W.M. Keck Observatory
Annual Report 2009

VISION

A world in which all humankind is inspired and united by the pursuit of knowledge of the infinite variety and richness of the Universe.

MISSION

To advance the frontiers of astronomy and share our discoveries, inspiring the imagination of all.

Observatory Groundbreaking: 1985
First light Keck I telescope: 1992
First light Keck II telescope: 1996

Headquarters location:
Kamuela, Hawai'i, USA
Management:
California Association for Research in Astronomy
Partner Institutions:
California Institute of Technology (CIT/Caltech),
University of California (UC),
National Aeronautics and Space Administration (NASA)

Observatory Director:
Taft E. Armandroff

Deputy Director:
Hilton A. Lewis

FY2009
Number of Full Time Employees: 117
Number of Observing Astronomers: 469
Number of Keck Science Investigations: 405
Number of Refereed Articles: 260
Fiscal Year begins October 1

COVER: University of Hawai'i photographer R. David Beales won Best in Show at the University Photographers Association of America, or UPAA, competition for his December 2009 image, "Mauna Kea Summit," showing the W. M. Keck Observatory's laser piercing the Hawaiian night sky.
INSIDE COVER: Visiting astronomers in the remote operations facility at Waimea headquarters discuss details of their observing run.
3: Award winning architecture of Keck headquarters framed by early evening light and the pastoral beauty of Waimea.

Contents

An Amazing Year of Discoveries

THE DIRECTOR'S REPORT

Dr. Taft E. Armandroff

"The year 2009 was the International Year of Astronomy, commemorating two major astronomical achievements that took place 400 years ago: Galileo Galilei first turned his simple refracting telescope toward the heavens, and in that same year Johannes Kepler published his book, Astronomia Nova, describing the first two laws of planetary motion.

How inspiring to consider what we have learned about the Universe since 1609 when the moons of Jupiter and the laws of physics came into focus. And how humbling to realize how many fundamental questions about the cosmos remain to be answered through the science of astronomy.

It is the W.M. Keck Observatory's role to answer these questions and over the past year we celebrated major milestones in both astronomical exploration and technology initiatives. It is my privilege to serve as the Director of the Keck Observatory and to introduce the chronicling of these achievements in the pages that follow.

One of the highlights of 2009 took place in January when a team of astronomers led by NASA's Mike Mumma reported the first definitive detection of methane in the atmosphere of Mars. Described in detail in the Discoveries section of the Report, their research indicates the Red Planet is either biologically or geologically active, finding variations in the concentration of this organic molecule over both time and location. Mumma and his team continue to apply the Keck telescopes, particularly our world leading adaptive optics system and NIRSPEC, a near-infrared echelle spectrograph, to more precisely map these methane emissions and guide further research to determine their source.

Another highlight of the year occurred in June 2009 when the Low Resolution Imaging Spectrograph (LRIS), one of Keck's first instruments and still our most popular and productive one, completed a major upgrade to its capabilities. LRIS is a double spectrograph that obtains data in the red and blue regions of the electromagnetic spectrum simultaneously. The entire red-side detector, electronics, and software were replaced with state-of-the-art technology.

The red region upgrade has made LRIS the most sensitive optical spectrograph in the world. With greater sensitivity and lower noise, the instrument now gives Keck astronomers the capability to work on scientific problems that were previously impossible and surpass observations that we could undertake before. Astronomers can observe more targets per night and yield more statistically robust results. Private philanthropy was essential in realizing the success of the LRIS upgrade project.

Over the past year, Keck Observatory made great progress on two other multi-year instrumentation initiatives: MOSFIRE, the Multi Object Spectrograph for Infrared Exploration and the next generation Laser Guide Star Adaptive Optics (LGS AO) system for the Keck I telescope. Both MOSFIRE and the new LGS AO system are scheduled for integration and commissioning in fiscal 2010 and are eagerly anticipated by our science community.

In this Annual Report you will meet some of the highly trained and dedicated staff members responsible for maintaining and operating the Keck telescopes as well as deploying these technological innovations. Alongside these and other Keck professionals you will also be introduced to leaders from our astronomy community who are contributing by developing new instrumentation or participating in Observatory governance.

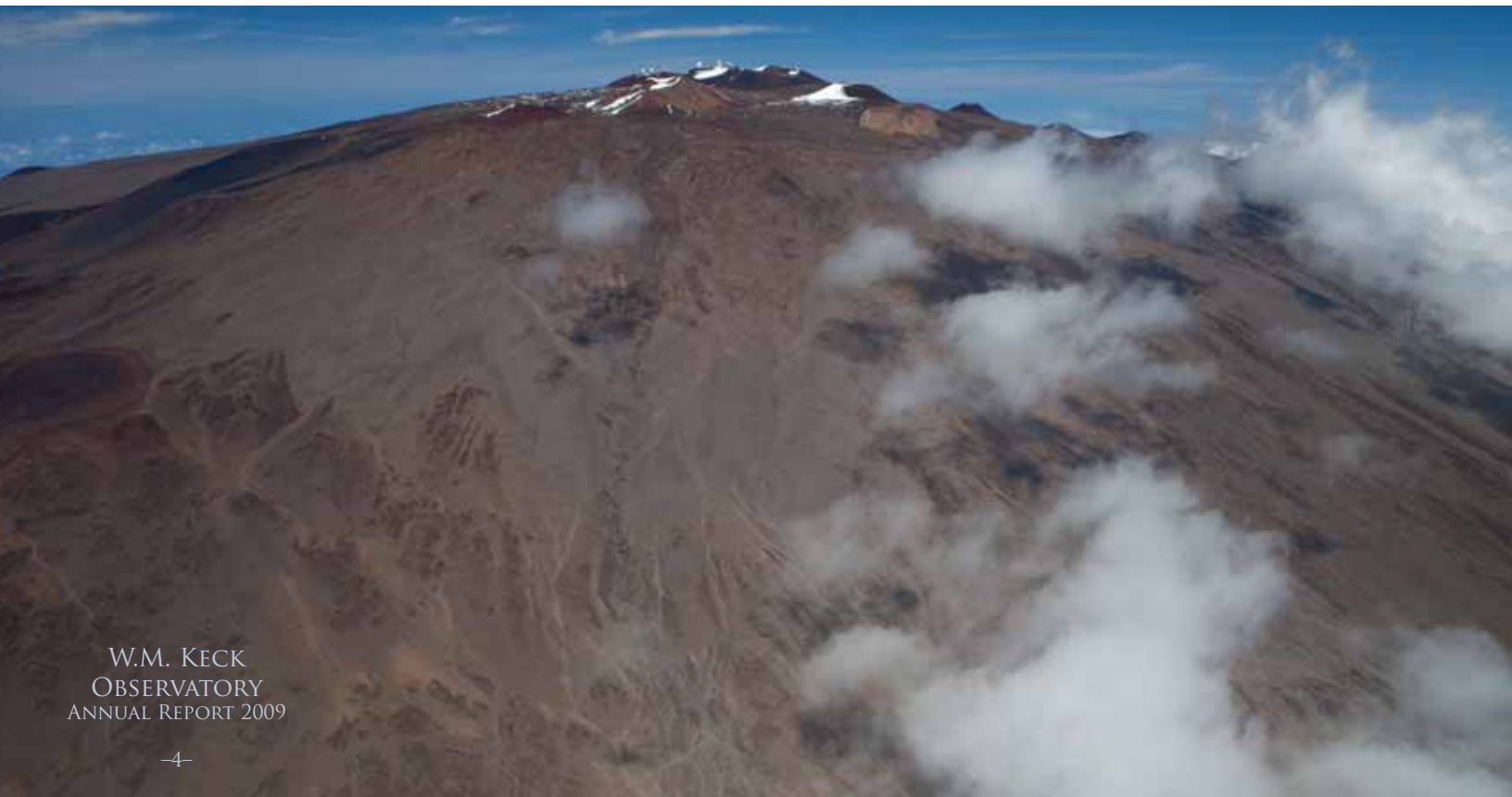
And you will learn how in the International Year of Astronomy we continued the trend of increasing both the quality and quantity of our education and outreach activities and growing the number of our philanthropic supporters. We are encouraged by the significant interest in and support of our work by the public.

Modern astronomy is a highly competitive and constantly changing field, and Keck Observatory continues to be honed as a powerful discovery machine with additions to our telescope instrumentation and enhancements to our adaptive optics systems. These technological enhancements are complex and require significant resources to design and build. As a private-public partnership, we rely on grants from federal agencies and gifts from individuals and foundations to fund these pathfinding developments. The new science enabled is dramatic and the results published over the past fiscal year by Keck's astronomers are also quantified in the Report.

ABOVE: Observatory Director Taft Armandroff and Deputy Director Hilton Lewis.

BELOW: A rare aerial view of majestic Mauna Kea and the Observatories.

In its short history, the twin ten-meter Keck telescopes have pushed Galileo's first concepts of astronomy to the extreme and brought the beauty, complexities and mysteries of the cosmos within reach. As an organization we are proud of what we have accomplished not only in cutting-edge discoveries but also in training and inspiring the next generation of explorers. I thank our professional staff, our governing board and advisors, our philanthropic supporters, and our volunteers for all their contributions and for their steadfast commitment to our continued leadership in this amazing scientific enterprise. ”



Welcome to the cutting edge of tomorrow...

The twin 10-meter Keck Telescopes are the leading optical/infrared telescopes in the world and are dedicated to astronomical research 365 days/nights per year.

Observing time on the Keck telescopes is highly prized and is divided each year among its partner institutions: the California Institute of Technology, the University of California and NASA, as well as the University of Hawai'i. The broader astronomical community has access to the telescopes through partnerships with the National Science Foundation and NASA.

Recognized as the most scientifically productive observatory in history, Keck Observatory has contributed to all areas of astronomy and astrophysics. Keck's legacy of exploration includes the discovery of exoplanets; the study of how planets, stars and galaxies form; the nature of black holes; and the chemical composition and evolution of the Universe.

Beyond offering the largest light collection mirrors on the planet, the Keck telescopes host a complete suite of nine state-of-the-art observing instruments to collect and analyze astronomical data with unprecedented power and precision.

Keck is a world leader in the field of adaptive optics, a breakthrough technology that removes the distortions caused by the turbulence in the Earth's atmosphere and provides image clarity of cosmic targets that rivals those of the Hubble Space Telescope.

Made possible by grants from the W. M. Keck Foundation, the Observatory today is a private 501(c)3 non-profit organization and depends upon competitive grants and philanthropy to sustain its frontier research capabilities.

Cosmic Vision

W. M. Keck Observatory Board of Directors

George Blumenthal, *Chair*
Edward Stolper, *Vice-Chair*
Michael Bolte
T. J. Keck, *liaison*
Shrinivas Kulkarni
Mario Perez, *liaison*
Thomas Soifer
Peter Taylor

Keck Observatory Advancement Advisory Council

Sanford Robertson, *Chair*,
and Jeanne Robertson
Taft Armandroff, *ex-officio*
Marc and Lynne Benioff
Michael Bolte, *ex-officio*
Clive and Carol Davies
C. Wallace and Bobbie Jean Hooser
Shrinivas Kulkarni, *ex-officio*
Art and Rita Levinson
Gordon Moore
Rob and Terry Ryan
Doug and Deborah Troxel

Keck Observatory Science Steering Committee

Jean Brodie, *Co-Chair*
Chris Martin, *Co-Chair*
Rachel Akeson
Michael Bolte, *ex-officio*
Judy Cohen
Alex Filippenko
Karl Glazebrook, *observer*
Thomas Greene
Richard Ellis
Shrinivas Kulkarni, *ex-officio*
Michael Liu
Jerry Nelson, *ex-officio*
Jason Prochaska
Pieter van Dokkum, *observer*

BELOW: Keck Observatory's signature Evenings with Astronomers lecture series, sponsored by the Rob and Terry Ryan Foundation, continues to connect Friends of Keck Observatory to their philanthropic investments.

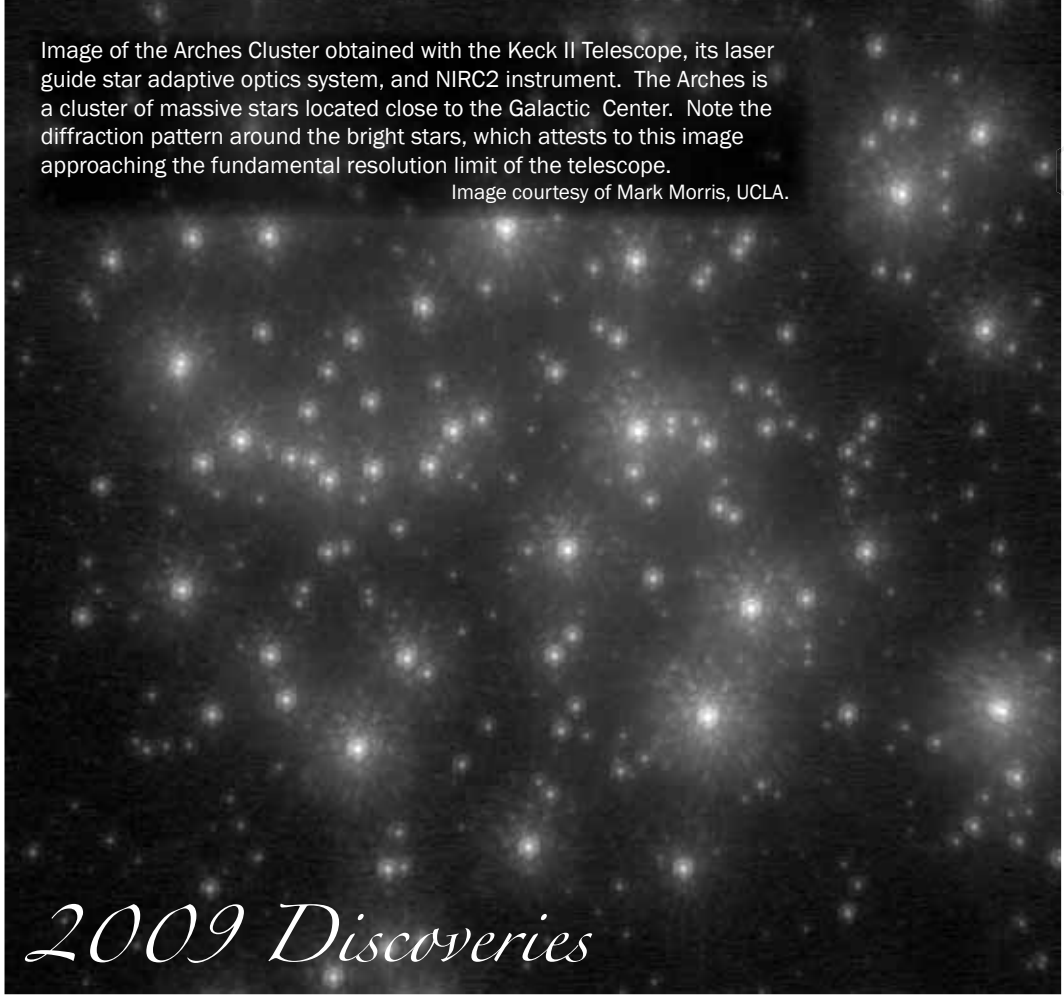
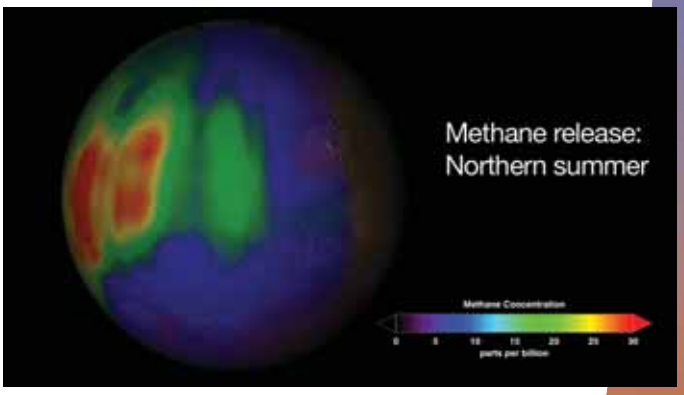


