

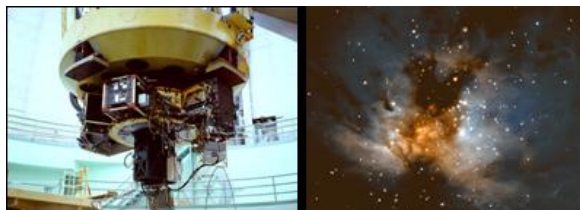
# The UCLA Infrared Laboratory

In the fall of 1989, UCLA initiated a new laboratory to support the rapidly growing field of infrared (IR) astronomy in the coming era of the Keck 10-meter telescopes.

W. M. Keck Observatory started as a joint project between the University of California and the California Institute of Technology to build the world's largest telescope on the 14,000 ft summit of Mauna Kea, Hawaii. Keck 1 began scientific operations in 1993 and was followed by Keck 2 in 1996. Our goal in forming the Lab was to build unique scientific instruments for these telescopes.

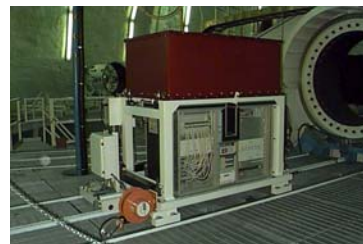


Beginning in 1990 with the development of a small infrared camera (KCam) to evaluate detectors intended for the Hubble Space Telescope, the IR Lab team grew in size and went on to create the first twin-channel infrared camera, known locally as “gemini” – the twins. In addition to capturing images at two infrared wavelengths simultaneously, this instrument was also designed to record the infrared spectrum of astronomical objects and to measure the linear polarization of their light. Commissioned on the 3-m Shane telescope at Lick Observatory in 1993, this unique instrument supported the research of many PhD students and is still in operation today.

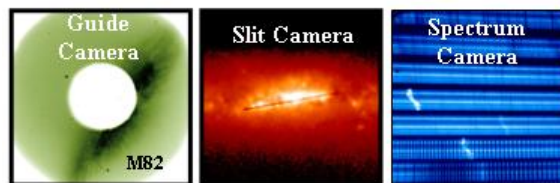


These initial successes led to a contract to build an infrared spectrograph for the Keck Observatory.

The NIRSPEC project began in fall 1994 and “first light” was obtained on the telescope April 1999, achieving



the goal of our 10-year plan. NIRSPEC was challenging. At the time of conception, it was the largest vacuum-cryogenic, high-resolution IR spectrograph in the world. Its optics were diamond-machined metal mirrors cooled to only 60° above absolute zero, it contained three cameras and stood 2 meters tall. One camera viewed the scene surrounding a target, the second camera picked up the reflected light from the entrance slit of the spectrograph and the final camera captured the spectrum.

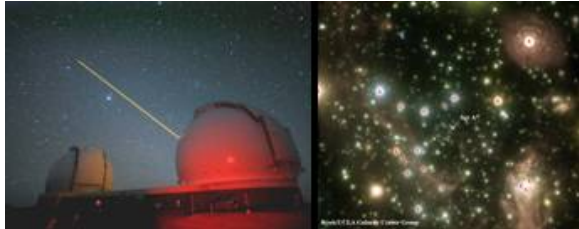


NIRSPEC is one of Keck Observatory's most-used instruments, having observed almost every kind of astronomical object, from comets to the most distant galaxies in the universe.

In 1998, KCam was upgraded and delivered to Keck Observatory where it was used to demonstrate the new adaptive optics (AO) on Keck 2. Another camera (SHARC) was delivered for Keck 1 in 2006. AO is a system that improves images blurred by turbulence in Earth's atmosphere. Corrections are made using high-speed imaging of a bright



comparison star, or an “artificial” star created by the returning light from a laser beacon projected up 92 km. As the de-blurring is most efficient for longer wavelengths, the benefit for infrared astronomy is very great. Images of objects like Neptune can now be obtained with a quality close to that of space missions.



UCLA collaborated with Caltech to deliver a sophisticated infrared camera (NIRC2) in 2001 that was fully optimized for imaging with very high spatial resolution, thus allowing fine detail to be seen for the first time even in very distant sources. For example, infrared observations of the center of the Milky Way over 26,000 light-years away revealed the orbital motion of numerous stars around a massive dark object, providing the best evidence yet of a black hole with about 4 million times the mass of the Sun. NIRSPEC was also modified to operate with the Keck Adaptive Optics (AO) system.

In 2005 a different kind of instrument was delivered to the Keck Observatory. Known as OSIRIS, it used an array of tiny lenses at the telescope focus to subdivide the field of view into many parts. In one mode, the field is split up by an array of 64 x 64 lenses, and up to 4096 spectra are then formed on the camera. When the complex image is analyzed, the result is a data “cube” consisting of a stack of high-resolution images at a sequence of slightly different wavelengths. Thus spectral and spatial data are obtained together. OSIRIS has provided the first spectrum of a planet around a main sequence star, the first confirmation of “rain” on Titan, and the rotation of very distant galaxies.



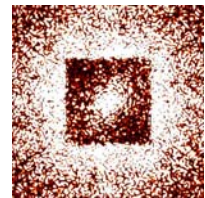
From 2003-2007 the IR Lab operated a new instrument at the Lick Observatory called

FLITECAM, an infrared camera intended for use on NASA’s Stratospheric Observatory for Infrared Astronomy (SOFIA).



Currently (2009), two major instrument projects are nearing completion, as well as a design study for the proposed Thirty Meter Telescope (TMT). One project, called MOSFIRE, is for the Keck Observatory and the other is the Gemini Planet Imager (GPI), a multi-institutional project for the Gemini-South 8-meter telescope.

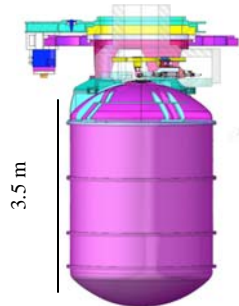
GPI is an advanced imaging system for direct detection of Jovian planets around young nearby stars. The IR Lab is building an integral field spectrometer for GPI to take 40,000 spectra simultaneously, or equivalently 17 images of the field in different wavelengths.



MOSFIRE, the Multi-Object Spectrometer For Infrared Exploration, is intended to survey many objects over a large field. A joint project with Caltech and UC Santa Cruz, MOSFIRE observes up to 46 objects at a time.



IRIS for the TMT is a direct extension of the OSIRIS concept but now at the diffraction limit of a 30-m telescope. With pixels as small as 0.004 seconds of arc, IRIS will have unprecedented ability to resolve compact objects, ranging from solar system moons to distant regions where the first stars are forming after the dark age of the Universe.



The Infrared Lab was founded in 1989 by Professors Eric Becklin and Ian McLean. James Larkin joined the faculty in 1997 and Michael Fitzgerald in 2009. For more information visit our web site: <http://irlab.astro.ucla.edu/>