Instruments and Science Programs at Fresno State's Campus Observatory

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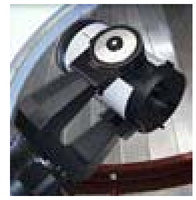

Fresno State's Campus Observatory opened in 2002 May, in back of the Downing Planetarium. It was relocated to its present position in 2004 February. It was built by Prof. White and Fresno State student Art Cowley. The advantage of a Campus Observatory is its convenience: students can easily gain experience by eyepiece observing and by taking "pretty pictures." Most of the observatory's science programs study phenomena that change in time, observations of which are made possible by easy access to the telescope. A second 16-inch telescope is being built at a dark site near Shaver Lake, at 6100 feet. It will produce superior results, but it will be accessible primarily by remote control. It will therefore be useful mainly for advanced students, who have gained hands-on experience at the Campus Observatory.

The Campus Observatory is at longitude 119.7447 degrees West, latitude 36.8147 degrees North, and elevation 398 feet. (The local mean time correction is +1m 01.3s.) The main telescope is a 16-inch Meade LX200, with a Schmidt-Cassegrain focus at f/10. The observatory is well instrumented, with a Santa Barbara Instruments Group (SBIG) ST-9XE CCD camera that is normally used with a Celestron f/6.3 focal reducer. An Optec Temperature-Compensating Focuser (TCF) does precise focusing, either through a hand controller on the table, or through the computer. Other instruments include two Philips ToUcam webcams for planetary imaging, an SBIG AO-7 Adaptive Optics guider, and an SBIG Self-Guiding Spectrograph with its own dedicated ST-7XE CCD camera. Eyepieces include a superb Pentax XL14 (with 300 power at f/10), TeleVue Plössls that range from a 2-inch 55-mm (with 74 power and a 30' field at f/10) to a 1.25-inch 8-mm (with 512 power), together with several Barlow lenses, diagonals, adaptors, and balance weights.

The ST-9XE camera is usually used with an SBIG CFW-8A color filter wheel and a variety of 1.25-inch filters. These include SBIG photographic Clear, Red, Green, and Blue filters for color imaging, standard broad-band UBVRI filters for photometry, a Custom Scientific Clear (IR suppressor) filter, a Custom Scientific H alpha filter with a 4.5-nm bandpass, a Schuler H alpha filter with a 10-nm bandpass, an Orion Moon filter, and a basic set of Orion color planetary filters. There is also an Orion Ultrablock Light-Pollution Filter, also called a nebular filter since it passes only hydrogen beta and the [O III] "nebulium" lines, often the strongest lines in nebulae. It works well for eyepiece observing of nebulae, but we were surprised to find higher contrast and throughput for CCD imaging with an Orion SkyGlow Broadband light pollution filter, which also passes the hydrogen alpha line.

The observatory's 1.25-inch Hutech IDAS light-pollution suppression (LPS) filter deserves special mention. It has five narrow bands in the visible spectrum that are opaque and centered on the wavelengths of the emission lines of mercury-vapor and sodium-vapor streetlights. This filter still passes enough of the rest of the visible spectrum to give natural-looking colors. It fits in a 1.25-inch eyepiece and improves the contrast the eye sees of most everything, even bright planets. It can also be used together with Red, Green, and Blue filters for full-color imaging with a camera. Be sure to remove it whenever doing photometry, however!

A 70-mm, f/5.7 refracting guidescope by Vixen is usually mounted piggyback on the 16-inch telescope, together with a Meade 10x50 finder scope. The guidescope is useful for wide-field imaging, since it has a 400-mm focal length. Through it, the ST-9XE camera covers a field of view of 1.5×1.5 degrees. The guidescope can be used as a finder: with the 5-mm illuminated reticle eyepiece, it has a field of view of 30 arcminutes, just enough to cover the entire moon. The guidescope can also be a useful "third eye" for public nights when used with a ToUcam, which gives color video on the computer screen that is visible to many planetarium visitors at the same time, both inside and outside the dome. It can also be used with either of the TV cameras the observatory has, either an Astrovid 2000, or a more-sensitive, integrating Astrovid Stellacam II. These cameras show black-and-white video on a 10-inch Toshiba monitor.

The dome's small 3-m diameter, unpainted aluminum skin, fans inside the dome, and being surrounded by grass all help its thermal properties. With the Celestron focal reducer at f/6.3 (the nominal deep-sky imaging setup), the ST-9XE camera has an image scale of 1.61"/pixel, and gets a field of view of 13.8' x 13.8'.