Image of the Arches Cluster obtained with the Keck II Telescope, its laser guide star adaptive optics system, and NIRC2 instrument. The Arches is a cluster of massive stars located close to the Galactic Center. Note the diffraction pattern around the bright stars, which attests to this image approaching the fundamental resolution limit of the telescope.
Image courtesy of Mark Morris, UCLA.

2009 Discoveries

Keck Observatory has had a major influence on astronomy during the first sixteen years of science operations, and the year 2009 reflected our continued worldwide dominance in ground-based astronomy. The following research highlights demonstrate the impressive reach Keck has had in expanding our knowledge of the Solar System, the Galaxy and the Universe.

METHANE ON MARS



This image shows the parts per billion of methane released globally on Mars during summer in the planet's northern hemisphere. Image courtesy of NASA.

On Earth, organisms release about 90 percent of our planet's methane as a by-product of digestion. Geological processes, like oxidation of iron, release the other ten percent. Despite the barren appearance of Mars, the first definitive detection of methane in the planet's atmosphere was announced in 2009, indicating the planet is alive in either a biologic or geologic sense. To obtain these exciting results, Michael Mumma of NASA's Goddard Space Flight Center and his colleagues used Keck's Near Infrared Spectrograph (NIRSPEC) and other facilities, particularly NASA's Infrared Telescope also on Mauna Kea, to observe the Red Planet's atmosphere over a period of three Martian years—the equivalent of seven Earth years.

During the Northern mid-summer on Mars, measurements were made of a large plume that contained about 19,000 metric tons of methane. The plume's source was comparable to that of the massive hydrocarbon seep at Coal Oil Point in Santa Barbara, California. By the vernal equinox about half of that methane had been lost.

Because such a large proportion of the Earth's gas comes from living creatures, the discovery of methane suggests it could come from microbes living on the Red Planet. The search for clues to its origin, either biological or geochemical, continues and Keck's adaptive optics will lead the way in future observations, mapping regions of the methane's release to an unprecedented detail of 50 kilometers.

SUPER-EARTHS REVEALED

Before the 1990s the only planets known were those we all learned in school. Detecting and studying planets orbiting nearby stars is now one of the most exciting and dynamic areas of astronomy. "Exoplanet" research, a relatively new field of study, has developed beyond its initial emphasis on proving whether or not planets exist beyond our own Solar System. With over 400 of these worlds identified within the last fifteen years, modern astronomers continue their hunt for the planets with the lowest possible mass.

This artist's impression shows a "super Earth" orbiting a star similar to the Sun. Several low mass planets have been discovered around nearby stars suggesting that they are more common than previously thought.
Credit: MicroFUN Collaboration, CfA, NSF

The Keck I telescope has been the most prolific scientific instrument in the world for finding exoplanets, the majority of them being gas giants, like Jupiter. Even with that great success, we are still left with a glaring holy grail—detecting the first extrasolar Earth-like planets ever found by humanity. Over the past year, two teams have used Keck Observatory's powerful High Resolution Echelle Spectrometer (HIRES) to reveal a number of "super-Earths," defined as planets more massive than Earth and less massive than Neptune. Steven Vogt of the University of California, Santa Cruz, and Paul Butler of the Carnegie Institution of Washington led an international team that found two new planetary systems by combining data gathered with the Keck I telescope and the Anglo-Australian telescope. These new systems orbit the bright stars 61 Virginis and HD 1461, with each hosting a super-Earth of five and 7.5 times that of our planet's mass, respectively. Separately, Andrew Howard and Geoff Marcy, both of the University of California, Berkeley, and colleagues identified an exoplanet with a mass just four times that of Earth orbiting its parent star HD 156668. It is the second-smallest exoplanet that has been found to date.

These super-Earth discoveries, combined with other recent data, suggest that planets orbiting the Sun's nearest neighbors are extremely common: about half of all nearby stars have a detectable planet with a mass equal to or less than the mass of Neptune. The data also tell us that lower mass planets form as a natural consequence of the same process that creates stars. With continued focus and innovation, the discovery of other potentially habitable worlds may be just a few years away.

A DISK OF YOUNG STARS AT THE GALACTIC CENTER

The center of our Galaxy harbors not only a supermassive black hole with a mass four million times the mass of the Sun, it also harbors an unexpected population of young, massive stars. The existence of these stars is an enigma because at the present time there is no observational evidence to suggest that sufficient gas exists at the Galactic Center to have allowed them to form. Moreover, the tidal force from the supermassive black hole should make it difficult for nearby gas to condense into stars. As a result, astronomers have debated the origin of these young stars extensively over the past several years.

Led by Jessica Lu at the California Institute of Technology, astronomers from the UCLA/Keck Galactic Center Group are investigating the orbits of the young, massive stars to better understand their origins in this extreme environment. The advent of the Keck laser guide star adaptive optics system has allowed the team to retroactively improve their 11-year Keck data set of the Galactic Center, increasing the precision with which stellar orbits can be determined. The movements of the young stars, or astrometry, imply they are rotating in a single disk at a high inclination and in a clockwise direction. These new measurements suggest that this group of stars, which orbit close to the black hole, may have formed in situ in a single event.

The stars in the central part of our Galaxy, the Milky Way, as seen at near-infrared wavelengths. By following the motions of the stars over more than 16 years, astronomers were able to determine the mass of the supermassive black hole that lurks there.

Credit: ESO / S. Gillessen et al.

DISCOVERY AND CHARACTERIZATION OF MOST DISTANT SUPERNOVAE

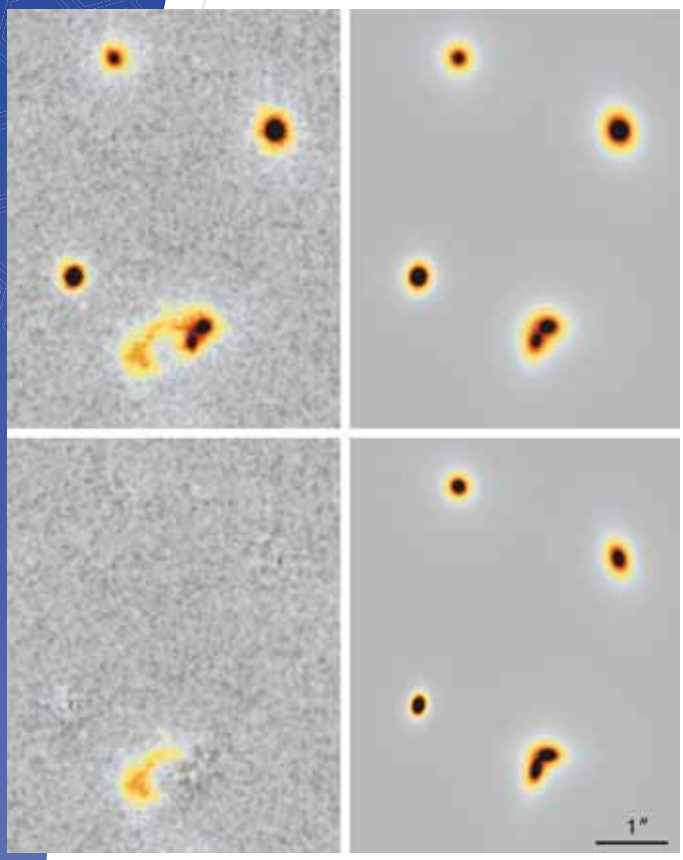
Supernovae are stellar explosions that can outshine an entire galaxy, such as the Milky Way, for a brief interval. As such, they are bright beacons that can be observed at very great distances from Earth. Astronomers have yet again rewritten the record books for discovering the most distant supernovae.

In 2009, using Keck Observatory and the Canada-France-Hawaii Telescope (CFHT), a team, led by Jeff Cooke, then of the University of California, Irvine, used a novel technique to identify explosions of two massive stars that occurred roughly 11 billion years ago. Studying the deaths of such early stars is essential to understanding the evolution of the Universe and how its elements were formed and distributed to later create stars and planets. To find the most distant of these supernovae, the team examined archival data from the CFHT Legacy Survey and identified four faint objects that appeared to brighten and then fade over time, suggesting they were distant supernovae candidates.

This artist's impression shows the deadly explosion of one of the Universe's most massive stars. After it exhausts its supply of nuclear fuel and collapses violently, the stellar core rebounds in a cataclysmic blast that spews most of its material into interstellar space.

Credit: G. Arguner

The astronomers then used the Low Resolution Imaging Spectrograph (LRIS) on the Keck I telescope and the Deep Imaging Multi-Object Spectrograph (DEIMOS) on the Keck II telescope to measure the spectrum of light emitted by each object to determine their composition and distance. The Keck spectra showed that the light from the supernovae traveled nearly 11 billion light years to reach Earth. Prior to this discovery, the astronomical literature showed that the most distant supernova of this type exploded roughly six billion years ago and that the most distant supernova of any type exploded roughly nine billion years ago. These early explosions give astronomers a glimpse of how the elements essential to planet formation and to the existence of life were created, since stars form heavier and heavier elements in their core. Cooke's novel technique may reveal even more distant explosions, which could provide additional clues of how some of the earliest elements were initially created and distributed throughout the cosmos.



This image shows a group of luminous galaxies near the radio galaxy TXS 2332+154, which has been identified with the galaxy at the upper right corner of the group at a distance of roughly 11 billion light years from Earth. The Keck II LGSAO image is shown in the upper-left panel. The best-fit model for the five galaxies is shown in the upper-right. Of special interest is the tidal tail between the lower galaxies and the galaxy at the lower left of the group: it appears to be a galaxy more massive than our own Milky Way, yet it packs most of its light within a radius of 1500 light years.

Credit: Alan Stockton, UH/WMKO

THE NATURE OF MASSIVE GALAXIES IN THE EARLY UNIVERSE

How galaxies form over time from the Big Bang to the present is one of the fundamental questions of astronomy. How have phenomena such as mergers and collisions changed the distribution of mass and the size of galaxies over cosmic time? The ability of astronomers to isolate samples of galaxies dating from the early Universe and to determine their properties is fundamental to addressing this issue.

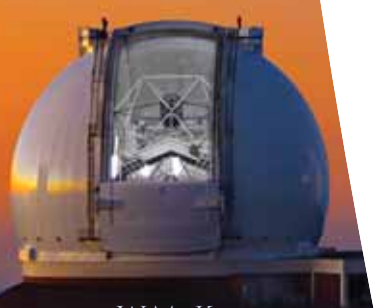
Alan Stockton of the University of Hawai'i, Gabriela Canalizo of the University of California, Riverside, and Elizabeth McGrath of the University of California, Santa Cruz, used the Keck II telescope and its laser guide star adaptive optics system to image radio galaxies and quasars that are roughly 11 billion light years from Earth.

Stockton and his team obtained near-infrared images from Keck that were nearly twice as sharp as those they could obtain with the Hubble Space Telescope at similar wavelengths. From these images, Stockton and colleagues discovered that the structures of these early galaxies are quite unlike those of today's massive galaxies. The team found the objects had masses that were one hundred billion times the mass of the Sun, yet were small in size, with diameters of roughly 3,000 to 15,000 light years across. By comparison, the diameter of the Milky Way Galaxy is 100,000 light years, yet it has a mass of about 500 billion solar masses. The early galaxies are ten to 1000 times more compact. Stockton has speculated that these early disk galaxies may have become, over time, the cores of present day galaxies.

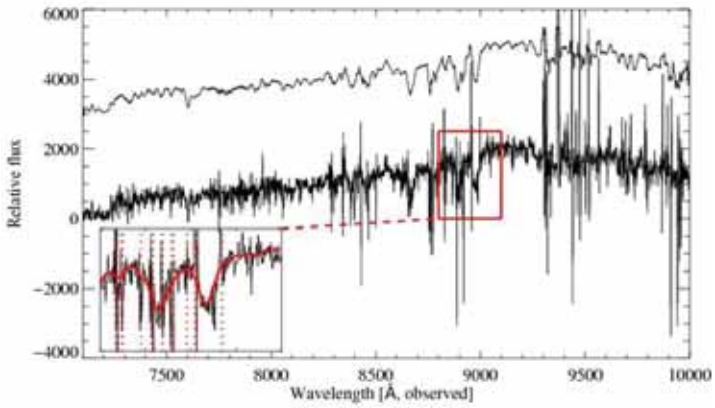
GRAVITATIONAL LENSING AND ADAPTIVE OPTICS RESOLVE EARLY STAR-FORMING GALAXY

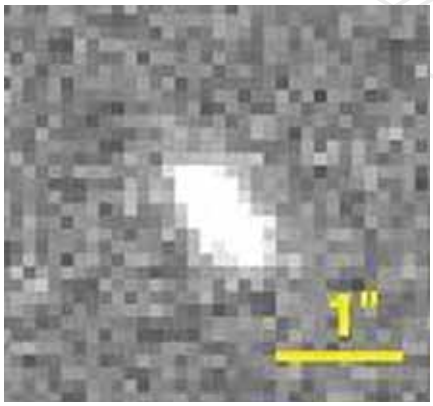
Astronomers at the California Institute of Technology, led by Richard Ellis, and their colleagues have provided unique insight into the nature of a young, star-forming galaxy as it appeared only two billion years after the Big Bang. The team made their observations by coupling two frontier techniques: laser guide star adaptive optics on the Keck II Telescope and gravitational lensing. The latter makes use of an effect, first predicted by Albert Einstein, in which the gravitational field of massive objects such as foreground galaxies bends light rays from objects located a distance behind, thus magnifying the appearance of the distant sources.

