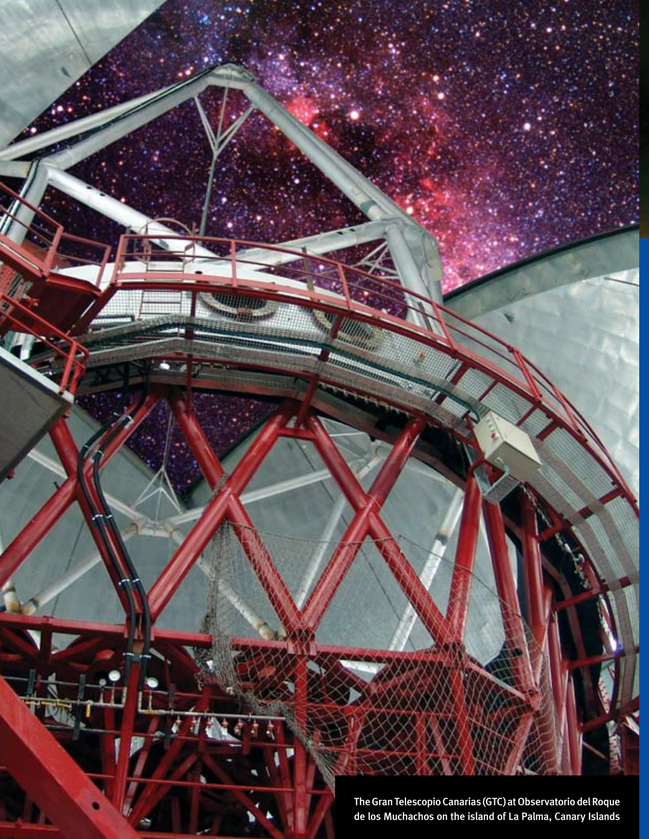


The Gran Telescopio Canarias (GTC) at Observatorio del Roque de los Muchachos on the island of La Palma, Canary Islands

Department Chair
Professor Stanley Dermott

UF Astronomy: Forming Partnerships For Discovery

The goal of the UF Department of Astronomy is to become one of the top 10 public astronomy departments in the United States. Thanks to strong support from the University, outstanding faculty and strong international collaborations, we are well on our way to achieving this goal. We have partnered with astronomers in Spain and Mexico to build the world's largest optical telescope, the GTC. This 10.4-meter telescope is being constructed in the Canary Islands and will begin operation in 2008. The superb image quality will allow the GTC to "see" both the faintest and the most distant objects in the universe—from nearby, newborn planets and stars, to the most distant galaxies.

The formation and evolution of planets, stars and galaxies is the major unifying research theme of our department, and we are pursuing that theme through related observational, theoretical and instrumentation research programs. Our partnership with Spain and Mexico has led to the development of new instruments that will be used to achieve the research goals of the department, such as CanariCam, FRIDA (Infrared Adaptive Optics Integral Field Unit) and CIRCE (Canarias Infrared Camera Experiment). UF astronomers are also partners in GOYA, a major near-infrared spectroscopic survey to be carried out on the GTC to study galaxy formation and evolution. In addition, UF has implemented a very successful program to bring Spanish graduate students and young postdocs to UF to acquire expertise in astronomical research and, in particular, astronomical instrumentation.

In the coming years, the Department of Astronomy is continuing to grow and broaden the research opportunities at the University of Florida. Several key initiatives are already underway. For instance, UF is playing a key role in the development of instrumentation for the proposed $1-billion Thirty Meter Telescope (TMT) project. A team of nine UF faculty, led by Professor Stephen Eikenberry, have been competitively selected to develop detailed scientific observation simulations and designs for the top-priority science instrument on TMT, the InfraRed Multi-Object Spectrograph (IRMOS). IRMOS will be the workhorse spectrograph for TMT, and will be the world's most powerful tool for investigating many astrophysical phenomena, including "Cosmic Dawn"—the birth of the first stars after the Big Bang. At the other end of the research spectrum, Professor Jian Ge and incoming UF Professor Eric Ford are leading the next steps in planet searching with the All-Sky Extra-Solar Planet Survey (ASEPS). ASEPS will use a number of Exoplanet Tracker instruments developed at UF to find hundreds to thousands of new planets around nearby stars, revolutionizing this area of study.

