

# THE ARIZONA ECONOMIC IMPACT of the NATIONAL OPTICAL ASTRONOMY OBSERVATORY and the NATIONAL SOLAR OBSERVATORY



**S**outhwest Arizona's Kitt Peak supports the most diverse collection of observatories found anywhere on Earth for nighttime astronomy and daytime study of the Sun.

Kitt Peak is located on a "sky island" in the **Sonoran Desert**, 56 miles southwest of Tucson, AZ. Kitt Peak National Observatory (KPNO) was founded in 1958 through a long-term lease with the Tohono O'odham Nation. KPNO is home to **22 visible light telescopes and two radio telescopes**, plus a variety of support facilities, and it has a Visitor Center open daily to the public.

Federally funded by the **National Science Foundation**, KPNO is part of the National Optical Astronomy Observatory (NOAO), which is based in Tucson near the University of Arizona campus. **The mission of NOAO** is to enable cutting-edge astronomical research, based on the principle of open access to observing time on our telescopes. This telescope time is awarded through competitive scientific proposals that are submitted to NOAO every six months, ensuring that the latest discoveries are factored in to new requests for observing time. We then share the results of this research in compelling ways with students, teachers, and the general public.

KPNO operates the **Mayall 4-meter telescope** and the **2.1-meter telescope** on Kitt Peak, and it has a 40 percent share in the 3.5-meter **WIYN telescope**, the most modern facility on Kitt Peak. The other telescopes on Kitt Peak are owned by numerous universities and other consortia, but are operated with critical logistical support from KPNO.

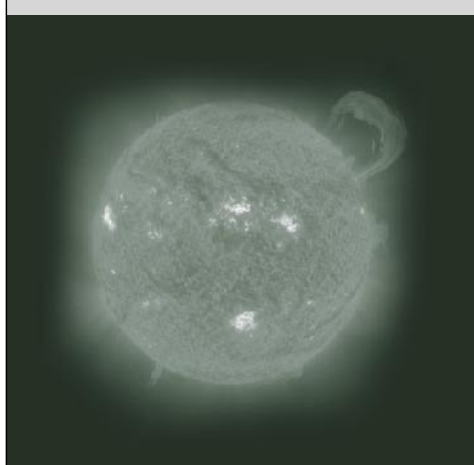
NOAO also operates a major telescope site in Chile at **Cerro Tololo Inter-American Observatory**, and it serves as the **gateway for U.S. scientists to gain access to the two new Gemini 8-meter telescopes**, located on Mauna Kea in Hawaii and on Cerro Pachón in Chile. NOAO Tucson provides support for U.S. users of these facilities via the new NOAO Gemini Science Center.

The **mission of the NSF-funded National Solar Observatory (NSO)** is to advance our knowledge of the Sun, both as an astronomical object and as the dominant external influence on Earth's climate. NSO operates **the world's largest solar telescope**, the McMath-Pierce Solar Telescope Facility, located on Kitt Peak. **A major new instrument, called SOLIS**, will head to Kitt Peak in 2003. SOLIS will make daily observations of the Sun with unprecedented accuracy, enabling precise studies of its cycle of magnetic activity, which is known to have profound affects on Earth's environment.

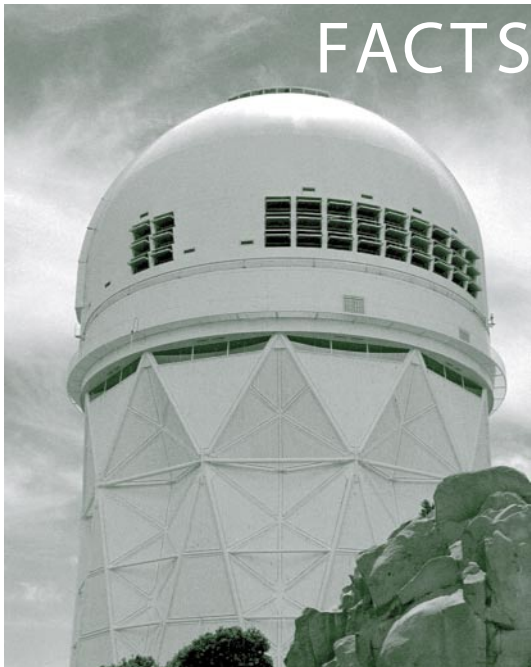
NSO **shares office space and support staff** in Tucson with NOAO. NSO Tucson also manages a global network of stations that constantly monitor the complex exterior vibrations of the Sun. The NSO operates other major telescope facilities in Sunspot, NM, and has its own active public education and outreach program.