Gravitational lensing enlarges the distant object in angular size by a factor of about eight in each direction. Together with the enhanced resolution obtained through adaptive optics, this allowed the team to observe with dramatically finer detail than previously possible. For the first time, the astronomers were able to determine the internal velocity structure of a galaxy located 11 billion light years from Earth. The researchers found that the distant galaxy, which is typical in many respects to others of that epoch, shows clear signs of orderly rotation.



The result, in association with observations conducted at millimeter wavelengths sensitive to cold molecular gas, suggests that this distant galaxy is in the early stages of assembling a spiral disk. It even appears to have a central nucleus similar to those seen in spiral galaxies, like the Milky Way, of the present day.





From the AO image and spectrum of this galaxy, which sits 11 billion light years from Earth, Ellis and his colleagues were able to determine that the disk is rotating and could be in the early stages of developing into the spiral galaxies seen today.

Credit: Richard Ellis, Caltech/WMKO

Carol and Clive Davies, members of the Keck Observatory Advancement Advisory Council, celebrate the success of "first light" of the enhancements to Keck Observatory's LRIS instrument. Donor events took place in Hawai'i, southern California, and northern California.

Finances

The W. M. Keck Observatory is managed by the California Association for Research in Astronomy (CARA), a tax-exempt, private, nonprofit organization dedicated to astronomical research and education. Established in 1985 by the California Institute of Technology (Caltech) and the University of California (UC), CARA's founding mission was to build and operate the world's two largest optical/infrared telescopes on Mauna Kea. The capital costs of the highly ambitious project were borne by Caltech, and the majority was funded by grants from the W. M. Keck Foundation. The Foundation's namesake, William Myron Keck, was an entrepreneur and founder of Superior Oil Company of California, and his heirs recognized the potential breakthrough in astronomical research promised by the revolutionary segmented design of the 10-meter telescope mirrors. The total funding of $138 million represented 25% of the Foundation's assets, and, at the time, was the largest charitable contribution of its kind. The Keck Foundation also helped fund the development of the adaptive optics system on the telescopes and today considers its capital investment in the Observatory an undisputed "home run."

The agreement between its founding partners, Caltech and UC, ensures an annual base of operating support for Keck Observatory through 2018. In fiscal year 2009, this amount was $12.2 million. As a one-sixth partner in the Observatory, the National Aeronautics and Space Administration (NASA) provided $3.2 million in operating support in 2009. In addition, $1.7 million in new federal grants and contracts was awarded in fiscal year 2009 for the Observatory's development projects. A total of $533,974 in new charitable gifts and pledges from the private sector provided additional resources for new instrumentation and capabilities. The total budget for Keck Observatory in fiscal year 2010 is $24.8 million. Audited financial statements are available upon request and at the Observatory website.

With the world's most accomplished astronomers, Keck Observatory has generated the greatest quality and quantity of astronomical discoveries of any ground-based observatory in history. A comprehensive strategic

planning process has identified a prioritized list of investments to energize existing capabilities and develop new ones.

In 2009 the Keck Observatory completed a successful multi-year fundraising campaign to support an important new capability for the Keck I telescope. The Low Resolution Imaging Spectrograph, one of original and most productive instruments behind the Keck telescopes, was strengthened and revitalized into what is now the world's most sensitive optical spectrograph. Representative of most development projects at Keck, the work was a collaboration of its partner institutions. The University of California at Santa Cruz designed, built and integrated the upgrade components. Caltech, the original LRIS developers, contributed detailed knowledge and counsel. Lawrence Berkeley National Labs developed the detector technology. The Observatory contributed overall management, infrastructure, and along with UCSC, commissioning, and secured $616,155 in private philanthropy towards the total project budget of $1.6 million.

Friends of Keck Observatory Jack and Ellen Toigo enjoy "A New View of the Universe" and the ambiance of Pu'u Wa'a Wa'a Ranch with Advancement Director Debbie Goodwin (center).

Major contributors to the multi-year campaign were the Change Happens Foundation, the Mt. Cuba Astronomical Foundation, the William J. and Dorothy K. O'Neill Foundation and Keck Observatory Advancement Advisory Council members Carol and Clive Davies, and Jeanne and Sanford Robertson.

The upgrade of the next generation instrument took place in a single five week period and in its first month back in science operation LRIS collected astonishing new data for four of the top astronomers in the world: Richard Ellis, Alex Filippenko, Shri Kulkarni and Chuck Steidel.

"I give to many organizations, most of them as short term bets. Keck Observatory is my long term bet, my gift to future generations. In 500 years children will learn about the Keck Observatory like kids today learn about Christopher Columbus."

—Dr. C. Wallace Hooser,
Keck Observatory Advancement Advisory Council

Special receptions called "A New View of the Universe," were held at hosts Henk and Akemi Rogers' Pu'u Wa'a Wa'a Ranch, at the Huntington Library, Art Collections and Botanical Gardens in Pasadena, and at hosts David and Nathalie Cowan's residence in Atherton, California, and honored the LRIS upgrade milestone.

Fueling Discovery

2009 PATRONS
October 1, 2008 –September 30, 2009

UNIVERSAL BENEFACTORS
> $100,000

Betty and Gordon Moore
Mt. Cuba Astronomical Foundation

COSMIC CONTRIBUTORS
> $10,000

The Annenberg Foundation
Fairmont Orchid Hawaii
Jeanne and Sanford Robertson
Terry and Rob Ryan
Sun Microsystems, Inc.
Xirrus

GALACTIC ASSOCIATES
Annual Gift of $10,000

Carol and Clive Davies
Ping and Fritz Faulhaber
Anne Barasch Ryan and John Cutler Ryan

Public Funding Sources

Association of Universities for Research in Astronomy
Center for Adaptive Optics
Jet Propulsion Laboratory
National Aeronautics and Space Administration
National Science Foundation
University of California

STELLAR ASSOCIATES
Annual Gift of $3,000

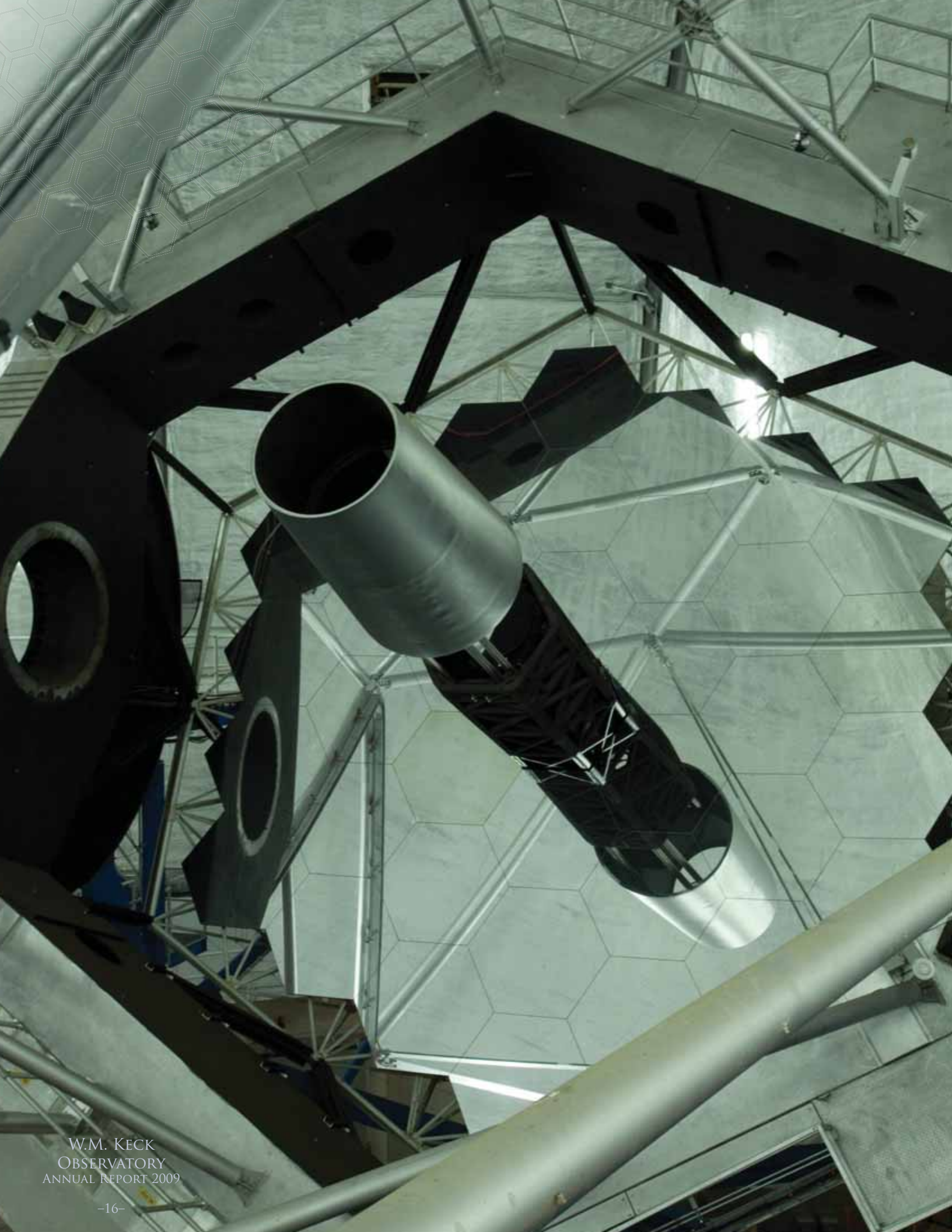
Blue Hawaiian Helicopters
Sharlee and Peter Eising
Laurie and Jack Goldstein
Pam and Gary Jaffe
Janet Gimbel Rogers and Stephen Rogers
Kathy and Charles Vasilius

PLANETARY ASSOCIATES
Annual Gift of $1,500

Liz and Taft Armandroff
Doris and Earl Bakken
Thomas Blackburn
Polly and Tom Bredt
Nathalie and David Cowan
David DeSante
Marilyn and Patrick Fitzgerald
Deborah Goodwin and James Fritz
Suzanne Hill and Mike Luce
Hualalai Resort
Milly and Mac Morris
William J. and Dorothy K. O'Neill Foundation
Joan Morgan and Richard Schleicher
Liz and Dave Sonne

Other Individuals, Corporations and Foundations

Naomi Ahuna
BB Embroidery, Ltd.
Astrid and Greg Bear
Ruth and Jerry Bentley
Big Island Tents
Diana and Andrew Bonnici
Rosalind and Stephen Butterfield
Peggy and William Cameron
Diana and Fred Chaffee
Chester Woodruff Foundation
Linda and James Clifford
AJ Clifford
Ginny and Hal Cogger
Karri and Mark Copman
Linda Copman
Sue and Richard Dekany
Patricia Dilworth and Bruce Miller
Paul A. Dolinsky
Marilyn and John Dougery
Marilyn and Thomas Elias
Carl Feinberg
Carolyn Zecca-Ferris and Timothy Ferris
First Hawaiian Bank
Amy and Morton Friedkin
Peggy and Peter Georgas
Barbara and Ron George
Petra and Robert Goodrich
Mary Ann and David Hunter Grafft
Thomas N. Hansen
Joanne and Jon Harmelin
Sylvia and Karl Hess
Kandace and Rick Holley
Sue and Dick Humphries
The Huntington Library, Art Collections and Botanical Gardens
Kristen McFarland and Norval W. Jasper, Jr.
Alette and Dean Kauka
Cynthia Roher and Thomas Kapp
W. M. Keck Foundation
Marsha and Tom Kerley
Cheryl and Mike Kessler
Val Kim and Gerald Weldon
Gregory A. Koestering
Darla and Earl Laing
Linda and Doug Lanterman
Elizabeth and Ron Laub
Jan Leeman
Barbara Fischlowitz-Leong and Michael Leong
Carol and Richard Little
Marlene and Sandy Louchheim
Patricia and James Ludwig
Dawn and Gerry Martin
Carol and Samuel McClung
Mary Ann and Samuel McClung
Microsoft Corporation
Jan and Frank Morgan
Pacific Radio Group
Mary and Jim Quinn
Bill Randolph
Denise and John Ray
R. Michael Rich
Tony Rich
Stephanie Robinson
Akemi and Henk Rogers
Michael Sack and John Saul
Margarita and Thomas Scheffel
Gretchen and Richard Scheumann
Barbara Schmidt
Maura and James Schumacher
Crystal and Gavin Sebastian
Vicki Serianni
Mary and Jas Singh
Tom and Mary Anna Soifer
Alice and Edward Stone
The Swig Foundation
Judith Tauber
Angie and Tom Thornbury
Ellen and Jack Toigo
Leslie and Richard Wallis
Marcia and Stanley Wishnick
Natalie Young and Richard Liebmann



The People of Keck

Keck Observatory is one of the largest employers in Waimea. Its professional staff reflect both local and global roots. A potent combination of dedicated and driven engineers, technicians, scientists, and administrators, together they represent the very best team in executing cutting-edge astronomy research.

Constance Rockosi

ASTRONOMER

Constance Rockosi, a leading astronomer and frequent observer at Keck, has an unwavering passion for the stars. She is a Professor of Astronomy and Astrophysics at the University of California at Santa Cruz and, even while sitting in traffic on her way to campus, her thoughts are always on her favorite subject.

