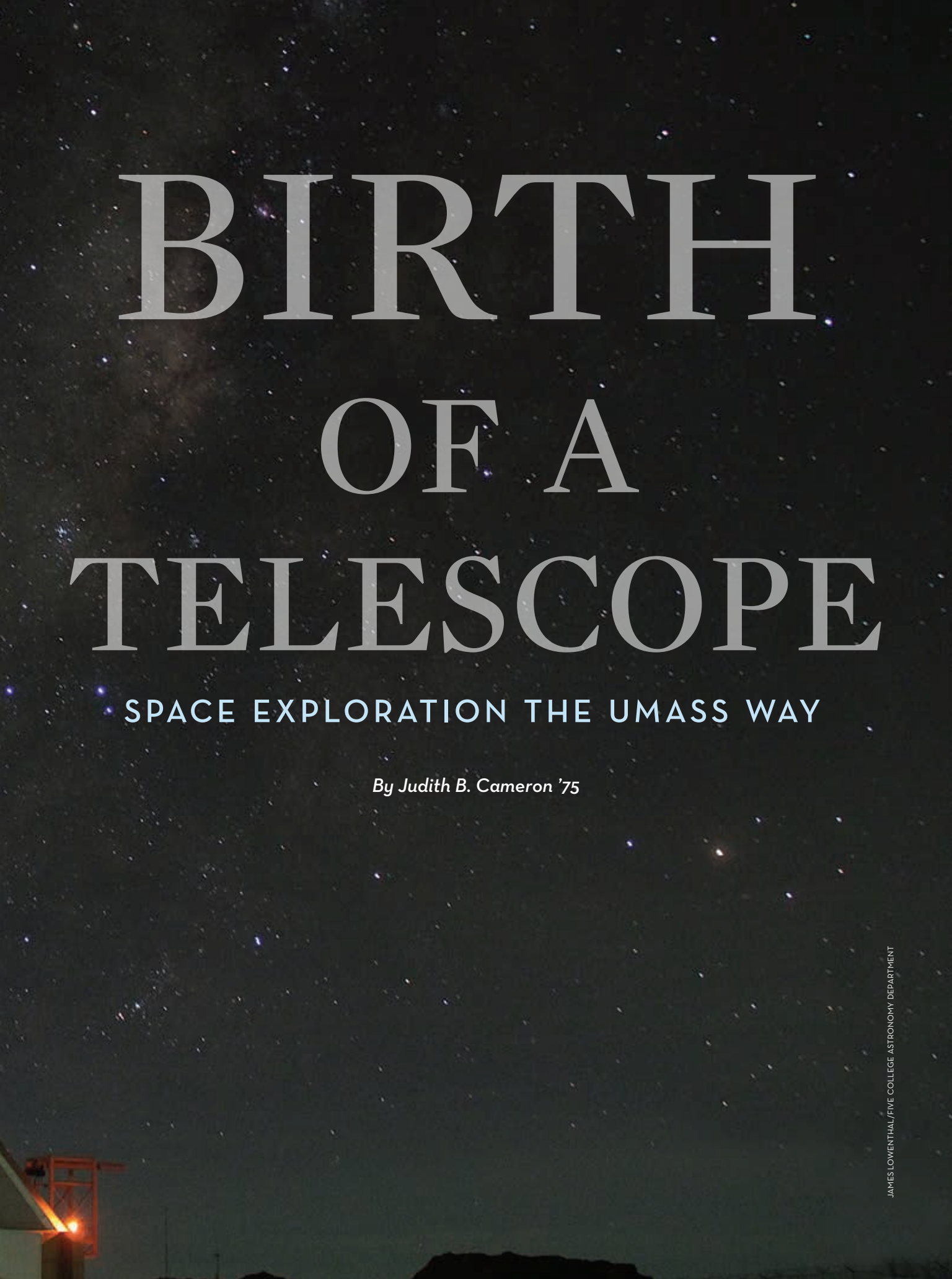
BIRTH OF A TELESCOPE

SPACE EXPLORATION THE UMASS WAY

By Judith B. Cameron '75



JAMES LOWENTHAL/FIVE COLLEGE ASTRONOMY DEPARTMENT

AS THE WORLD'S OLDEST SCIENCE, astronomy has long fired the imaginations of those seeking answers to existential questions about our origins. From the observations of the ancient Mayans and Chinese, who laid the foundations of astronomy, to today's space explorers, scientists are much closer to deciphering the mysteries of the universe. On the frontiers of discovery are UMass Amherst astronomers, who this summer commissioned the Large Millimeter Telescope (LMT), in Mexico, the biggest millimeter-wave telescope ever built.

