

**Astrophysical Research Consortium**  
**Apache Point Observatory**  
*Sunspot, New Mexico 88349*

This report covers the period from November 1, 1994 to October 31, 1995.

## 1. PERSONNEL

The Astrophysical Research Consortium (ARC) operates the Apache Point Observatory (APO) in the Sacramento Mountains, near Sunspot NM. ARC was chartered in 1984 to build and operate observatory facilities at Apache Point for the shared use of consortium astronomers and students. Consortium members are the University of Chicago (UC), the Institute for Advanced Study (IAS), Johns Hopkins University (JHU), New Mexico State University (NMSU), Princeton University (PU), the University of Washington (UW), and Washington State University (WSU). Telescope time is allocated to these institutions in proportion to their level of project contributions. All but IAS and JHU participate in the expenses and use of the 3.5-meter reflector, and all but NMSU and WSU participate in the Sloan Digital Sky Survey (SDSS).

D. York (UC) is the Observatory Director and E. Turner (PU) was appointed this year to be the Associate Director for the 3.5-meter telescope. E. Turner has selected C. Stubbs (UW) to be the 3.5-meter Telescope Scientist. The Directors also formed a User's Committee this year, comprised of R. Walterbos (NMSU), M. Strauss (PU), J. Lutz (WSU), C. Stubbs (UW), L. Hobbs (UC), and B. Gillespie (APO).

NMSU operates the observatory under contract to ARC. K. Anderson is the Site Director, B. Gillespie is Site Manager, J. Fowler is Observatory Computer System Manager, M. Klaene is Observatory Engineer, D. Long and K. Gloria are Observing Specialists, and G. Van Doren is the Records Specialist. Positions for a Telescope Systems Engineer, a Scientific Instruments Engineer, and a third Observing Specialist were filled this year by J. Davis, J. Brinkmann, and L. Bergeron, respectively.

## 2. FACILITIES

There are four telescopes at APO, various operations and support buildings, and two dormitories which can house twelve people. The 3.5-meter telescope is the topic of most of this report. The second telescope is a 1-meter reflector owned by NMSU. The third is a 0.6-meter telescope which is used to monitor sky conditions during the sky survey. The fourth is the SDSS 2.5-meter telescope; its mechanical structures were installed during the Fall of 1995, and optics and instruments are expected next year. The SDSS enclosure and support building have been in place since 1994.

## 3. 3.5-METER TELESCOPE AND OPERATIONS HIGHLIGHTS

The 3.5-meter telescope has been in routine scientific operation for a year, with useful science data and calibrations taken during 53% of the scheduled observing time, the bal-

ance given to inclement weather (30%) and engineering activities (17%). As reported elsewhere, published scientific results based on data taken with the telescope have begun to appear.

Design and construction details of the telescope have been given in previous reports. Telescope characteristics have now been baselined, with improvements in some areas underway or being planned. Currently,

- blind pointing is typically better than 4 arcseconds rms, which allows for efficient acquisition on targets with known coordinates. With tuning to the drive servos and mechanical components, we expect to realize our blind-pointing design goal of 1 arcsecond rms;
- image sizes are as small as one arcsecond FWHM on a regular basis. The difference between this and our goal of 0.5 arcseconds is attributable to known figure errors in the secondary mirror and in equal measure to other combined factors such as image jitter, collimation, local enclosure seeing. A campaign to mitigate these effects is underway, under the direction of C. Stubbs with support of other ARC scientists, students, and the APO operations staff;
- open-loop tracking is as good as 0.1 arcsecond over a few minutes, enabling short-exposure images and spectra without the extra overhead of guide star acquisition. Tuning the drive systems should extend this tracking ability to as long as ten minutes; and
- closed-loop (guided) tracking is 0.2 arcsecond rms, using the off-set guider system which has just recently been brought into service.