NOAO fosters wide-reaching **research** about the history and evolution of our Solar System, the Milky Way galaxy, and the Universe at large. NSO studies all facets of the Sun's complex behavior, from daily variations in its surface activity to major flares and mass ejections. The research agendas of both NOAO and NSO are closely linked to space missions operated by NASA, and to other federal and international scientific organizations.

NOAO and NSO are **operated by the non-profit Association of Universities for Research in Astronomy (AURA)**, Inc., under a cooperative agreement with the National Science Foundation. AURA also manages the International Gemini Observatories and the Hubble Space Telescope Science Institute.



# FACTS & FIGURES



Number of full-time **NOAO and NSO employees in Tucson** = 252  
plus approx. 10 scientific and technical staff  
supported by NASA and other funding agencies beyond NSF

**Average salary & benefits** per employee = \$50,515

External **economic impact per employee**, using the Arizona multiplier effect for the "instruments and related products" sector (2.35) = \$118,710

**Total FY 2003** funding for Arizona-based programs = \$16m NOAO, \$5.2m NSO

KPNO conducts on-going coordination with the **Tohono O'odham tribal employment office** on preferential hiring of Native American employees on Kitt Peak, and opportunities for technical job training and crafts sales

Approx. **700 visiting scientists** conduct 250 scientific programs annually, with about 20 percent of these related directly to a graduate student thesis – **another 425 astronomers visit Tucson** to use other tenant facilities on Kitt Peak

More than **50,000 public visitors** from around the world each year come to Kitt Peak, driven by an attractive Visitor Center and popular nighttime programs for the general public and advanced amateur astronomers

NOAO and NSO have **trained 350 K-12 teachers and astronomer partners** in the past five years, reaching more than **15,000 students** in Tucson and beyond

## Frequent Subcontractors

M3 Engineering & Technology Inc., Tucson  
Merit Manufacturing, Tucson  
Landmark Tool and Gage, Chandler  
Vroom Manufacturing, Tucson  
Abram's Airborne, Tucson

## Some Private Companies Founded by NOAO Employees

Arizona Machine Tool Center  
Barr Engineering Arts  
Orach Machine Shop Service  
Engineering & Research Associates  
Stark Electric  
Applegate Electric  
Photometrics  
Digital Television Imagery  
B.L. Specialties  
Sallegro Precision Grinding

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## Examples of NOAO Technology Transfer

**coatings for optical interference gratings, solid-state photomultipliers, fiber optics, CCD evaluation techniques, optical test software and hardware, liquid crystal filters, high-speed infrared electronics, light pollution studies...**

## THE FUTURE

NOAO and NSO have submitted a major five-year plan to the National Science Foundation that proposes significant new investments to keep the United States on the forefront of astronomical research:

- a large new facility called the **Giant Segmented Mirror Telescope (GSMT)**, which features a 30-meter primary mirror and ambitious science goals **matched to the next generation of space telescopes** and ground-based radio antenna arrays
- a **major sky survey telescope (LSST)** with an 8-meter mirror that can gather deep images of the entire night sky on a time scale of days, bringing variable phenomena such as supernovae and near-Earth asteroids alive in new ways for researchers and the general public
- a revolutionary **Advanced Technology Solar Telescope (ATST)** with a 4-meter primary mirror and optics that adapt to changing atmospheric conditions, making it capable of routinely resolving fundamental structural features in the Sun's ever-changing magnetic fields
- a **unique role for NOAO in the National Virtual Observatory**, an emerging electronic network that will cut across vast data archives to span the electromagnetic spectrum from gamma-rays to radio waves, creating a searchable database ready to be mined in unforeseen ways by future generations of astronomers and the general public.