"My mind just starts thinking about things I work on, like the origins of the Universe and how planets form," she says. "We deal with such fascinating questions."

A New Jersey native, Rockosi earned her B.S.E. in Electrical Engineering at Princeton University then obtained a Ph.D. in her chosen fields at the University of Chicago. She is an instrument-builder by training and a world expert on CCDs and CCD cameras. Rockosi was deeply involved in a multi-year, multi-million dollar upgrade to improve Keck Observatory's Low Resolution Imaging Spectrograph, or LRIS. She joined many in celebrating the successful first light of the modified science instrument in June, 2009.

Rockosi was in Hawai'i for the final commissioning of LRIS. It was snowing the day the instrument was delivered to the summit, and the snow was deep enough to block the entrance to Keck. "There was Bill Bates, the summit lead, greeting us at the Observatory door with shovel in hand, ready to dig a path and help bring LRIS inside," Rockosi says. "This 'can-do' spirit of cooperation happens all the time at Keck."

The "next generation" LRIS, now the most sensitive spectrograph of its kind, allows astronomers to probe extremely faint and distant cosmic targets. For the first time, the new LRIS detectors are able to capture photons from galaxies in the "redshift desert." Some of this light has traveled over nine billion years to give astronomers more clues about how galaxies form and mature.

Rockosi's own current research seeks to understand how the outer edges of our Milky Way Galaxy evolved. With Keck she is able to study the oldest stars in our Galaxy, some almost as old as the Universe itself.

For most of us, pondering "galactic archeology" is beyond our reach. For Rockosi, it is just another day at the office.

Tom Soifer

KECK OBSERVATORY BOARD MEMBER

In the economic sag of 2009, nonprofit organizations that thrive do so because they are entrepreneurial. They understand they must provide excellent value and must constantly innovate. "Keck Observatory's greatest value is its scientific vitality, and, as a privately funded facility, it is able to respond quickly to changing opportunities," says Tom Soifer, Chair of the Division of Physics, Mathematics and Astronomy at the California Institute of Technology and former Co-Chair of Keck's advisory group, the Science Steering Committee. He currently serves on the Observatory Board of Directors.

Soifer explains that every other eight-to-ten-meter class observatory is a publicly funded national or international facility, where, because of bureaucracy, both planning and execution take much longer. The Observatory's ability to capitalize on emerging scientific priorities is a tribute to the quality of its staff in Waimea and its tremendously creative scientific user community, Soifer says.

Earning his B.S. degree in physics from Caltech, Soifer went on to earn his Ph.D. in astronomy at Cornell University. He returned to teach and do research at his undergraduate alma mater in 1978. Soifer has both witnessed and helped foster all of the technical capabilities that have been responsible for making Keck's legacy discoveries. In 1993, Soifer had the first-ever science run with The Observatory's debut instrument, the Near Infrared Camera. Since then he has also used NIRC2, DEIMOS, OSIRIS, and LRIS —both before and after its 2009 upgrade.

Soifer's research focuses on dusty, "adolescent" galaxies and he obtains data from both space-based telescopes and Keck. He directs the Spitzer Science Center, which operates NASA's Spitzer Space Telescope out of Caltech. The orbiting telescopes drive his observing program, but "it's the ground-based telescopes like Keck that are essential to developing a more complete understanding of what one is seeing from space," Soifer says.

"What is wonderful about astronomy is that we can describe these discoveries in pretty simple language, and there's a solid outreach program at Keck, which I hope is inspiring the youth of Hawai'i to take advantage of the opportunities in science, math and engineering taking place in their backyard," Soifer says.

Gregory Wirth

SUPPORT ASTRONOMER

In Keck Observatory's early days, astronomers would observe from the summit of Mauna Kea, where although they could walk outside to admire the brilliantly clear Hawaiian night skies, the high elevation conditions were arduous. Today they operate under much milder circumstances from the remote observing rooms in Waimea or from dedicated facilities at their universities. Wherever they observe, Gregory Wirth is there to greet them as each observing team's "deluxe customer service representative."

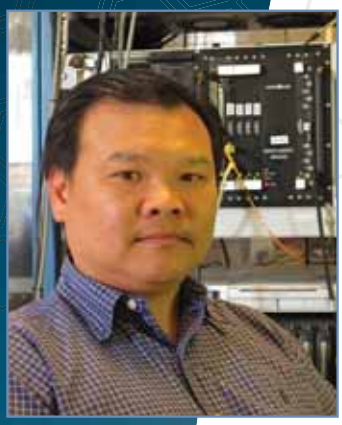
Wirth is one of six Support Astronomers on staff at Keck Observatory who are both scientists and instrument specialists. Their primary responsibility is to make sure visiting astronomers have everything they need to achieve their science proposal goals. In their position at Keck, Support Astronomers also enjoy the exceptional privilege of having access to the Keck telescopes for their own research.

Wirth first experienced Keck Observatory in 1994 as a doctoral candidate in astrophysics. In 1998, after earning his PhD in astronomy at UC Santa Cruz, he joined the Keck staff and became the "instrument master" first of LRIS, the Low-Resolution Imaging Spectrometer, and then of DEIMOS, the Deep Imaging Multi-Object Spectrograph. DEIMOS is a world leading wide-field multi-object spectrograph that has been key to understanding large scale structure in the Universe.

"It is never boring. One night I'll be with a new astronomer explaining how to calibrate and interpret DEIMOS data, the next day at the summit troubleshooting an instrument problem, the next day writing software," he says.

Wirth also collects his own data on galaxy clusters. "Galaxy clusters are the largest self-gravitating objects in the Universe that we can study as they form and evolve," he says.

In addition to his observing support, instrument work and personal research, Wirth also participates in Keck's outreach programs. The Observatory encourages all employees to dedicate two percent of their work time benefitting the community. Many, like Wirth, are active in education, encouraging children to learn more about science through "hands-on" astronomy activities. "Kids here may never visit New York City or the Eiffel Tower, but we can take them into a world many others will never see," he says.



Jason Chin

SENIOR ELECTRONICS ENGINEER

Jason Chin has ridden the information technology tidal wave from aerospace to outer space. Born in Hong Kong, Chin's family moved to Honolulu in 1973, and as a teenager at Damien Memorial High School, he learned to use the first crude personal computers. When the Radio Shack TRS-80 came out in the late '70s, Chin saw its world-changing potential and enrolled in electrical engineering at the University of Southern California. He received both his bachelor's and a master's degree in four and a half years.

After graduation, Chin was hired by Hughes Aircraft outside Los Angeles as a software systems engineer for projects including high flying reconnaissance missions. "But I vowed that I would return to Hawai'i by the time I was 30," he says. "Besides my family being here, Hawai'i just gets into your blood."

Chin joined Keck in 1995. He is currently Project Manager for both the Keck I Laser Guide Star Adaptive Optics (LGS AO) System and the Keck II Laser Center Launch Project, and lead engineer for the Next Generation LGS AO Facility.

After years of planning, the arrival of the Keck I Laser at Observatory headquarters in 2009 was a gratifying moment for Chin. Keck was the first observatory to exploit natural guide star adaptive optics systems in the late 1990's. In 2004, the Keck II telescope began science operations with the first laser guide star system on a large telescope. Driven by the high demand for LGS AO observing time and the goal to use LGS AO with the Keck Interferometer, the new laser system was another milestone in extending this groundbreaking capability for modern astronomy.

Weeks of tests at headquarters proved the new laser performed well in several key areas: power, spectral content, wavefront quality and stability. The laser and subsystems were taken to the summit and, after more tweaks and adjustments, Chin and his team celebrated its first light propagation on January 28, 2010.

"Keck is not your run-of-the-mill non-profit organization," Chin says. "The Observatory pursues goals with a vengeance. The challenge of the work here is far greater than anywhere else, and I love it."

Jeff Mader

SOFTWARE ENGINEER

Koa is the name of a native Hawaiian hardwood. It is also the acronym for the Keck Observatory Archive, a database of all spectral observations taken by Keck's High Resolution Echelle Spectrograph, or HIRES. Funded by NASA, KOA is housed at Caltech's Exoplanet Science Institute in Pasadena. Mader helped develop the software for the HIRES archive and is now developing a database for another Observatory instrument, the Near-Infrared Echelle Spectrograph, or NIRSPEC.

While his specialty is software programming, Mader is an astronomer. He received his master's degree from San Diego State University and his first job was at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts. "But I've always been into archives," he says. "I like the creativity in writing programs to give the world access to these remarkable findings."

Mader's work isn't just archival. One piece of software he wrote analyzed a recent night's findings concerning the light curves of binary stars, that is, the change in the orbital period of these star duos which helped reveal their gravitational pull on each other.

Mader thinks of himself as a “software programmer on call.” He is available 24/7 to deal with a variety of problems expected in the computer driven environment of modern astronomy. It can be as minor as an internet browser not working for a visiting astronomer or as immediate as a guider camera not functioning at the summit during an observing run.

Beyond the technological prowess of the Observatory, Mader believes it is the ‘ohana, or family, connection that makes Keck a very special place to work. “At Keck, we are not just co-workers or neighbors, we’re friends. We bring that connection into our work. It makes a difference,” he says.

One way to strengthen friendships at Keck can be seen on Friday during the lunch hour when Mader and many of his colleagues play Ultimate Frisbee at Waimea’s community park. Mader also leads a youth group and manages the little league baseball team his sons, Jake and Zack, play on. He is married to his high school sweetheart and wife of thirteen years, Christine.

Naomi Ahuna

HUMAN RESOURCES AND ADMINISTRATION MANAGER

Growing up in Kahalu’u on the island of Oahu, Naomi Ahuna remembers travelling to Kohala to visit her father’s family and during those visits, she was moved by the beauty of Mauna Kea. In late 2004, during her interview process, Ahuna travelled to the summit to tour the Observatory and experienced both the magnificence of Hawaii’s sacred mountain and the awe-inspiring power of the telescopes. “This was more than a job. It was a calling,” she recalls.

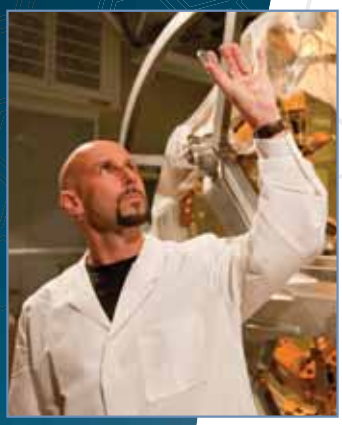
Today, as the head of Human Resources and Administration, Ahuna believes communication is the most important aspect of her job. She is the lead administrator for approximately 120 employees, and has initiated a number of activities that ensure camaraderie. “We have a wide span of credentials, from high school graduates to multi-degree academics.” At Keck the theme is, “Embrace diversity.” “Staff really care about staff,” she says.

Ahuna oversees all recruitment efforts, with as many as 200 people applying annually from all over the world for jobs posted on Keck’s web site. Last year, her staff of six also started the WMKO Employee Newsletter, a first, to share news, awards, outside activities and social events. “This is an active group of people – from scuba diving and triathlons to coaching soccer and science teams.”

“Our employees are passionate about acknowledging the cultural importance of Mauna Kea and about our contributions to astronomy and to mankind as a whole,” she says. In celebration of the International Year of Astronomy, Hilo hosted a Galileo Block Party. Ahuna attended the community event to represent Keck Observatory and share her enthusiasm for science and culture.

Typical of the Islands’ ethnic mix – part Japanese, part Chinese and part Hawaiian, Ahuna is a graduate of the prestigious Kamehameha Schools and she earned her bachelor’s degree from the University of Hawai’i at Manoa.

Aside from her work at the Observatory, Ahuna teaches a financial management class at her church and travels the world with her daughter. To date they have visited 30 states, climbed the Great Wall in China, ridden elephants in South East Asia and toured the classic empires of Europe.



George Wall

OPTICS TECHNICIAN

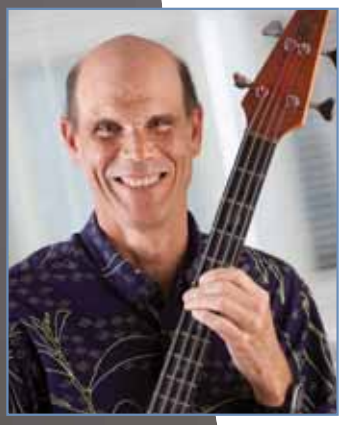
George Wall moved to Hawai'i in 2003 to get away from the long winters in his native New England. Today he spends four days a week atop Mauna Kea where inside the Keck Observatory domes the temperatures are kept near freezing to match the night time conditions at the summit.

"That wasn't Plan A," he says. But, besides warm weather, the former technical director of the famous Music Hall Theatre in Portsmouth, New Hampshire, and his wife were seeking a new adventure. "That part worked."

At Keck, Wall has a role in the Operations and Infrastructure Department and he often takes part in some unusual scenarios, particularly cold and high ones. As an example, Wall periodically finds himself suspended "mid-dome" in a crane's bucket, cleaning the telescope mirrors "in situ" by dusting their surfaces with carbon dioxide snow. The carbon dioxide spray loosens dirt and debris which is then swept away by sublimation, the process of changing directly from a solid to a gas.

Wall and his colleagues are also responsible for recoating the 36 segments of each of the two ten-meter primary mirrors. Twelve spare segments are kept in reserve in the room aptly named the mirror barn. The hexagonal segments have to be stripped and resurfaced periodically due to wear and tear caused by the nightly exposure to the elements. With hydrochloric acid, the old aluminum coating is removed, and new metal is applied in an eight-foot high vacuum chamber. The vacuum has to be greater than that found in space to keep it uncontaminated by the atmosphere so that 45 tungsten filaments heat the new aluminum into a mist to evenly coat the segment.

After work, Wall reverts to his first loves: writing short fiction (B.A., University of New Hampshire) and painting and sculpture (M.F.A. from the Rhode Island School of Design). "As humans, we are naturally curious about the world around us. Each day I am surrounded by some of the smartest and hardest working people I've ever known," he says, "and I love being a part of the exploration of who we are and where we come from."



Drew Medeiros

MECHANICAL ENGINEER

By education and experience Drew Medeiros is a mechanical engineer, but a better description of his professional career is "explorer." Before coming to Keck Observatory 13 years ago, he helped build robotic submarines that could dive to a record depth of 20,000 feet to explore the origin, content and limits of the world's oceans. At Keck, he is involved in exploring the origin, content and limits of the Universe.

