere and produce a series of alternating bright and dark bands called fringes. By studying the pattern and spacing of these interference fringes, astronomers can determine the star's physical characteristics -- and whether it has any close companions.

Each computer-controlled telescope in the proposed array would have a primary mirror one meter in diameter. The telescopes would be dispersed along three baselines in a "Y" configuration. By alternately coupling the wave fronts from different pairs of telescopes, full two-dimensional coverage of any desired object would be possible.

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The result, said McAlister, would be "resolving power equivalent to a single enormous telescope 400 meters in diameter."

Bringing the light waves together posed complex technical problems. Because the telescopes are located at minutely different distances from the star, light actually encounters one telescope slightly before it reaches the other, explained Dr. Allen Garrison, senior research scientist at the Georgia Institute of Technology.

"These distances, and the corresponding delay, change constantly as the telescopes follow a star across the sky," he added. "What is needed is a kind of optical trombone that continually compensates for the varying optical path lengths."

Garrison and a team of researchers in Tech's Electromagnetics Laboratory designed and built a unique optical/mechanical system to adjust the optical path of one telescope to precisely match the other. Consisting of an elaborate arrangement of fixed and movable mirrors, this Optical Path Length Equalizer (OPLE) can maintain equal path lengths to the micron accuracies necessary for optical interferometry.

Each pair of telescopes will require a separate OPLE system with "optical pipes" carrying light from the telescopes to a central observing building. There, the optical paths will be matched, wave fronts coupled and the resulting interference fringes analyzed, Garrison explained.

In addition to seeking astronomical data, Georgia Tech researchers hope to use the facility for developing highly sensitive light detectors and other electro-optic devices.

With the help of other researchers and students at Georgia State University and Georgia Tech, McAlister has designed and tested the interferometer's major components, studied potential sites in Arizona and New Mexico, and examined what role the proposed instrument would play in astronomical research.

McAlister estimates the array will cost about $10 million --approximately the same as a single four-meter telescope. By providing more than 100 times the resolution of a four-meter telescope, the new instrument would offer astronomers a new and unique measurement capability.

Using the array, astronomers could obtain accurate data for systems of binary stars: two stars located so close together that conventional instruments cannot separate their images. The greater resolution could also let scientists watch individual stars pulsate, observe sunspots on distant stars, or detect tiny perturbations in a star's orbital motion produced by otherwise invisible planets.

"Beginning with Galileo's first crude instrument, ever larger telescopes have pushed back the frontiers of our knowledge," said McAlister. "Modern stellar interferometers likewise mark the beginning of a new era in which we can better view and comprehend our universe."