Through our programs, partnerships and future endeavors, the University of Florida's Astronomy Department is on an upward trajectory of distinction that we believe is limited only by our imagination.

UF University of Florida
Department of Astronomy
211 Bryant Space Science Center
PO Box 112055
Gainesville FL 32611-2055
Phone: (352) 392-2052
Fax: (352) 392-5089
www.astro.ufl.edu

discovering THE UNIVERSE

UF University of Florida
Department of Astronomy

The University of Florida has taken a unique approach to building one of the nation's top astronomy programs.

The Department of Astronomy has been able to gain extensive observing time on the world's most powerful telescopes by becoming one of the premiere centers for astronomical instrumentation.

The instruments built at UF address a variety of important areas in science. Infrared cameras constructed at the university are being used to investigate a wide range of astrophysical objects, including star-forming regions, circumstellar disks, starbursts and active galaxies. Meanwhile, other devices created at UF focus on detecting exosolar planets.

The resulting observations with these instruments have led to ground-breaking discoveries by UF astronomers - in areas ranging from the birth of the Universe to the development and detection of new planets.

These successes positioned the UF Department of Astronomy to become a partner with the Spanish and Mexican governments in building the world's largest telescope, the Gran Telescopio Canarias, located in the Canary Islands.

The projects discussed here are just a sample of the cutting edge astronomy research being conducted at the University of Florida. New projects and programs are constantly emerging as the Department of Astronomy continues its work at the forefront of the field.

Front Cover:
Orion Nebula from the Hubble Space Telescope Orion Treasury Project Team (top) and a galaxy cluster image from the ESO Distant Cluster Survey (bottom)

Professor Jian Ge

Distant Worlds & Their Origins

With the first detection in 1995 of a planet orbiting another Sun-like star, a new and exciting era of astronomy began. To date, more than 180 such exosolar planets have been found, mainly using the "radial velocity (RV) technique" that measures the small back-and-forth motion of a star in response to the tug of unseen planets. Professor Jian Ge and his team are on the verge of revolutionizing this field by implementing a new approach to RV measurements. The Exoplanet Tracker, or ET for short, permits observations of many stars at once using wide field telescopes such as the Sloan Digital Sky Survey's 2.5-meter telescope at Apache Point Observatory. By greatly increasing the discovery rate of exosolar planets, this technique promises to lay the groundwork for a much broader appreciation of the variety of distant worlds beyond our solar system.

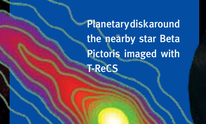
Professor Ge's team recently achieved a major milestone in this quest with the discovery of a planet, ET-1, found with their ET prototype instrument at Kitt Peak National Observatory. The planet has half the mass of Jupiter and orbits its partner star every 4.1 days. In Ge's words, "This approach promises to discover thousands of planetary systems around Sun-like stars, as well as hundreds of systems around low-mass stars in the solar neighborhood that could host life."

How planets like Earth and those detected by Professor Ge form and evolve is a problem being addressed by Professors Stanley Dermott, Bo Gustafson and Charles Telesco. The disks of gas and dust that surround many of the stars in our universe are nurseries for newly born planets and provide natural laboratories for observing the evolution of planetary systems. Light from the star is scattered by the dust particles in these disks and the properties of these particles are investigated by Professor Gustafson using replica particles in his unique Microwave Analog to Light Scattering Facility. The dust particles are also heated by the starlight incident upon them and glow with infrared radiation that is captured by electronic cameras like the T-ReCS and CanariCam that were designed and built at UF by Professor Telesco's team.