"The Keck telescopes give a broad perspective of our planet within the cosmos, constantly breaking the frontiers of knowledge," he says. "So too does undersea exploration." Both fields demand high level achievers from science and engineering fields.

A graduate of the University of Hawai'i at Manoa, Medeiros specializes in optical mechanics, especially integration of new systems like the Adaptive Optics (AO) laser guide star system recently installed on Keck I and the next generation adaptive optics system in development on Keck II. "The new laser will have multiple beams to measure atmospheric turbulence, significantly increasing the capability of AO to view what is currently not yet observable," he says.

Medeiros also deals with the mechanical operation of the telescopes on Mauna Kea. The 300-ton machines, rotating on a thin film of hydraulic oil, have to be precise – within 1/1000th of an inch – to be able to track cosmic targets billions of light years away. "That's the confidence we operate with and what makes Keck so productive," he says.

"Everyone at Keck is clever with amazing ingenuity to solve problems," Medeiros says. "The Observatory is also one of the few places engineers have the opportunity to do cutting-edge work in Hawai'i."

Medeiros is equally proud of his unmanned submarine's work and records. "I worked on a team that developed the submarine for the Navy which later dove on the U.S.S. Yorktown," he says. "There was as much science and computation there as we do at Keck, just looking the other way."

For relaxation Medeiros explores still another realm: music. He plays bass guitar and performs from time to time with "Solar Wind," a local rock band that entertains at venues across Hawai'i Island.

Craig Nance

OPERATIONS ENGINEERING MANAGER

There is no doubt that Keck Observatory is the premiere astronomy center in the world, attracting outstanding astronomers and breakthrough research. But without its engineering staff, there would be no astronomy.

"We are like a NASCAR race team," says Craig Nance. "The drivers are the stars, the best, but without the support crew they can't compete."

Nance manages a staff of 12 mechanical, electrical, and software engineers to make sure the telescopes and their facilities are operational one hundred percent of the time. "It's tough enough for the astronomers to get their night's work done without the dome not opening or the telescope not turning." Yet breakdowns and problems occur almost daily. "What the engineering staff does is mostly invisible," he says. "For instance, when one of the three large drives turning the telescopes failed we immediately put in the spare, and then scrambled to make sure the failed drive got repaired as soon as possible."

Nance was destined to be in astronomy. As a youngster in the 1980s he watched Halley's Comet pass over his Florida home and was hooked. He took his small telescope apart to see how it worked and put it back together. He then started to build his own telescopes.

Earning an electrical engineering degree from Florida State University, he served as an engineer in the U.S. Air Force and afterward joined the McDonald Observatory in West Texas.

Nance joined Keck in 2001. One of his first tasks was to help install the laser guide star system on Keck II. Later he took responsibility for maintenance of the Observatory's optics systems, including the coating laboratory where the mirror segments are applied with a layer of aluminum 1/1000th the width of a human hair, no less, no more. In 2009, as part of the Observatory's infrastructure renewal program, Nance, along with George Wall and Anthony Jaramillo, successfully redesigned and reconstructed the coating chamber to improve its performance.

Away from Keck, Nance can be found tinkering with three new 20-inch amateur telescopes, swinging his golf clubs on the greens of Waikoloa, and enjoying sunset vistas with his wife Laura.

Education and Outreach

Astronomy is a story of receding horizons. With each breakthrough in telescope technology, the edges of our knowledge about the cosmos dissolve and extend. The purpose of the W. M. Keck Observatory is to keep pushing back these horizons of understanding and our mission above all is to inspire a sense of wonder and curiosity for learners young and old.

To communicate the impact of astronomy and 400 years of the telescope, Keck Observatory kicked off the International Year of Astronomy with a spectacular Open House celebration. The event involved the entire Observatory staff and welcomed more than 1,800 people to the organization's Waimea campus. Throughout the day, 37 hands-on activities, exhibits and displays about science, technology and astronomy gave credence to the theme, Welcome to the Edge of Discovery. Residents of North Hawaii and from across the state and visitors all gained a better appreciation of the world-class research taking place on Hawai'i Island.

The Observatory was also proud to host a three-part lecture series called "Sharing Astronomy with Kupuna" to strengthen the connections between science and the Hawaiian culture. The 2009 Mauna Kea Lecture Series followed. For this special commemorative program held monthly in the Observatory's Hualalai Learning Theater as well as in Hilo, the directors of each of the Mauna Kea Observatories shared with audience members highlights of their particular facility and its scientific achievements. All Keck Astronomy lectures are recorded and available on the website.

Nearly 400 Island families and Hawai'i visitors got a more direct experience of the local cosmos during the first "Waimea Solar System Walk," an interactive planetary journey by foot sponsored by the Observatory in partnership with the Canada-France-Hawai'i Telescope. In addition, 30 children ages eight through 12 spent three days at the Observatory during its first-ever "Keiki Cosmic Camp" held in August 2009. Both events were organized by Keck's education and outreach team, a small group of Keck astronomers and engineers who all share a passion for education. The outreach group also led tours of the telescopes, organized star-gazing parties, and presented astronomy lessons in island schools to answer children's questions about the stars.

"We work at the greatest observatory in the world and reaching out to the community, especially the schools, is a way to show off our discoveries and inspire future scientists and engineers," says Keck Support Astronomer Randy Campbell, a member of the outreach group.


RICH

NEW GUIDE STAR DOCENT PROGRAM LAUNCHES IN 2009

In September 2009, the Observatory launched a pilot volunteer program. Ten "Guide Stars" were selected to serve as docents for a new interactive visitor's center to educate the public about Keck Observatory and Hawai'i astronomy. With the pilot's success, the Visitor Center is open for business at Keck's Waimea headquarters Tuesday through Friday from 10 am to 2 pm.

Rosalind Butterfield
Carol Davies
Sue and Dick Humphries
Jan Morgan
Dave and Liz Sonne
Jack Toigo
Marcia and Stanley Wishnick

All staff members at Keck are encouraged to dedicate two percent of their work time to community service projects of their choice and a wide variety of local organizations benefit from their time and talents.

For example, Team Keck took to the track at the annual "Waimea Relay for Life" and was the top Waimea fundraiser, donating $6,000 to the charity. In May 2009 a group of the Observatory's avid scuba divers traveled to Hilo to judge the regional "MATE" (Marine Advanced Technology Education) robotics competition. Staff also served as mentors in "GEMS" (Girls Exploring Math and Science) program, and judged school science fairs across the state, including the Parker School's eighth-grade fair which took place at Keck headquarters. Keck also welcomed island college students to learn first hand the basics of cutting edge science and technology as mentors in the Akamai Internship Program held in the summer in cooperation with the other Observatories on Mauna Kea.

Finally, at the annual Waimea Christmas Parade in December, the Keck float wowed crowds reflecting the theme of "Sharing our Blessings" with three generations of cosmic explorers: Polynesian navigators, Galileo and Keck, represented by original Hokule'a crew member Francis Lee, Keck senior engineer Jim Bell, and Keck philanthropic supporter and volunteer Jack Toigo, respectively.

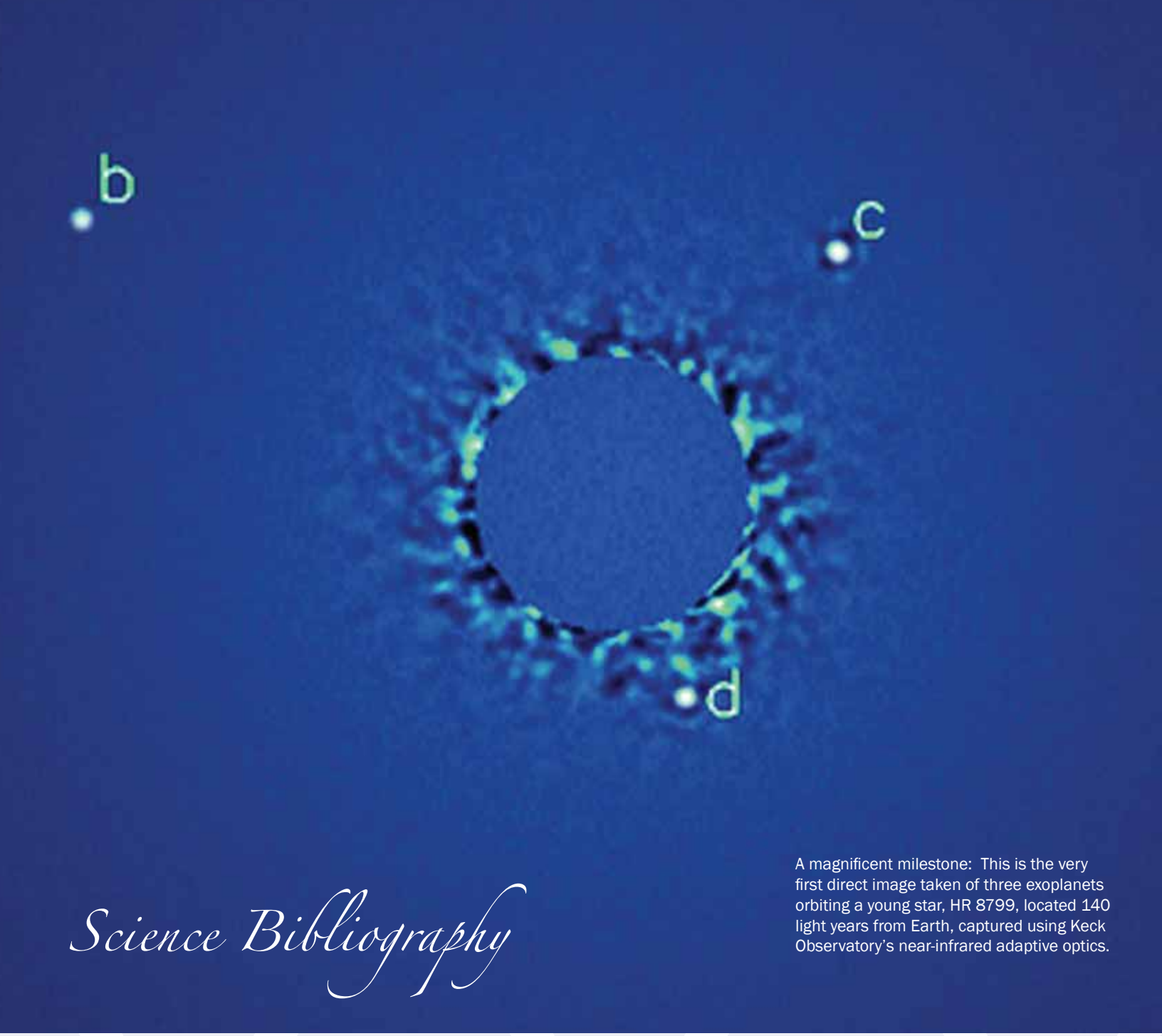
Across the world, people learned of the Observatory's current research through several quality documentaries released in 2009, including the Discovery Channel's "Engineering the Universe: Black Holes" and the internationally distributed planetarium show "Awesome Light." New York's Moey Inc. also produced the "Welcome to Keck Observatory" documentary, along with a detailed model of the telescopes, now on permanent display at the National Academies of Science Keck Center in Washington D.C. Dr. Andrea Ghez was a featured speaker at the international ideas conference, TEDGlobal, held in Oxford, England in July and Observatory Director Dr. Taft Armandroff was featured on the SETI Institute's radio show "Are We Alone?" in September discussing the discovery of extrasolar planets and plans for the future of Keck astronomy.

The best science magazines—Nature, Science News, Sky and Telescope and Astronomy—all highlighted Keck's scientific breakthroughs throughout the year. Cosmic Matters, Keck's in-house, electronic magazine, featured discoveries, technological advancements and other news, sharing these achievements with the Observatory's 3,300 Keck Nation enthusiasts.

It is Keck's policy that staff dedicate two percent of their work time for community service projects.

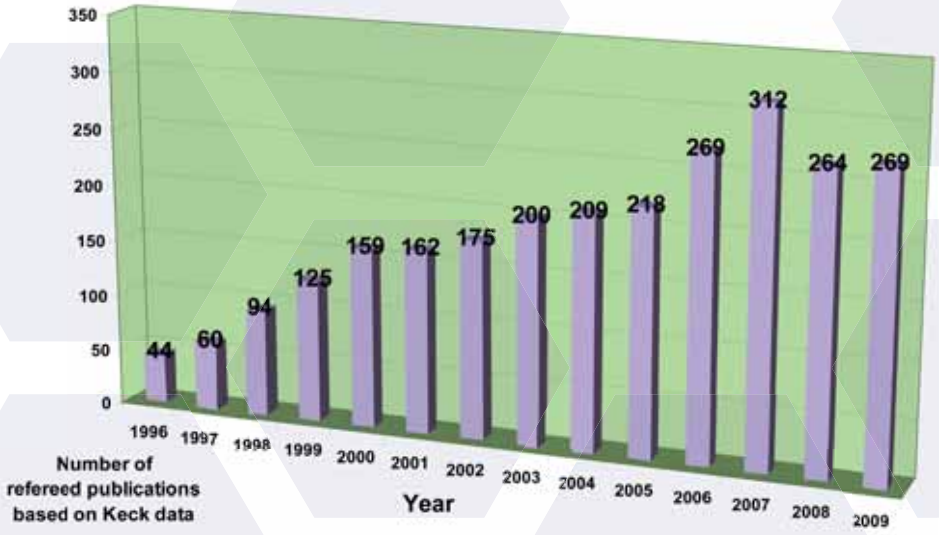
Through this broad spectrum of outreach efforts, Keck Observatory endeavors to realize its vision of a world in which all humankind is inspired and united by the pursuit of knowledge of the infinite variety of the universe. And, although the International Year of Astronomy has ended, Keck Observatory will continue its educational efforts in 2010 and beyond.

CLOCKWISE FROM TOP LEFT: The Keck II laser seen from inside the telescope dome. RIGHT: To a rapt audience at the 2009 TEDGlobal conference, astronomer Andrea Ghez explains how Keck Observatory has helped advance her research. BELOW: The spiral galaxy UGC 2847, located 10 million light years from Earth in the direction of the constellation Camelopardalis, was captured in this image taken by the next generation Low Resolution Imaging Spectrograph on Keck I.



