# Annual Report
# Atmospheric Research Observatory

## First Light and Dedication Ceremony


NAU President John Haeger, left, Interim CEFNS Dean Barry Lutz, and Vice Provost Susanna Maxwell. Photo courtesy of Diane Rechel, NAU Pubic Affairs.

On the evening of September 30, 2008, Northern Arizona University celebrated the first light and dedication of its new Ritchey-Cretien 20-inch telescope at the Atmospheric Research Observatory. The telescope was made possible by a generous gift from Interim CEFNS Dean Barry Lutz and Vice Provost Susanna Maxwell. Distinguished guests attending the event included NAU President John Haeger, Vice President for Research Laura Huenneke,Vice President For Enrollment Management and Student Affairs David Bousquet, and Lowell Observatory Director Robert Millis. After the ceremony, guests enjoyed eyepiece viewing with the telescope on a clear and warm September night.

## Public Outreach

Every clear Friday night during the academic year between 7:30 and 10:00 p.m., the NAU Astronomy Club hosted public viewing with the new 20-inch telescope. Typically, 10 to 30 people attended each public night.

In addition to Friday public nights, the Observatory hosted a number of special events during the year. In September 2008, we hosted two hundred people during the Flagstaff Festival of Science, and almost two hundred more people during Parent's Weekend.

In February 2009, we hosted a special program to view comet Lulin at its brightest. NAU/NASA Spacegrant student Michael Thiel, working as an intern at the Arizona Daily Sun, wrote a front page article for the paper that helped us draw well over two hundred people to the event.

During three nights in June 2009, the Observatory hosted 60 high school students participating in a NAU College of Education program for disadvantaged high school students.

# Observatory Development

At the right is an image of the globular cluster Messier 3 (M3) taken with the Lutz 20-inch telescope and Apogee 1k x 1k CCD science camera. The exposure time was 15 minutes. The field of view is 11 arc min x 11 arc min.

Messier 3 is an immense spherical cluster of 500,000 stars over 30,000 light-years from the Earth.

There are about 150 globular clusters in the halo of our Milky Way galaxy. They are some of the oldest objects in the observable Universe. The typical globular cluster is 11 billion years old.

Image courtesy of Stephen Tegler, Arron Shiffer, and Logan Tegler

Once the telescope was installed in the dome in mid-August 2008, we began the process of making calibration observations necessary for computer control of the telescope's motion. Specifically, we made observations of dozens of stars around the sky over several nights to establish a pointing map. The pointing map makes it possible for us to input coordinates for a celestial object into a computer program which then commands the telescope to slew to the point where the object resides in the sky . In January 2009, we refined the pointing map in preparation for observing with a digital (CCD) camera.

Between October and May, we successfully installed the hardware and software necessary to take images with a CCD camera. In particular, we attached and tested an instrument rotator, off-axis guider, guide camera, filter wheel, UBVRI filters, and science camera to the back plate of the telescope's primary mirror. These components and the telescope make for a research-grade astronomical facility. During the same time, we converted the old dark room in the Observatory into the control room for observing with the CCD camera.

In May, we upgraded the dome so that its movement is controlled by computer rather than a hand paddle attached to the pier. In addition, we installed an infrared camera to the telescope's secondary ring. The infrared camera lets us sight the telescope out the slit from our control room.

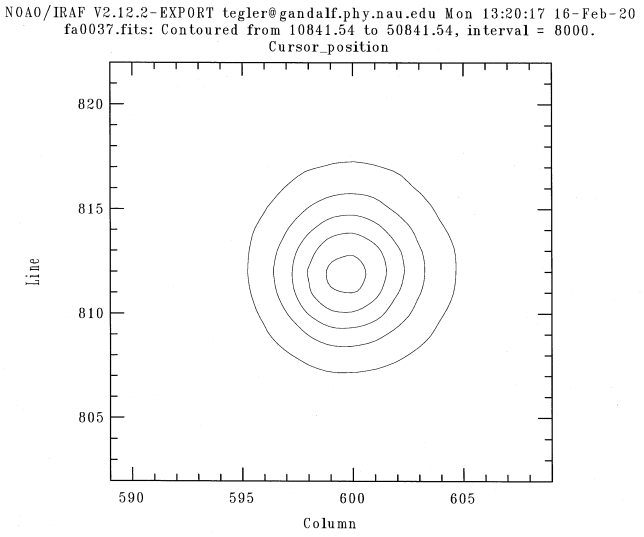
As of June 2009, the telescope is nearly fully functional for observing with a research grade CCD camera. Eyepiece observing is done on the second floor with the telescope. CCD imaging is done from the control room on the first floor.

