Fred L. Whipple Observatory (FLWO)

A brief introduction
March 2018

General information

FLWO is located near Amado, AZ, within the Coronado National Forest. Visitors first encounter FLWO at its visitor center on Mt. Hopkins Road, at the foot of Mt. Hopkins. At the visitor center, an exhibit orients visitors to FLWO and its surroundings. A friendly volunteer provides assistance at the front desk. Hours of operation are weekdays 8:30am to 4:30pm, excluding federal holidays. FLWO offers public tours of the telescopes on Mt. Hopkins, 3 times a week between March and November. Tours may be arranged as instructed here: http://www.cfa.harvard.edu/facilities/flwo/.

The narrow road to the summit of Mt. Hopkins is 20 km (12.5 miles) long; it is unpaved for the first 13.5 km (8 miles), to just below the gate above which private vehicles are not allowed. The main reason for paving is to minimize the amount of dust near the telescopes, as dust is the bane of telescopes and associated instruments.

Astronomers submit proposals to use the telescopes each quarter and are assigned time by Time Allocation Committees (TACs) made up of scientific peers, who carefully weigh the scientific merit of each proposal. Once allocations are made, schedules are composed, and astronomers come to FLWO to use the telescopes at their scheduled times. FLWO telescopes operate nearly every night of the year, with the exception of Christmas and during August when the monsoons make it impossible to observe. When the telescopes shut down in August, the respite allows for maintenance of telescopes and instruments. During normal operations, if the weather is uncooperative, the telescopes may not be able to open due to clouds, high humidity, high winds or precipitation. Because each night is allocated in advance, time lost to weather cannot be made up.

At FLWO, weather conditions are continually monitored, using weather stations, all-sky cameras, cloud monitors, and satellite maps from NOAA.

FLWO activities are enabled by a communications system for voice and data that are transmitted over a microwave system to Steward Observatory at the University of Arizona, and on to the rest of the world over the internet. FLWO uses a slew of networked computers for control of telescopes and instruments. In most cases, the software that is used on these computers is coded in-house or at the parent institutions.

FLWO staff collaborate with local jurisdictions to preserve the quality of the night sky in southern Arizona. Such collaborations with development offices at Santa Cruz, Pima and Cochise Counties have led to effective Outdoor Lighting Codes that protect the night sky by minimizing uplight. FLWO staff also collaborate with the Forest Service, to ensure proper utilization of the site, and to maximize its scientific utility.

FLWO Telescopes

Telescopes are tagged by the sizes of their primary optics. For example, the primary mirror of the MMT is 6.5m in diameter, and the telescope is referred to as "the 6.5m MMT." The majority of the telescopes at FLWO are reflectors, where the main optics are mirrors. A few of the smallest telescopes at FLWO are refractors, where all optics are lenses.

FLWO telescopes are capable of obtaining both images and spectra with different instruments. Images are used to analyze the properties of astronomical objects that are directly visible. They reveal the positional distribution of light emitted by various targets at different wavelengths, ranging for example from stars to galaxies. Spectra consist of light from astronomical objects that is dispersed, or decomposed into its wavelength, or color components. The dispersion may be high, which reveals finer details over narrow wavelength bands ("narrow-band") to study, for example, the effects of planets on their parent stars. It may also be low, thus revealing coarser detail but over broad wave bands ("broad-band"), for example to study the properties of supernovae.

The four 12m VERITAS (Very Energetic Radiation Imaging Array) gamma-ray telescopes surround the FLWO visitor center. The telescope nearest the main gate is accessible for viewing from near its base. The VERITAS telescopes detect gamma-rays (the highest-energy form of radiation) indirectly, by measuring the blue light produced when gamma rays from distant sources strike the atmosphere. These sources include exploding stars (supernovae), pulsars, quasars and black holes. VERITAS telescopes use photomultiplier tube arrays to detect the blue light that is a signature of gamma rays.

VERITAS is an international joint project of SAO, Iowa State University, McGill University, Purdue University, UCLA, University of Chicago, University College Dublin, University of Leeds, University of Utah and Washington University.

The 6.5m MMT is located at the 2580m (8600-foot) summit of Mt. Hopkins. Its large mirror makes it one of the 3 largest telescopes in the continental US. The MMT is a joint project of the Smithsonian Astrophysical Observatory (SAO) and the University of Arizona (UA). SAO and UA provide funding for instrumentation, development, maintenance, and operations. Researchers from Harvard University and SAO (the two members of the Harvard-Smithsonian Center for Astrophysics headquartered in Cambridge, MA), ASU and NAU have access to the telescope.

The MMT is able to provide very sensitive observations of a large variety of astronomical objects, ranging from the most distant galaxies to extra-solar planets within the Milky Way. Its instruments operate in the range encompassing infrared to visible wavelengths. The telescope has a suite of instruments that can be used to obtain images (MMTCam, CLIO, PISCES, SPOL, MMTPol) or spectra (Hectospec, Hectochelle, Blue Channel, Red Channel), or both (MMIRS, BINOSPEC).

At the 2340m (7800-foot) level of Mt. Hopkins, the "Ridge" houses the 1.5m Tillinghast and the 1.2m telescopes, as well as two telescope arrays, the HATs (four 0.11m refractor telescopes and one 0.25m reflector) and MEarth (eight 0.4m telescopes. The new MINERVA project (four 0.7m telescopes) began operations in 2015..

The “Ridge” telescopes are used to study a wide range of phenomena, ranging from extrasolar planets to galaxies, supernovae and gamma-ray bursts.

The Tillinghast telescope is used exclusively for spectroscopy at visible wavelengths. It requires an operator to run the telescope each night. It has 2 instruments, FAST for coarse resolution, wide-band spectra to study quasars, galaxies, supernovae, stars and solar system bodies; and TRES for fine resolution, narrow-band spectra to study stars and extrasolar planets.

The 1.2m is used exclusively for imaging through various filters at visible wavelengths to study quasars, galaxies, supernovae, stars and extrasolar planets. It is a robotic system; an operator is not required to run it, although it is possible to run it manually, either on-site or remotely.

The HATs and MEarth are robotic systems that obtain images at visible wavelengths. They are dedicated to search for and study extrasolar planets by seeking transits, the slight, temporary dips in the lightcurve (the run of brightness as it varies with time) of each parent star. Discoveries made with these telescopes are followed by refinement of lightcurves with the 1.2m, and with spectroscopy with TRES on the 1.5m to measure the telltale wobble of parent stars caused by orbiting extrasolar planets.

MINERVA is another robotic system that seeks to discover Earth-like planets in close-in (less than 50-day) orbits around nearby stars, and super-Earths (3-15 times the mass of Earth) in the habitable zones of the closest Sun-like stars. A secondary goal is to search for transits (eclipses) of known and newly-discovered extrasolar planets; these can yield the radii and information about interior structures of the planets. This second goal employs the proven method used by the Kepler satellite mission, and the unique design of the Minerva observatory allows the pursuit of both goals simultaneously.