In addition, the disks will interact with any planetary systems embedded within them to produce telltale signatures that indicate their existence. Professor Dermott and his colleague Dr. Thomas Kehoe have developed models using theoretical techniques and numerical simulations that link the structure observed in some disks to the presence of such unseen planets. For some stars, the images reveal intriguing structures that may instead be due to single cataclysmic events. The luminous disk surrounding the 20-million-year-old "Beta Pictoris" star contains a bright clump of particles that could have resulted from the catastrophic collisional disruption of a small planet hundreds-to-thousands of kilometers in size. "We may have captured, for the first time, the image of a major, highly energetic event that must have occurred many times in the early history of our own solar system, and could even have been responsible for the creation of our own moon," Telesco says.

ET Comes Home

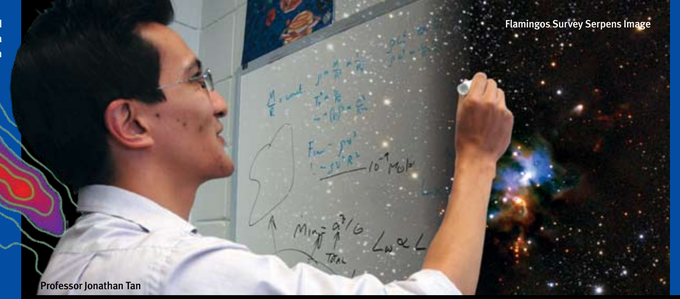
Funded by the W.M. Keck Foundation, the Keck Exoplanet Tracker (ET) is the first in a new generation of Doppler instruments used for detectingh exosolar planets. This innovative approach, which is completely different from traditional Doppler techniques, opens up a new capability for simultaneous precision radial velocity measurements of many stars.



Planetary disk around the nearby star Beta Pictoris imaged with T-ReCS

T-ReCS: Thermal-Region Camera and Spectrograph

T-ReCS, built by Professor Charles Telesco and his team, and the first major facility-class instrument to be built in the Infrared Instrumentation Laboratory, has been fully operational since 2003 at the Gemini South 8-meter telescope in Chile. It is optimized for observations of thermal-infrared (heat) radiation that dominates the radiation output from relatively cool celestial objects and is nearly impervious to interstellar extinction. This highly productive imager and spectrograph is now being used by the international community of astronomers to search for planets and brown dwarfs, explore planet-forming circumstellar disks and probe visually obscured star-forming regions and the hidden cores of galaxies.



Professor Jonathan Tan

Flamingos Survey Serpens Image

Stars: From Cradle to Grave

Just like people, stars experience birth, middle-age, senior citizenship and, eventually, death. The lifespan of stars can be as short as a few million years, and yet some are almost as old as the universe itself. Researchers in the UF Department of Astronomy are actively studying stars in a variety of life stages—from the cradle to the grave.

Professors Elizabeth Lada and Jonathan Tan use observational and theoretical methods, respectively, to aid in their study of the birth of stars and planetary systems. They are particularly curious about how this process changes across different areas of the universe—from the crowded centers of star clusters like the nearby Orion Nebula to the swirling disks of gas around mysterious black holes in the centers of galaxies. "Our studies of star formation have determined that the first stars in the universe were very massive, about 200 times that of our Sun," notes Professor Tan. "Furthermore, it appears that massive stars form via the same mechanism as lower-mass stars, namely the collapse of a gas core to an accretion disk, which then channels gas to the star."

Stars in their middle to senior years of age are the focus of Professor Ata Sarajedini's research efforts. He is not only interested in the properties of the stars themselves, but he is also using stars within the context of their parent galaxies to understand the process of galaxy formation and evolution. "Using stars as tools, we are increasingly confident that large galaxies like our own Milky Way are formed through the disruption and eventual destruction of smaller galaxies," says Sarajedini. "Furthermore, the age of the oldest stars—such as those in globular clusters—sets a lower limit on the age of the universe, which has broad implications for cosmology."