The LMT, a radio telescope that can detect electromagnetic radiation from objects far away, is a high-precision time machine that observes and makes images of galaxies born billions of years ago, providing insight into the birth and evolution of the universe. "The LMT is a bridge to our understanding of the universe," says Grant Wilson, a professor of astronomy who designed and built the telescope's sophisticated camera system. The commissioning of the telescope, a joint venture between UMass and Mexico's National Institute of Astrophysics, Optics and Electronics, is the realization of an idea that began percolating in the late 1980s: build a one-of-a-kind telescope that uses high-frequency radio astronomy to create new knowledge and expand UMass Amherst's international reputation.

The telescope is nearly as tall as the 16-story Lederle Graduate Research Tower. It cost $200 million to build; most of the funding came from Mexico while UMass provided significant parts of the project's brain trust. The binational project produced the largest and most complex scientific instrument ever constructed in Mexico. Its sits atop the country's fifth-highest peak, Sierra Negra, a 15,000-foot high inactive volcano 150 miles east of Mexico City. The location provides ideal conditions for large millimeter wavelength telescopes—low humidity and good vantage points with views of both southern and northern skies. The telescope will be able to create maps of distant objects, thereby revealing thousands of new galaxies.

"This instrument makes UMass Amherst a big-time player internationally. It's been gratifying to see it come on line," says F. Peter Schloerb, a professor of astronomy, who has worked tirelessly to secure UMass's portion of funds and managed unforeseen challenges that delayed construction.

Last summer the astronomers conducted the first official scientific studies using the telescope. The LMT team received 35 study proposals, representing 146 scientists from 57 insti-

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The LMT stands on a mountaintop 150 miles east of Mexico City.

tutions in 12 countries. "More would have been submitted but we discouraged them for our maiden observations," says Schloerb. A second round of studies from different proposals was undertaken in December. "Once we establish and report on the LMT's level of precision, which is excellent, I think people are going to beat a path to our door to get time on it for their own projects," notes Schloerb.

The maiden observations of the LMT paved the way for another milestone when UMass joined an international experiment to demonstrate the LMT's ability to make joint observations with an array of radio telescopes operated by the US National Radio Astronomy Observatory. The test was successful, and the LMT is now ready to be part of the team that plans to take the first image of the black hole at the center of the Milky Way later this year. "Nobody has been able to take a picture of the black hole before, so this was an important achievement," notes Schloerb.

The LMT can see objects such as black holes that are invisible to other ground-based telescopes and to spacecraft, which can only observe objects in gamma rays, X-rays, and ultraviolet or infrared light. The combination of the large dish, the excellent environmental conditions at the site, and the world-class instrumentation is what makes the LMT a unique research instrument. "We can see the earliest objects with the LMT and that is the real beauty of the telescope," says Wilson, who joined the astronomy department in 2000 to help build the telescope's camera system, a feat of engineering wonder. For instance, the camera equipment contains 144 detectors that must be cooled to .25 degrees above absolute zero to guarantee precise images. Wilson is now working on a second-generation optical system that will employ 7,000 detectors. He and his graduate students work in a small laboratory machine shop in Lederle where they build equipment destined to uncover new knowledge.

The LMT is the envy of many college astronomy departments. "Having access to a big telescope attracts good students and faculty who will publish research that will generate a lot of excitement," says Schloerb. The UMass Amherst department of astronomy has a long history of building telescopes. Its first radio astronomy observatory was erected in 1969 near the Quabbin Reservoir.

Over the years, the astronomy faculty has advanced the study of cosmology by making several contributions, including building other telescopes and cocreating computer programs that make it possible to analyze the massive amounts of data that result from space exploration. For example, Mauro Giavalisco, a member of the astronomy department, and others developed a new technique which enabled NASA's orbiting Hubble Space Telescope to recently identify the most distant and earliest galaxy ever detected. With 14 tenure-track and three research faculty members, the astronomy department is ranked 17th nationally in receiving grant funding. Four faculty members are listed as among the most-cited space scientists, according to the ISI Web of Knowledge.


PhD student **Allison Kirkpatrick**

For PhD students, the LMT offers hands-on experience, counter to trends of "remote observing" where images and data are collected on site and sent to desktops for further study. Funded by a gift from astronomy alumnus William B. Bannick '70 for graduate students to travel to Mexico, PhD candidate Allison Kirkpatrick visited Sierra Negra last summer, where she operated the LMT's control panel, moved the telescope, and amassed data. "Most graduate students don't get to work this closely with a telescope," explains Kirkpatrick, who hopes to work as a research professor after she earns her PhD in 2016.

Kirkpatrick, who studies galaxies that originated from three billion years after the Big Bang, adds, "It is really exciting to be at the birth of a telescope and watch it get data for the first time." Thus far, she has learned that galaxies formed in the early part of the universe look different from younger galaxies. She says, "Ultimately, we want to understand how the Milky Way became what it is and how life formed on our planet." UM