(More precisely, the ST-9XE camera at f/6.3 and with no filter can detect stars with V = 19 at S/N = 5 in 7 s, in an urban sky with no Moon and V = 3 stars visible to the unaided eye, rating 10 on the Bortle scale. The ST-7XE can reach V = 13.3 at S/N = 60 in a single 30s exposure, so it's about 1/6 as sensitive as the ST-9XE. This makes sense, since the ST-9XE's dark count is 4 times lower, and its quantum efficiency is about 50% higher. The ST-7XE is about twice as sensitive as the ST-8, although it covers only 1/4 as much area as the ST-8. The ST-7XE has 1/3 as much area as the ST-9XE, which is why the ST-9XE is now the primary imaging camera, the ST-7XE is dedicated to spectroscopy, and the old ST-8 is a backup and autoguider.)

Ongoing science programs at the Campus Observatory include:

(1) Discovering and timing transits of exoplanets. This is in collaboration with `Transitsearch.org`, at UC Santa Cruz, Lick Observatory, and NASA Ames Research Center, who post predictions of when the planets transit, or move in front of their parent stars. Exoplanets, also called extrasolar planets, are planets that orbit stars other than the Sun. Over 150 of them have been discovered since 1995, and hundreds more are expected to be discovered in the next decade. Fewer than 10 are currently known to transit: it is important to discover transits in more systems, since the transits uniquely reveal the planets' radii and densities. It is also desirable to continue to do precise timing of the transits of exoplanets that are known to transit, since doing this can reveal other planets in these star systems. Successful observations of transits have been done by Fresno State students Jesse Rorabaugh, John Prigge, and Matthew Garrett.

(2) Timing the spins and orbits of magnetic cataclysmic variables, particularly intermediate polars, by Dave Reynolds and Michelle Meyers. These include campaigns with the Center for Backyard Astrophysics. CBA is a global network of telescopes, dedicated to observing cataclysmic variables and their outbursts.

(3) Target-of-opportunity observations of the eruptions of classical novae, by Greg Morgan and Fresno State students Matthew Garrett and John Prigge. Astronomers have been taking spectra of novae for over a century, but systematic study with sensitive, linear, digital CCD detectors only started in the 1990s. Only about two dozen novae have been observed in this way, and novae are idiosyncratic: every one we observe is an education. We have so far published two papers in refereed professional astronomy journals on our spectroscopic observations of three novae through their eruptions. We intend to observe more novae, but this is a target-of-opportunity program: in order to get data, a nova has to be having an eruption.

Completed science programs include:

(1) Observations for Dr. Ringwald's *Hubble Space Telescope* project with Steve Saar, at Harvard, on the low states in the magnetic cataclysmic variables AM Her and AR UMa, with students Dave Reynolds and Michelle Meyers.

(2) Observations simultaneous with NASA's *Chandra X-ray Observatory* and *Rossi X-ray Timing Explorer* spacecraft with Koji Mukai, at NASA Goddard Space Flight Center, on accretion during a high state in the magnetic cataclysmic variable AM Her, with Greg Morgan and Fresno State student Ron Severson.

(3) Variable star searches, particularly for hot, high-gravity stars that heat cool companions that have undergone common envelope evolution, by Dan Chase, Scott Endler, John Prigge, and Nader Inan. A paper on this is in preparation and will be submitted to a refereed journal in the coming year.

If you're interested in these programs, please read these books:

- *Cataclysmic Variables: How and Why They Vary*, by Coel Hellier (the whole book).
- Chapters 1-7 and 10-11 for the 2nd edition from 2005
  (or Chapters 1-5 and 8-9 for the 1st edition from 2000),
  and any other chapters that interest you of:
  The Handbook of Astronomical Image Processing, by Richard Berry and James Burnell.

We can always use more pretty pictures, too. These can be done at any time, preferably at New Moon. Many professional astronomers sneer at pretty pictures, but I find they're educationally useful. Show me a student who, through care and patience, has developed the skill to be able to get publishable-quality pretty pictures, and I'll show you an observer for whom taking nearly any kind of science data will seem easy. Few science programs require one to be as fussy as when getting a really good picture, many of which are now on our gallery page, at:

`http://zimmer.csufresno.edu/~fringwal/gallery.html`.

If you are a student or CVA member and have ideas for projects, particularly if they describe a specific, plausible path from telescope to finished scientific objective, which we can do with the equipment we have now, please contact Dr. Ringwald by e-mail at `ringwald@csufresno.edu` or by phone at 278-8426.