When stars reach the end of their lives, the more massive ones form such exotic objects as neutron stars and black holes. These remnants of stellar evolution are the focus of Professor Stephen Eikenberry and Dr. Reba Bandyopadhyay's work. When one of these stellar remnants interacts in an orbit with a normal star, spectacular and violent fireworks can result. Studying the details of this phenomenon can shed light on both the most extreme physical conditions in the universe and on the nature of the most massive stars in the galaxy. Professor Eikenberry summarizes his work by noting, "Our group focuses on the biggest, the hottest and the fastest things there are."

Flamingos: Florida Multi-object Imaging Near-IR Grism Observational Spectrometer

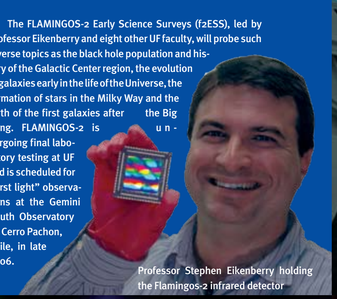
Most stars in our galaxy form in Giant Molecular Clouds (GMCs), yet we still don't fully understand the process of star formation in this environment. Professor Elizabeth Lada, Dr. Nick Raines and their group are using FLAMINGOS, the world's first fully cryogenic, near-infrared multi-object spectrometer, to learn in detail about the birth of stars in these clouds. FLAMINGOS offers unparalleled capabilities for this research, enabling Lada's team to observe dozens of stars at a time. This group is currently conducting a large survey that will address such fundamental issues as how star formation and the initial mass function vary between different clouds and how star formation changes with time within a cloud.

Flamingos-II

On large modern telescopes, observational time can cost more than $1 per second. With target objects numbering in the billions, FLAMINGOS-2, built by Professor Stephen Eikenberry's team at UF which includes Dr. Reba Bandyopadhyay and Dr. Nick Raines, offers astronomers a hundred-fold increase in the number of objects they can study at a time—greatly improving the "bang for the buck" scientific performance of modern observatories.

Traditional methods provide for observations of one star or galaxy at a time, but, using techniques pioneered at the University of Florida with the FLAMINGOS instrument by the late Professor Richard Elston, FLAMINGOS-2 can gather infrared spectroscopic data on up to 120 such objects simultaneously on the world-class Gemini Observatory 8-meter telescopes. Surveys of the cosmos, which used to be prohibitively expensive for astronomers to undertake, can now be accomplished in just a few nights of observation.

The FLAMINGOS-2 Early Science Surveys (f2ESS), led by Professor Eikenberry and eight other UF faculty, will probe such diverse topics as the black hole population and history of the Galactic Center region, the evolution of galaxies early in the life of the Universe, the formation of stars in the Milky Way and the birth of the first galaxies after the Big Bang. FLAMINGOS-2 is undergoing final laboratory testing at UF and is scheduled for "first light" observations at the Gemini South Observatory on Cerro Pachon, Chile, in late 2006.



Professor Stephen Eikenberry holding the Flamingos-2 infrared detector

Unlocking the Mysteries of the Cosmos

How do galaxies like our own Milky Way form and evolve? Answering this question is at the core of extragalactic research at the University of Florida.

It has become quite clear to the scientific community in recent years that supermassive black holes, which lie at the center of all galaxies, play an important role in galaxy evolution. Galaxies where material is flowing into the central black hole and producing enormous amounts of light and energy are known as active galaxies. Professors Vicki Sarajedini and Fred Hamann, along with Dr. Chris Packham, study these active galaxies in hopes of better understanding how they change over time and alter the properties of their host galaxies. Hamann's research focuses on the most luminous type of active galaxies known as quasars. These objects, a trillion times brighter than the Sun, are visible from billions of light years away. Hamann's work focuses on the early evolution of both the quasars and their host galaxies.