A magnificent milestone: This is the very first direct image taken of three exoplanets orbiting a young star, HR 8799, located 140 light years from Earth, captured using Keck Observatory's near-infrared adaptive optics.

Science Bibliography



The number of refereed publications per year based on data from W. M. Keck Observatory is plotted against the year of publication. Note the increase in scientific productivity with time. This growth is attributed to the cutting-edge instruments and adaptive optics systems that have been installed on the Keck telescopes over the period between first light and today.

Refereed publications FY2009

Key to Publications:

A&A: Astronomy and Astrophysics
AdSpR: Advances in Space Research
AJ: Astronomical Journal
ApJ: Astrophysical Journal
ApJL: Astrophysical Journal Letters
ApJS: Astrophysical Journal Supplement Series
Ap&SS: Astrophysics and Space Science
ARA&A: Annual Review of Astronomy and Astrophysics
CoAst : Communications in Asteroseismology
EM&P : Earth, Moon, and Planets
Icarus
JPhCS: Journal of Physics Conference Series
JQSRT: Journal of Quantitative Spectroscopy and Radiative Transfer
MNRAS: Monthly Notices of the Royal Astronomical Society
Nature
NewAR: New Astronomy Review
P&SS : Planetary and Space Science
PASJ : Publications of the Astronomical Society of Japan
PASP: Publications of the Astronomical Society of the Pacific
PhST : Physica Scripta Volume T
Science

Adami, C.; Ilbert, O.; Pelló, R.; et. al.
Photometric redshifts as a tool for studying the Coma cluster galaxy populations
A&A 491 681 2008 December

Aguirre, A.; Dow-Hygelund, C.; Schaye, J.; Theuns, T.
Metallicity of the Intergalactic Medium Using Pixel Statistics. IV. Oxygen
ApJ 689 851 2008 December

Allende Prieto, C.; Sivarani, T.; Beers, T.; et. al.
The SEGUE Stellar Parameter Pipeline. III. Comparison with High-Resolution Spectroscopy of SDSS/SEGUE Field Stars
AJ 136 2070 2008 November

Allers, K.; Liu, M.; Shkolnik, E.; et. al.
2MASS 22344161+4041387AB: A Wide, Young, Accreting, Low-Mass Binary in the LkHa233 Group
ApJ 697 824 2009 May

Alves-Brito, A.; Forbes, D.; Mendel, J.; et. al.
The outer halo globular clusters of M31
MNRAS 395 L34 2009 May

Ammons, S.; Melbourne, J.; Max, C.; et. al.
Spatially Resolved Stellar Populations of Eight GOODS-South AGN at z~1
AJ 137 470 2009 January

Aspin, C.; Greene, T.; Reipurth, B.
V1647 Orionis: Keck/NIRSPEC 2 μm Echelle Observations
AJ 137 2968 2009 February

Bakos, G.; Pal, A.; Torres, G.; et. al.
HAT-P-10b: A Light and Moderately Hot Jupiter Transiting a K Dwarf
ApJ 696 1950 2009 May

Baldovin-Saavedra, C.; Audard, M.; Duchêne, G.; et. al.
HDE 245059: A Weak-Lined T Tauri Binary Revealed by Chandra and Keck
ApJ 697 493 2009 May

Barbary, K.; Dawson, K.; Tokita, K.; et. al.
Discovery of an Unusual Optical Transient with the Hubble Space Telescope
ApJ 690 1358 2009 January

Barger, A.; Cowie, L.; Wang, W.-H.
A Highly Complete Spectroscopic Survey of the GOODS-N Field
ApJ 689 687 2008 December

Barth, A.; Strigari, L.; Bentz, M.; et. al.
Dynamical Constraints on the Masses of the Nuclear Star Cluster and Black Hole in the Late-Type Spiral Galaxy NGC 3621
ApJ 690 1031 2009 January

Basu-Zych, A.; Gonçalves, T.; Overzier, R.; et. al.
An OSIRIS Study of the Gas Kinematics in a Sample of UV-Selected Galaxies: Evidence of "Hot and Bothered" Starbursts in the Local Universe
ApJ 699 L118 2009 July

Baumgardt, H.; Côté, P.; Hilker, M.; et. al.
The velocity dispersion and mass-to-light ratio of the remote halo globular cluster NGC 2419
MNRAS 396 2051 2009 July

Bean, J. L.; Seifahrt, A.
The architecture of the GJ 876 planetary system. Masses and orbital coplanarity for planets b and c
A&A 496 249 2009 March

Beasley, M.; Cenarro, A.; Strader, J.; Brodie, J.
Evidence for the Disky Origin of Luminous Virgo Dwarf Ellipticals from the Kinematics of Their Globular Cluster Systems
AJ 137 5146 2009 June

Becker, G.; Rauch, M.; Sargent, W.
High Redshift Metals I.: The Decline of C IV at z > 5.3
ApJ 698 1010 2009 June

Bender, C.; Simon, M.
The Detection of Low-Mass Companions in Hyades Cluster Spectroscopic Binary Stars
ApJ 689 416 2008 December

Bensby, T.; Johnson, J.; Cohen, J.; et. al.
Chemical evolution of the Galactic bulge as traced by microlensed dwarf and subgiant stars. Detailed abundance analysis of OGLE-2008-BLG-209S
A&A 499 737 2009 June

Bitner, M.; Richter, M.; Lacy, J.; et. al.
The TEXES Survey for H_2 Emission from Protoplanetary Disks
ApJ 688 1326 2008 December

Blustin, A.; Dwelly, T.; Page, M.; et. al.
Properties of X-ray-selected broad absorption-line quasars
MNRAS 390 1229
2008 November

Boden, A.; Akeson, R.; Sargent, A.; et. al.
Interferometric Evidence for Resolved Warm Dust in the DQ Tau System
ApJ 696 L111 2009 May

Boesgaard, A.; Krugler Hollek, J.
Beryllium Abundances in Stars of One Solar Mass
ApJ 691 1412 2009 February

Boesgaard, A.; Jensen, E.; Deliyannis, C.
Abundances in Turnoff Stars in the Old, Metal-Rich Open Cluster, NGC 6791
AJ 137 4949 2009 June

Bonev, B.; Mumma, M.; Gibb, E.; et. al.
Comet C/2004 Q2 (Machholz): Parent Volatiles, a Search for Deuterated Methane, and Constraint on the CH_4 Spin Temperature
ApJ 699 1563 2009 July

Bonifacio, P.; Spite, M.; Cayrel, R.; et. al.
First stars XII. Abundances in extremely metal-poor turnoff stars, and comparison with the giants
A&A 501 519 2009 July

Bradac, M.; Allen, S.; Treu, T.; et. al.
Revealing the Properties of Dark Matter in the Merging Cluster MACS J0025.4-1222
ApJ 687 959 2008 November

Brown, T.; Beaton, R.; Chiba, M.; et. al.
The Extended Star Formation History of the Andromeda Spheroid at 35 kpc on the Minor Axis
ApJ 685 L121 2008 October

Burningham, B.; Pinfield, D.; Leggett, S.; et. al.
The discovery of an M4+T8.5 binary system
MNRAS 395 1237 2009 May

Bussmann, R.; Dey, A; Lotz, J.; et. al.
Hubble Space Telescope Morphologies of z ~ 2 Dust Obscured Galaxies. I. Power-Law Sources
ApJ 693 750 2009 March

Butler, R.; Howard, A.; Vogt, S.; Wright, J.
Nondetection of the Neptune-Mass Planet Reported Around GJ 176
ApJ 691 1738 2009 February

Carilli, C.; Lee, N.; Capak, P.; et. al.
Star Formation Rates in Lyman Break Galaxies: Radio Stacking of LBGs in the COSMOS Field and the Sub-μJy Radio Source Population
ApJ 689 883 2008 December

Cenarro, A.; Trujillo, I.
Mild Velocity Dispersion Evolution of Spheroid-Like Massive Galaxies Since z ~ 2
ApJ 696 L43 2009 May

Chapman, S.; Ibata, R.; Irwin, M.; et. al.
The kinematic footprints of five stellar streams in Andromeda's halo
MNRAS 390 1437 2008 November

Chapman, S.; Neri, R.; Bertoldi, F.; et. al.
Interferometric CO Observations of Submillimeter-faint, Radio-selected Starburst Galaxies at z ~ 2
ApJ 689 889 2008 December

Chen, H.; Perley, D.; Pollack, L.; et. al.
High-Redshift Starbursting Dwarf Galaxies Revealed by γ-Ray Burst Afterglows
ApJ 691 152 2009 January

Chornock, R.; Filippenko, A.
Deviations from Axisymmetry Revealed by Line Polarization in the Normal Type Ia Supernova 2004S
AJ 136 2227 2008 December

Cohen, J.; Huang, W.
The Chemical Evolution of the Draco Dwarf Spheroidal Galaxy
ApJ 701 1053 2009 August

Coil, A.; Georgakakis, A.; Newman, J.; et. al.
AEGIS The Clustering of X-Ray Active Galactic Nucleus Relative to Galaxies at z~1
ApJ 701 1484 2009 August

Colavita, M.; Serabyn, E.; Millan-Gabet, R.; et. al.
Keck Interferometer Nuller Data Reduction and On-Sky Performance
PASP 121 1120 2009 September

Collins, M.; Chapman, S.; Irwin, M.; et. al.
A spectroscopic survey of EC4, an extended cluster in Andromeda's halo
MNRAS 396 1619 2009 July

Comerford, J.; Gerke, B.; Newman, J.; et. al.
Inspiralling Supermassive Black Holes: A New Signpost for Galaxy Mergers
ApJ 698 956 2009 June

Comerford, J.; Griffith, R.; Gerke, B.; et. al.
1.75h^{-1} kpc Separation Dual Active Galactic Nuclei at z = 0.36 in the Cosmos Field
ApJ 702 L82 2009 September

Conrad, A.; Goodrich, R.; Campbell, R.; et. al.
Keck Observations of Solar System Objects: Perspectives for Extremely Large Telescopes
EM&P 105 115 2009 September

Cooke, J.; Sullivan, M.; Barton, E.; et. al.
Type IIn supernovae at redshift z~2 from archival data
Nature 460 237 2009 July

Coppin, K.; Smail, I.; Alexander, D.; et. al.
A submillimetre galaxy at z = 4.76 in the LABOCA survey of the Extended Chandra Deep Field-South
MNRAS 395 1905 2009 June

Cordiner, M.; Smith, K.; Cox, N.; et. al.
Diffuse interstellar bands in M 33
A&A 492 L5 2008 December

Covone, G.; Paolillo, M.; Napolitano, N.; et. al.
Gauging the Dark Matter Fraction in an L*S0 Galaxy at z = 0.47 Through Gravitational Lensing from Deep Hubble Space Telescope/Advanced Camera for Surveys Imaging
ApJ 691 531 2009 January

Cowie, L.; Barger, A.
An Integrated Picture of Star Formation, Metallicity Evolution, and Galactic Stellar Mass Assembly
ApJ 686 72 2008 October

Cowie, L.; Barger, A.; Trouille, L.
Measuring the Sources of the Intergalactic Ionizing Flux
ApJ 692 1476 2009 February

Cunningham, N.; Moeckel, N.; Bally, J.
A Pulsed, Precessing Jet in Cepheus A
ApJ 692 943 2009 February

Daddi, E.; Dannerbauer, H.; Stern, D.; et. al.
Two Bright Submillimeter Galaxies in a z = 4.05 Protocluster in GOODS-North, and Accurate Radio-Infrared Photometric Redshifts
ApJ 694 1517 2009 April

Dahm, S.; Carpenter, J.
Spitzer Spectroscopy of Circumstellar Disks in the 5 Myr Old Upper Scorpius OB Association
AJ 137 4024 2009 April

Davies, B.; Origlia, L.; Kudritzki, R.; et. al.
The Chemical Abundances in the Galactic Center from the Atmospheres of Red Supergiants
ApJ 694 46 2009 March

Davies, B.; Origlia, L.; Kudritzki, R.; et. al.
Chemical Abundance Patterns in the Inner Galaxy: The Scutum Red Supergiant Clusters
ApJ 696 2014 2009 May

del Burgo, C.; Martín, E.;
Zapatero Osorio, M.; Hauschildt, P.
Physical parameters of T dwarfs derived from high-resolution near-infrared spectra
A&A 501 1059 2009 July

Dello Russo, N.; Vervack, R.;
Weaver, H.; et. al.
The Parent Volatile Composition of 6p/d'Arrest and a Chemical Comparison of Jupiter-Family Comets Measured at Infrared Wavelengths
ApJ 703 187 2009 September

Descamps, P.; Marchis, F.; Durech, J.; et. al.
New insights on the binary Asteroid 121 Hermione
Icarus 203 88 2009 September

Devor, J.; Charbonneau, D.; Torres, G.; et. al.
T-Lyr1-17236: A Long-Period Low-Mass Eclipsing Binary
ApJ 687 1253 2008 November

Diamond-Stanic, A.; Fan, X.; Brandt, W.; et. al.
High-redshift SDSS Quasars with Weak Emission Lines
ApJ 699 782 2009 July

Do, T.; Ghez, A.; Morris, M.; et. al.
A Near-Infrared Variability Study of the Galactic Black Hole: A Red Noise Source with No Detected Periodicity
ApJ 691 1021 2009 February

Drummond, J.; Christou, J.
Triaxial ellipsoid dimensions and rotational poles of seven asteroids from Lick Observatory adaptive optics images, and of Ceres
Icarus 197 480 2008 October

Drummond, J.; Christou, J.; Nelson, J.
Triaxial ellipsoid dimensions and poles of asteroids from AO observations at the Keck-II telescope
Icarus 202 147 2009 July

Dupuy, T.; Liu, M; Ireland, M.
Dynamical Mass of the Substellar Benchmark Binary HD 130948BC
ApJ 692 729 2009 February

Dupuy, T.; Liu, M.; Ireland, M.
Keck Laser Guide Star Adaptive Optics Monitoring of the M8+L7 Binary LHS 2397aAB: First Dynamical Mass Benchmark at the L/T Transition
ApJ 699 168 2009 July

Eisner, J.; Graham, J.; Akeson, R.; Najita, J.
Spatially Resolved Spectroscopy of Sub-AU-Sized Regions of T Tauri and Herbig Ae/Be Disks
ApJ 692 309 2009 February