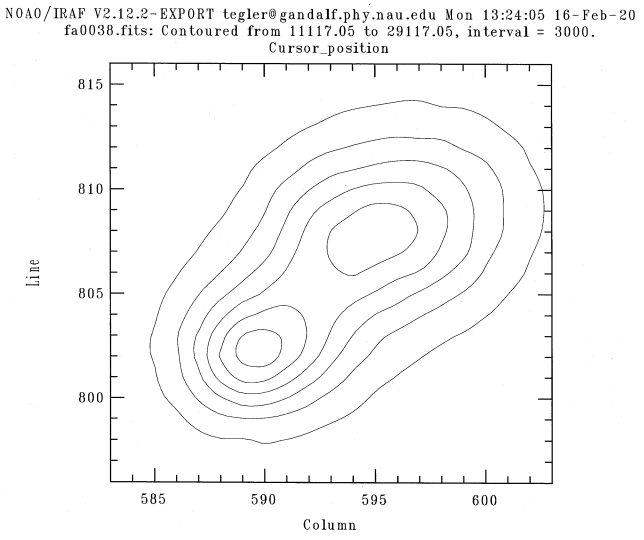
# Auto-Guider Camera

Besides the Apogee Instruments science camera, our telescope has a second camera, a Santa Barbara Instruments Group 765 x 510 pixel CCD guide camera. The purpose of the guide camera is to more accurately move the telescope as it keeps up with the Earth's rotation.

To illustrate the importance of the guide camera, we took two 5-minute exposures of a star with the science camera, one exposure with the guide camera working and one exposure without the guide camera working. The brightness contour to the right and on top shows an image of a nice round star with a single brightness peak. The contour below shows an image of the same star that is not round and has two peaks. During the 5-minute unguided exposure, the telescope jumped a tiny amount and produced an image of a star with two peaks. In effect, the image of the star was smeared out. During the guided exposure, the guide camera was able to detect tiny jumps and correct for the jumps before they smeared the image of the star. The nice round stars in the image of M3 in this report were possible because of the auto-guide camera.

With the guide camera, we can take very long exposures, and thereby image very faint celestial objects. In fact, we've taken exposures as long as 35 minutes and imaged stars as faint as R ~ 20, i.e. stars with brightnesses about one million times fainter than the faintest stars visible with the unaided eye.



Arron Shiffer (BS Physics & Astronomy, 2009) prepares for a night of observing with the Lutz telescope and the Apogee Instruments 1k x 1k CCD science camera (blue box in the photo).

## Research

Starting in June 2009, students began using the telescope and its CCD camera for research projects. Professor David Trilling and his students, Sarah Jones of NAU and Colin Fitzgerald and Dustin Hickey of the NAU/NSF Research Experience for Undergraduates program, began a program to accurately measure V magnitudes of near Earth asteroids. By combining V magnitudes with Spitzer Space Telescope data, they will accurately measure the diameters and albedos of hundreds of near Earth asteroids. Characterizing the physical properties of near Earth asteroids is an important NASA objective. Some near Earth objects have the potential to impact the Earth.

Professor Tegler and his NAU/NASA Spacegrant students, Arron Shiffer and Kimberly Ward-Duong, began a long term program to observe planets transiting in front of their parent stars. Their goal is to detect moons around extrasolar planets.

## Teaching

In November 2008, 26 students in Observational Astronomy, Ast 301, were able to apply some of what they learned in the classroom during a night of observing with the telescope and CCD camera. It marked the first time the telescope was used as part of a class, and the first time we observed from the control room.

# 2008 - 2009 Observatory Donors

**$500 Contribution**

Ed Anderson
Nadine G. Barlow
Gary and Kay Bowman
Joseph Boyce
David and Lou Ann Cornelison
John and Kathy Eastwood
In memoriam,
R. Donald and Capitola Lutz
Barry Lutz
Susanna Maxwell
Frances McAllister
Gary Miller
David B. Shaffer
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Stephen and Kem Tegler
Donna Weistrop

**$250 Contribution**

Joseph L. Hall
Mark James

**$100 Contribution**

Jason Brown
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William Delinger
Bonnie O'Donnell
Timothy Porter

## A Special Thank You

As I hope you can tell from the previous pages, it was a banner year for us at the Observatory. On behalf of the students and faculty of the Department of Physics and Astronomy, I would like to extend a special thanks to NAU Astronomer Ed Anderson for his tireless work on installing, maintaining, and upgrading the numerous hardware and software systems necessary to run our facility. In addition, I would like to thank our donors for their generous support.

Stephen Tegler, ARO Director

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**Support the Observatory**

For a gift of $100, $250, or $500 we will engrave your name on an aluminum star that will permanently reside on the "Wall of Stars" in the Observatory.

**Contact Us**

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