The telescope regularly uses an infrared imager and spectrometer, a medium-resolution spectrograph and imager, and a large-format drift-scan CCD camera. An echelle spectrograph, a high-angular resolution camera, and an adaptive optics system are also being integrated with the telescope. Manual instrument changes at the Nasmyth port can be typically made in ten to twenty minutes by one person.

The site has a dedicated T1 circuit to NMSU, and remote operation of the 3.5-meter telescope is conducted from ARC member campuses through the Internet, nominally at about 10% of T1 data rates. Although not mandatory, roughly 70% of all observing is presently conducted through the remote interface. Visits to the site by astronomers are mainly for installation and testing of new instruments, or for training purposes. Observing functions, which include complete telescope control, instrument control, quick-look quality assurance, and data retrieval, are all accomplished by the remote observer. The telescope is scheduled two months in advance by calendar quarters, with multiple programs frequently scheduled for the same night. These science programs often involve different instruments, observers, and institutional affiliations. Multiple remote users can also connect simulta-

neously from several geographical locations, allowing “eavesdropping” or even active collaboration at a distance.

In addition to travel cost and time savings, remote observing has enabled different types of science programs at APO which have been traditionally difficult to accommodate at other large telescopes, such as synoptic programs, reactive scheduling (e.g., queue, target-of-opportunity), and group collaborations involving scientists at widely dispersed locations. An additional benefit is that it works “in reverse,” allowing off-site technical staff, engineers, and software experts to diagnose problems at a distance and, in some cases, download repairs.

In October, science operations were suspended for a four-week engineering shutdown, during which time the telescope drives were repaired, other major mechanical systems serviced and tuned, an enclosure wheel replaced, and instrument maintenance performed. Science operations were scheduled to resume in mid-November.

Other miscellaneous projects and accomplishments during the year include:

- E. Kibblewhite and his group at the University of Chicago installed their adaptive optics instrument on the 3.5-meter telescope and conducted commissioning tests. Early results were encouraging, and a laser beacon “launcher” is planned to be added to the telescope this coming year to allow the use of adaptive optics on fainter targets;
- The Adler Planetarium in Chicago began a regular Friday evening program which demonstrates the use of APO’s remote observing system to the public. Local astronomers control the telescope and instruments from the planetarium during twilight and transfer images for public viewing;
- An extensive campaign to monitor site meteorological conditions has begun. A tower provides wind direction and speed transducers at three different heights, plus micro-thermal sensors to detect turbulence. Thermal and wind speed transducers, a barometer, and a dew

point measuring device are also mounted at the telescope enclosure. Most of these data are available to the remote observer in real time. Satellite images are also accessible to users showing near real-time cloud cover and water vapor in the visible and infrared. Through a cooperative agreement with the Atmospheric Research Laboratories at White Sands Missile Range, a differential image motion telescope has been loaned to APO, which makes routine measurements of the isoplanatic patch (r-naught);

- A prototype all-sky 10-micron scanner is in use to monitor and archive sky conditions, producing an image of the sky in the thermal infrared each few minutes at half-degree resolution. Clouds that are otherwise undetectable by eye are easily seen in the images during dark time;
- APO is participating with the National Solar Observatory, the US Forest Service, the NMSU Dept. of Astronomy, the Space Center Museum and the State of New Mexico Department of Tourism to establish a new Visitor Center and Education Center at Sunspot, which is scheduled to open in early 1997; and
- Site personnel have been active participants in a local group of volunteers who advocate the use of modern outdoor light fixtures to control light pollution. Due to the initiatives of this group, the nearby village of Cloudcroft enacted a stringent outdoor lighting control ordinance during 1995. Efforts to maintain enforcement of the existing lighting ordinance in the city of Alamogordo, plus promotion of new legislation at the county and state levels are underway.

*Additional APO information is available via the world wide web at URL <http://www.apo.nmsu.edu>. Detailed information on the SDSS is also given under the University of Chicago Astronomy Department report, and elsewhere.*

Bruce Gillespie