Esteban, C.; Bresolin, F.; Peimbert, M.; et. al.
Keck HIRES Spectroscopy of Extragalactic H II Regions: C and O Abundances from Recombination Lines
ApJ 700 654 2009 July

Faucher-Giguère, C.; Lidz, A.; Hernquist, L.; Zaldarriaga, M.
Evolution of the Intergalactic Opacity: Implications for the Ionizing Background, Cosmic Star Formation, and Quasar Activity
ApJ 688 85 2008 November

Finkelstein, S.; Papovich, C.;
Rudnick, G.; et. al.
Turning Back the Clock: Inferring the History of the Eight O'clock Arc
ApJ 700 376 2009 July

Fischer, W.; Kwan, J.; Edwards, S.; Hillenbrand, L.
Redshifted Absorption at He I λ10830 as a Probe of the Accretion Geometry of T Tauri Stars
ApJ 687 1117 2008 November

Foley, R.; Matheson, T.; Blondin, S.; et. al.
Spectroscopy of High-Redshift Supernovae from the Essence Project: The First Four Years
AJ 137 3731 2009 April

Foley, R.; Chornock, R.; Filippenko, A.; et. al.
SN 2008ha: An Extremely Low Luminosity and Exceptionally Low Energy Supernova
AJ 138 376 2009 August

Fox, A.; Prochaska, J.; Ledoux, C.; et. al.
Metal-enriched plasma in protogalactic halos. A survey of N V absorption in high-z damped and sub-damped Lyman-α systems
A&A 503 731 2009 September

Gal-Yam, A.; Nakar, E.; Ofek, E.; et. al.
New Imaging and Spectroscopy of the Locations of Several Short-Hard Gamma-Ray Bursts
ApJ 686 408 2008 October

Gal-Yam, A.; Leonard, D.
A massive hypergiant star as the progenitor of the supernova SN 2005gl
Nature 458 865 2009 April

Geha, M.; Willman, B.; Simon, J.; et. al.
The Least-Luminous Galaxy: Spectroscopy of the Milky Way Satellite Segue 1
ApJ 692 1464 2009 February

Georgakakis, A.; Gerke, B.; Nandra, K.; et. al.
X-ray selected AGN in groups at redshifts z~1
MNRAS 391 183 2008 November

Gezari, S.; Heckman, T.; Cenko, S.; et. al.
Luminous Thermal Flares from Quiescent Supermassive Black Holes
ApJ 698 1367 2009 June

Ghez, A.; Salim, S.; Weinberg, N.; et. al.
Measuring Distance and Properties of the Milky Way's Central Supermassive Black Hole with Stellar Orbits
ApJ 689 1044 2008 December

Gilbert, K.; Font, A.; Johnston, K.; Guhathakurta, P.
The Dominance of Metal-rich Streams in Stellar Halos: A Comparison Between Substructure in M31 and CDM Models
ApJ 701 776 2009 August

González Hernández, J.; Ruiz-Lapuente, P.; Filippenko, A.; et. al.
The Chemical Abundances of Tycho G in Supernova Remnant 1572
ApJ 691 1 2009 January

Graham, J.; Fruchter, A.; Levan, A.; et. al.
GRB 070714B—Discovery of the Highest Spectroscopically Confirmed Short Burst Redshift
ApJ 698 1620 2009 June

Grinin, V.; Stempels, H.; Gahm, G.; et. al.
The unusual pre-main-sequence star V718 Persei (HMW 15). Photometry and spectroscopy across the eclipse
A&A 489 1233 2008 October

Hainline, K.; Shapley, A.; Kornei, K.; et. al.
Rest-Frame Optical Spectra of Three Strongly Lensed Galaxies at z ~ 2
ApJ 701 52 2009 August

Hamann, F.; Kaplan, K.; Hidalgo, P.; Prochaska, J.; Herbert-Fort, S.
Emergence of a quasar outflow
MNRAS 391 L39 2008 November

Hammel, H.; Sromovsky, L.; Fry, P.; et. al.
The Dark Spot in the atmosphere of Uranus in 2006: Discovery, description, and dynamical simulations
Icarus 201 257 2009 May

Harrison, T.; Bornak, J.; Howell, Steve B.
Infrared Photometry and Spectroscopy of VY Aqr and EI Psc: Two Short-Period Cataclysmic Variables With Curious Secondary Stars
AJ 137 4061 2009 April

Hau, G.; Spitler, L.; Forbes, D.; et. al.
An ultra-compact dwarf around the Sombrero galaxy (M104): the nearest massive UCD
MNRAS 394 L97 2009 March

Hennawi, J.; Prochaska, J.; Kollmeier, J.; Zheng, Z.
A z = 3 Lyα Blob Associated With a Damped Lyα System Proximate to Its Background Quasar
ApJ 693 L49 2009 March

Herbig, G.; Vacca, W.
The Unusual Object IC 2144/MWC 778
AJ 136 1995 2008 November

Herbig, G.
The Outflowing Wind Of V1057 Cygni
AJ 138 448 2009 August

Herczeg, G.; Cruz, K.; Hillenbrand, L.
Measuring tiny mass accretion rates onto young brown dwarfs
ApJ 696 1589 2009 May

Hicks, E.; Davies, R.; Malkan, M.; et. al.
The Role of Molecular Gas in Obscuring Seyfert Active Galactic Nuclei
ApJ 696 448 2009 May

Hildebrandt, H.; Pielorz, J.; Erben, T.; et. al.
CARS: the CFHTLS-Archive-Research Survey. II. Weighing dark matter halos of Lyman-break galaxies at z = 3-5
A&A 498 725 2009 May

Hilton, M.; Stanford, S.; Stott, J.; et. al.
The XMM Cluster Survey: Galaxy Morphologies and the Color-Magnitude Relation in XMMXCS J2215.9 – 1738 at z = 1.46
ApJ 697 436 2009 May

Hodapp, K.; Iserlohe, C.; Stecklum, B.; Krabbe, A.
Orionis IRS1 A and B: A Binary Containing a Proplyd
ApJ 701 L100 2009 August

Hoffman, J.; Leonard, D.; Chornock, R.; et. al.
The Dual-Axis Circumstellar Environment of the Type IIn Supernova 1997eg
ApJ 688 1186 2008 December

Holden, B.; Franx, M.; Illingworth, G.; et. al.
The Ellipticities of Cluster Early-type Galaxies from z ~ 1 to z ~ 0: No Evolution in the Overall Distribution of Bulge-to-Disk Ratios
ApJ 693 617 2009 March

Holtzman, J.; Marriner, J.; Kessler, R.; et. al.
The Sloan Digital Sky Survey-II: Photometry and Supernova IA Light Curves from the 2005 Data
AJ 136 2306 2008 December

Howard, A.; Johnson, J.; Marcy, G.; et. al.
The NASA-UC Eta-Earth Program. I. A Super-Earth Orbiting HD 7924
ApJ 696 75 2009 May

Howell, S.; Harrison, T.; Huber, M.; et. al.
Optical and Infrared Observations of Two Magnetic Interacting Binaries: Tau 4 (RXJ0502.8+1624) & SDSS J121209.31+013627.7
AJ 136 2541 2008 December

Hsieh, H.; Jewitt, D.; Ishiguro, M.
Physical Properties of Main-Belt Comet P/2005 U1 (Read)
AJ 137 157 2009 January

Hsieh, H.; Jewitt, D.; Fernandez, Y.
Albedos of Main-Belt Comets 133P/Elst-Pizarro and 176P/LINEAR
ApJ 694 L111 2009 April

Hu, E.; Cowie, L.; Kakazu, Y.; Barger, A.
Deep Spectroscopy of Ultra-Strong Emission-Line Galaxies
ApJ 698 2014 2009 June

Humphrey, A.; Villar-Martín, M.; Sánchez, S.; et. al.
Spatially extended absorption around the z = 2.63 radio galaxy MRC 2025-218: outflow or infall?
MNRAS 390 1505
2008 November

Ilbert, O.; Capak, P.; Salvato, M.; et. al.
Cosmos Photometric Redshifts with 30-BANDS for 2-deg^2
ApJ 690 1236 2009 January

Imanishi, M.; Nakagawa, T.; Ohyama, Y.; et. al.
Systematic Infrared 2.5-5μm Spectroscopy of Nearby Ultraluminous Infrared Galaxies with AKARI
PASJ 60 S489 2008 December 25

Jackson, W.; Yang, X.; Shi, X.; Cochran, A.
The Temporal Changes in the Emission Spectrum of Comet 9p/Tempel 1 after Deep Impact
ApJ 698 1609 2009 June

Jewitt, D.; Yang, B.; Haghighipour, N.
Main-Belt Comet P/2008 R1 (Garradd)
AJ 137 4313 2009 May

Jewitt, D.
The Active Centaurs
AJ 137 4296 2009 May

Johns-Krull, C.; Greene, T.; Doppmann, G.; Covey, K.
First Magnetic Field Detection on a Class I Protostar
ApJ 700 1440 2009 August

Johnson, J.; Winn, J.; Narita, N.; et. al.
Measurement of the Spin-Orbit Angle of Exoplanet HAT-P-1b
ApJ 686 649 2008 October

Johnson, J.; Winn, J.; Albrecht, S.; et. al.
A Third Exoplanetary System with Misaligned Orbital and Stellar Spin Axes
PASP 121 1104 2009 September

Jordi, K.; Grebel, E.; Hilker, M.; et. al.
Testing Fundamental Physics with Distant Star Clusters: Analysis of Observational Data on Palomar 14
AJ 137 4586 2009 June

Kalas, P.; Graham, J.; Chiang, E.; et. al.
Optical Images of an Exosolar Planet 25 Light Years from Earth
Science 322 1345 2008 November

Kaminski, T.; Schmidt, M.; Tylenda, R.; et. al.
Keck/HIRES Spectroscopy of V838 Monocerotis in October 2005
ApJS 182 33 2009 May

Kawakita, H.; Kobayashi, H.
Formation Conditions of Icy Materials in Comet C/2004 Q2 (Machholz). II. Diagnostics Using Nuclear Spin Temperatures and Deuterium-to-Hydrogen Ratios in Cometary Molecules
ApJ 693 388 2009 March

Kiminki, D.; Kobulnicky, H.; Gilbert, I.; et. al.
Five More Massive Binaries in the Cygnus OB2 Association
AJ 137 4608 2009 June

Kirkpatrick, J. D.; Cruz, K.; Barman, T.; et. al.
A Sample of Very Young Field L Dwarfs and Implications for the Brown Dwarf "Lithium Test" at Early Ages
ApJ 689 1295 2008 December

Kobayashi, H.; Kawakita, H.
Formation Conditions of Icy Materials in Comet C/2004 q2 (Machholz). I. Mixing Ratios of Organic Volatiles
ApJ 703 121 2009 September

Kocevski, D.; Lubin, L.; Gal, R.; et. al.
Chandra Observations of the CL1604 Supercluster at z = 0.9: Evidence for an Overdensity of Active Galactic Nuclei
ApJ 690 295 2009 January

Kocevski, D.; Lubin, L.; Lemaux, B.; et.al.
Properties of Galaxies Hosting X-ray-selected Active Galactic Nuclei in the CL1604 Supercluster at z = 0.9
ApJ 700 901 2009 August

Kocevski, D.; Lubin, L.; Lemaux, B.; et. al.
No Evidence of Quasar-Mode Feedback in a Four-Way Group Merger at z ~ 0.84
ApJ 703 L33 2009 September

Koch, A.; Rich, R.; Reitzel, D.; et. al.
Kinematic and Chemical Constraints on the Formation of M31's Inner and Outer Halo
ApJ 689 958 2008 December

Kowalski, M.; Rubin, D.; Aldering, G.; et. al.
Improved Cosmological Constraints from New, Old, and Combined Supernova Data Sets
ApJ 686 749 2008 October 20

Krivov, A.; Müller, S.; Löhne, T.; Mutschke, H.
Collisional and Thermal Emission Models of Debris Disks: Toward Planetesimal Population Properties
ApJ 687 608 2008 November 1

Kuraszkiewicz, J.; Wilkes, B.;
Schmidt, G.; et. al.
The Spectral Energy Distributions of Red Two Micron All Sky Survey Active Galactic Nuclei
ApJ 692 1143 2009 February

Lai, D.; Rockosi, C.; Bolte, M.; et. al.
A Unique Star in the Outer Halo of the Milky Way
ApJ 697 L63 2009 May

Langland-Shula, L.; Vogt, S.;
Charbonneau, D.; et. al.
A HIRES/Keck Spectroscopic Investigation of the Measurement of Sodium in the Atmosphere of HD 209458b
ApJ 696 1355 2009 May

Laughlin, G.; Deming, D.; Langton, J.; et. al.
Rapid heating of the atmosphere of an extrasolar planet
Nature 457, 562 2009 January

Laver, C.; de Pater, I.
The global distribution of sulfur dioxide ice on Io, observed with OSIRIS on the W.M. Keck telescope
Icarus 201 172 2009 May

Law, D.; Steidel, C.; Erb, D.; et. al.
The Kiloparsec-scale Kinematics of High-redshift Star-forming Galaxies
ApJ 697 2057 2009 June

Lehner, N.; Howk, J.; Prochaska, J.; Wolfe, A.
Probing feedback in protogalaxies: multiphase gas in a DLA at z ~ 2.4
MNRAS 390 2 2008 October

Lemaux, B.; Lubin, L.; Sawicki, M.; et. al.
Serendipitous Discovery of an Overdensity of Lyα Emitters at z ~ 4.8 in the CL1604 Supercluster Field
ApJ 700 20 2009 June

Leonard, D.; Gal-Yam, A.; Fox, D.; et. al.
An Upper Mass Limit on a Red Supergiant Progenitor for the Type II-Plateau Supernova SN 2006my
PASP 120 1259 2008 December

Limousin, M.; Richard, J.; Kneib, J.-P.; et. al.
Strong lensing in Abell 1703: constraints on the slope of the inner dark matter distribution
A&A 489 23 2008 October

Limousin, M.; Cabanac, R.; Gavazzi, R.; et. al.
A new window of exploration in the mass spectrum: strong lensing by galaxy groups in the SL2S
A&A 502 445 2009 August