Packham, in collaboration with Spanish astronomers, is studying the inner regions of such objects in unprecedented detail using T-ReCs and Canaricam. Sarajedini is currently using the Hubble Space Telescope to conduct deep field surveys to identify very faint emissions from active galaxies in the distant universe. She is studying several thousand galaxies to determine whether their central luminosity has changed over time. "While the fainter active galaxies can be difficult to detect, understanding their properties sheds light on the critical link between active and normal galaxies" she says.

Professors Rafael Guzman and Anthony Gonzalez are examining the growth and star formation histories of galaxies and how the environment in which a galaxy resides affects these properties. Professor Guzman's research focuses on understanding a type of galaxy that was once common in the universe but today is very rare—luminous blue compact galaxies. By studying how these galaxies evolve his research addresses how modern galaxies, like our own Milky Way, are formed. Professor Gonzalez also has his gaze fixed on the distant universe. He has discovered some of the most distant galaxy clusters known and is currently studying how their high-density environments influence galaxy evolution.

Professor Anthony Gonzalez and a galaxy cluster image showing X-ray emission contours

Astronomy for the People

The department is involved in a wide range of public outreach activities designed to bring the wonders of astronomy to the general public. The campus observatory hosts open nights throughout the year, allowing visitors to view night-sky objects through several telescopes. Many of the department's professors, postdoctoral researchers and students visit local schools to present astronomy-related activities to children. The department runs teacher training workshops in the summer and recently worked closely with local officials to help the school board obtain a $1.1-million grant to provide science training for teachers. The StarLab Portable Planetarium is being used in kindergarten through 12th grade classrooms across North Central Florida to get the astronomers of tomorrow excited about science. They learn about the nature of stars and galaxies, the making of comets, our solar system and the Milky Way galaxy. The department also sponsors an annual "museum night" at the local natural history museum, where the public is invited to hear lectures and enjoy many of the activities presented at schools.

Professor Vicki Sarajedini and the Starlab portable planetarium

The GOYA Survey: Exploring The Early Universe

"Astronomers are the ultimate explorers," says Professor Rafael Guzman. "Each new astronomical instrument launches an expedition to explore the unknown universe with the expectation of new discoveries ahead." In cosmology, these expeditions are trips through the vastness of space to the beginning of time. The new generation of large telescopes like the GTC allows observations of galaxies that are very faint because they are very far away. Since the larger the distance the longer it takes for light to travel from the object to the observer, GTC observations of very distant galaxies will reveal how the universe looked like when it was only one tenth of its current age.

The exploration of the early universe is the focus of the UF Key Project: Galaxy Origins and Young Assembly (GOYA). The GOYA survey is being carried out by a team of astronomers at UF in collaboration with astronomers from Spain, Mexico and two other European countries. "GOYA will provide the most complete characterization of the optical properties of galaxies at the earliest epoch of the universe explored thus far," says Professor Guzman, co-Principal Investigator for the GOYA team. This survey is unique in the unparalleled access to the best instruments ever built for exploring the early universe: EMIR (built in Spain) at the GTC and FLAMINGOS-2 (built at UF) in Gemini-S. Using these instruments, astronomers from the GTC partner institutions will be able to map the distribution of matter in the early universe, classify its galaxy population and test our current ideas about the geometry and the fate of the universe itself.

Professor Rafael Guzman

CanariCam

CanariCam, led by PI Professor Charles Telesco and Deputy PI Dr. Chris Packham, is currently being completed in the UF Infrared Instrumentation Laboratory and will be available for use on the Gran Telescope Canarias on its first day of operations. Like T-ReCS, CanariCam is optimized for imaging and spectroscopy in the thermal-infrared spectral region, but it will also have two completely new modes of operation: coronagraphy and polarimetry. For the coronagraphic mode, special occulting and pupil masks suppress a star's light by an order of magnitude to enable astronomers to detect faint objects such as giant planets or brown dwarfs that may orbit a bright star. The polarimetric capability will provide a unique probe of accretion disks associated with heavily obscured massive black holes found at the center of most galaxies and it will illuminate previously inaccessible properties of particles orbiting in circumstellar disks where planets are formed.