Liu, M.; Dupuy, T.; Ireland, M.
Keck Laser Guide Star Adaptive Optics Monitoring of 2MASS J1534-2952AB: First Dynamical Mass Determination of a Binary T Dwarf
ApJ 689 436 2008 December

Looper, D.; Gelino, C.; Burgasser, A.;
Kirkpatrick, J.
Discovery of a T Dwarf Binary with the Largest Known J-Band Flux Reversal
ApJ 685 1183 2008 October

Looper, D.; Kirkpatrick, J.; Cutri, R.; et. al.
Discovery of Two Nearby Peculiar L Dwarfs from the 2MASS Proper-Motion Survey: Young or Metal-Rich?
ApJ 686 528 2008 October

Lowenthal, J.; Koo, D.;
Simard, L.; van Dampen, E.
Dynamics of Lyman Break Galaxies and Their Host Halos
ApJ 703 198 2009 September

Lu, J.; Ghez, A.; Hornstein, S.; et. al.
A Disk of Young Stars at the Galactic Center as Determined by Individual Stellar Orbits
ApJ 690 1463 2009 January

Lubin, L.; Gal, R.; Lemaux, B.; et. al.
The Observations of Redshift Evolution in Large Scale Environments (ORELSE) Survey: I. The Survey Design and First Results on Cl 0023+0423 at z = 0.84 and RX J1821.6+6827 at z = 0.82
AJ 137 4867 2009 June

Luo, B.; Brandt, W.; Silverman, J.; et. al.
Discovery of the Most Distant Double-Peaked Emitter at z = 1.369
ApJ 695 1227 2009 April

Ly, C.; Malkan, M.; Treu, T.; et. al.
Lyman Break Galaxies at z ~ 1.8-2.8: GALEX/NUV Imaging of the Subaru Deep Field
ApJ 697 1410 2009 June

Ma, C.; Ebeling, H.; Barrett, E.
An X-Ray/Optical Study of the Complex Dynamics of the Core of the Massive Intermediate-Redshift Cluster MACSJ0717.5+3745
ApJ 693 L56 2009 March

Mace, G.; Prato, L.; Wasserman, L.; et. al.
The Highly Eccentric Pre-Main-Sequence Spectroscopic Binary RX J0529.3+1210
AJ 137 3487 2009 March

Maeda, K.; Kawabata, K.; Li, W.; et. al.
Subaru and Keck Observations of the Peculiar Type Ia Supernova 2006GZ at Late Phases
ApJ 690 1745 2009 January

Magnelli, B.; Elbaz, D.; Chary, R.; et. al.
The 0.4 < z < 1.3 star formation history of the Universe as viewed in the far-infrared
A&A 496 57 2009 March

Manfroid, J.; Jehin, E.; Hutsemékers, D.; et. al.
The CN isotopic ratios in comets
A&A 503 613 2009 August

Marois, C.; Macintosh, B.; Barman, T.; et. al.
Direct Imaging of Multiple Planets Orbiting the Star HR 8799
Science 322 1348 2008 November

Martell, S.; Smith, G.
CN Variations in High-Metallicity Globular and Open Clusters
PASP 121 577 2009 June

Martinache, F.; Rojas-Ayala, B.; Ireland, M.; et. al.
Visual Orbit of the Low-Mass Binary GJ 164 AB
ApJ 695 1183 2009 April

Melbourne, J.; Bussman, S.; Brand, K.; et. al.
High Redshift Dust Obscured Galaxies, A Morphology-SED Connection Revealed by Keck Adaptive Optics
AJ 137 4854 2009 June

Meléndez, J.; Barbuy, B.
Both accurate and precise gf-values for Fe II lines
A&A 497 611 2009 April

Meléndez, J.; Cohen, J. G.
The Rise of the AGB in the Galactic Halo: Mg Isotopic Ratios and High Precision Elemental Abundances in M71 Giants
ApJ 699 2017 2009 July

Melis, C.; Zuckerman, B.; Song, I.; et. al.
A Substantial Dust Disk Surrounding an Actively Accreting First-Ascent Giant Star
ApJ 696 1964 2009 May

Meschiari, S.; Wolf, A.; Rivera, E.; et. al.
Systemic: A Testbed for Characterizing the Detection of Extrasolar Planets. I. The Systemic Console Package
PASP 121 1016 2009 September

Metchev, S.; Hillenbrand, L.
The Palomar/Keck Adaptive Optics Survey of Young Solar Analogs: Evidence for a Universal Companion Mass Function
ApJS 181 62 2009 March

Meyer, L.; Do, T.; Ghez, A.; et. al.
A 600 minute near-infrared lightcurve of Sagittarius A*
ApJ 688 L17 2008 November

Meyer, L.; Do, T.; Ghez, A.; et. al.
A Power-Law Break in the Near-Infrared Power Spectrum of the Galactic Center Black Hole
ApJ 694 L87 2009 March

Miller, A.; Chornock, R.; Perley, D.; et. al.
The Exceptionally Luminous Type II-Linear Supernova 2008es
ApJ 690 1303 2009 January

Modjaz, M.; Li, W.; Butler, N.; et. al.
From Shock Breakout to Peak and Beyond: Extensive Panchromatic Observations of the Type Ib Supernova 2008D Associated with Swift X-ray Transient 080109
ApJ 702 226 2009 September

Monnier, J.; Tuthill, P.; Ireland, M.; et. al.
Mid-Infrared Size Survey of Young Stellar Objects: Description of Keck Segment-Tilting Experiment and Basic Results
ApJ 700 491 2009 July

Montero-Dorta, A.; Croton, D.; Yan, R.; et. al.
The DEEP2 Galaxy Redshift Survey: the red sequence AGN fraction and its environment and redshift dependence
MNRAS 392 125 2009 January

Moskovitz, N.; Jedicke, R.; Gaidos, E.; et. al.
The Distribution of Basaltic Asteroids in the Main Belt
Icarus 198 77 2008 November

Mumma, M.; Villaneuva, G.; Novak, R.; et. al.
Strong Release of Methane on Mars in Northern Summer 2003
Science 323 1041 2009 February

Muzzin, A.; Wilson, G.; Lacy, M.; Yee, H.; Stanford, S.
The Evolution of Dusty Star Formation and Stellar Mass Assembly in Clusters: Results from the IRAC 3.6, 4.5, 5.8, and 8.0 μm Cluster Luminosity Functions
ApJ 686 966 2008 October 20

Najita, J.; Crockett, N.; Carr, J.
CO Fundamental Emission from V836 Tauri
ApJ 687 1168 2008 November

Najita, J.; Doppmann, G.; Carr, J.; et. al.
High-Resolution K-Band Spectroscopy of MWC 480 and V1331 Cyg
ApJ 691 738 2009 January

Najita, J.; Doppmann, G.; Bitner, M.; et. al.
High-Resolution Spectroscopy of [Ne II] Emission from AA Tau and GM Aur
ApJ 697 957 2009 May

Nobili, S.; Fadeyev, V.; Aldering, G.; et. al.
Constraining Dust and Color Variations of High-z SNe Using NICMOS on the Hubble Space Telescope
ApJ 700 1415 2009 August

O'Toole, S.; Tinney, C.; Butler, R.; et. al.
A Neptune-mass Planet Orbiting the Nearby G Dwarf HD 16417
ApJ 697 1263 2009 June

O'Toole, S.; Jones, H.; Tinney, C.; et. al.
The Frequency of Low-Mass Exoplanets
ApJ 701 1732 2009 August

Ouchi, M.; Ono, Y.; Egami, E.; et. al.
Discovery of a Giant Lyα Emitter Near the Reionization Epoch
ApJ 696 1164 2009 May

Pál, A.; Bakos, G.; Fernandez, J.; et. al.
Independent confirmation and refined parameters of the hot Jupiter XO-5b
ApJ 700 783 2009 July

Pannella, M.; Carilli, C.; Daddi, E.; et. al.
Star Formation and Dust Obscuration at z ~ 2: Galaxies at the Dawn of Downsizing
ApJ 698 L116 2009 June

Patel, S.; Kelson, D.; Holden, B.; et. al.
A Wide-Field Study of the z ~ 0.8 Cluster RX J0152.7–1357: The Role of Environment in the Formation of the Red Sequence
ApJ 694 1349 2009 April

Peek, K.; Johnson, J.; Fischer, D.; et. al.
Old, Rich, and Eccentric: Two Jovian Planets Orbiting Evolved Metal-Rich Stars
PASP 121 613 2009 June

Peek, K.
A New Technique for Determining Europium Abundances in Solar-Metallicity Stars
PASP 121 755 2009 July

Perley, D.; Li, W.; Chornock, R.; et. al.
GRB 071003: Broadband Follow-up Observations of a Very Bright Gamma-Ray Burst in a Galactic Halo
ApJ 688 470 2008 November

Perley, D.; Metzger, B.; Granot, J.; et. al.
GRB 080503: Implications of a Naked Short Gamma-Ray Burst Dominated by Extended Emission
ApJ 696 1871 2009 May

Pollack, L.; Chen, H.; Prochaska, J.; Bloom, J.
An Imaging and Spectroscopic Study of Four Strong Mg II Absorbers Revealed by GRB 060418
ApJ 701 1605 2009 August

Poznanski, D.; Butler, N.; Filippenko, A.; et. al.
Improved Standardization of Type II-P Supernovae: Application to an Expanded Sample
ApJ 694 1067 2009 April

Prochaska, J.; Sheffer, Y.; Perley, D.; et. al.
The First Positive Detection of Molecular Gas in a GRB Host Galaxy
ApJ 691 L27 2009 January

Prochaska, J.; Hennawi, J.
Quasars Probing Quasars. III. New Clues to Feedback, Quenching, and the Physics of Massive Galaxy Formation
ApJ 690 1558 2009 January

Proctor, R.; Forbes, D.; Romanowsky, A.; et. al.
Probing the 2D kinematic structure of early-type galaxies out to three effective radii
MNRAS 398 91 2009 September

Ragland, S.; Akeson, R.; Armandroff, T.; et. al.
First L-Band Interferometric Observations of a Young Stellar Object: Probing the Circumstellar Environment of MWC 419
ApJ 703 22 2009 September

Ragozzine, D.; Brown, M.
Orbits and Masses of the Satellites of the Dwarf Planet Haumea (2003 EL61)
AJ 137 4766 2009 June

Rahmani, H.; Saslaw, W.; Tavasoli, S.
The Spatial Distribution Function of Galaxies at High Redshift
ApJ 695 1121 2009 April

Reach, W.; Faied, D.; Rho, J.; et. al.
Properties of Protostars in the Elephant Trunk in the Globule IC 1396A
ApJ 690 683 2009 January

Reddy, N.; Steidel, C.
A Steep Faint-End Slope of the UV Luminosity Function at z ~ 2-3: Implications for the Global Stellar Mass Density and Star Formation in Low-Mass Halos
ApJ 692 778 2009 February

Reiners, A.; Basri, G.; Browning, M.
Evidence for Magnetic Flux Saturation in Rapidly Rotating M Stars
ApJ 692 538 2009 February

Reiners, A.; Basri, G.
On the magnetic topology of partially and fully convective stars
A&A 496 787 2009 March

Reiners, A.; Basri, G.; Christensen, U.
Surprisingly Weak Magnetism on Young Accreting Brown Dwarfs
ApJ 697 373 2009 May

Rich, J.; Boesgaard, A.
Beryllium, Oxygen, and Iron Abundances in Extremely Metal-Deficient Stars
ApJ 701 1519 2009 August

Richard, J.; Stark, D.; Ellis, R.; et. al.
A Hubble and Spitzer Space Telescope Survey for Gravitationally Lensed Galaxies: Further Evidence for a Significant Population of Low-Luminosity Galaxies beyond z=7
ApJ 685 705 2008 October

Richard, J.; Pei, L.; Limousin, M.; et. al.
Keck spectroscopic survey of strongly lensed galaxies in Abell 1703: further evidence of a relaxed, unimodal cluster
A&A 498 37 2009 April

Riess, A.; Macri, L.; Li, W.; et. al.
Cepheid Calibrations of Modern Type Ia Supernovae: Implications for the Hubble Constant
ApJS 183 109 2009 July

Roederer, I.; Kratz, K.; Frebel, A.; et. al.
The End of Nucleosynthesis: Production of Lead and Thorium in the Early Galaxy
ApJ 698 1963 2009 June

Romanowsky, A.; Strader, J.; Spitler, L.; et. al.
Mapping The Dark Side with DEIMOS: Globular Clusters, X-Ray Gas, and Dark Matter in the NGC 1407 Group
AJ 137 4956 2009 June

Rossi, A.; de Ugarte Postigo, A.; Ferrero, P.; et. al.
A photometric redshift of z = 1.8{+0.4} {-0.3} for the AGILE GRB 080514B
A&A 491 L29 2008 November

Rubin, D.; Linder, E.; Kowalski, M.; et. al.
Looking Beyond Lambda with the Union Supernova Compilation
ApJ 695 391 2009 April

Ryan-Weber, E.; Pettini, M.; Madau, P.; Zych, B.
A downturn in intergalactic C IV as redshift 6 is approached
MNRAS 395 1476 2009 May

Saintonge, A.; Tran, K.; Holden, B.
Spitzer/MIPS 24 μm Observations of Galaxy Clusters: An Increasing Fraction of Obscured Star-forming Members from z = 0.02 to z = 0.83
ApJ 685 L113 2008 October

Salim, S.; Dickinson, M.; Michael, R.; et. al.
Mid-IR Luminosities and UV/Optical Star Formation Rates at z < 1.4
ApJ 700 161 2009 July

Salvato, M.; Hasinger, G.; Ilbert, O.; et. al.
Photometric Redshift and Classification for the XMM-COSMOS Sources
ApJ 690 1250 2009 January

Salyk, C.; Blake, G. A.; Boogert, A. C. A.; Brown, J.
High-resolution 5 μm Spectroscopy of Transitional Disks
ApJ 699 330 2009 July

Sambruna, R.; Reeves, J.; Braito, V.; et. al.
Structure of the Accretion Flow in Broad-Line Radio Galaxies The Case of 3C 390.3
ApJ 700 1473 2009 August

Sánchez Contreras, C.; Sahai, R.; Gil de Paz, A.; Goodrich, R.
Echelle Long-Slit Optical Spectroscopy of Evolved Stars
ApJS 179 166 2008 November

Sato, B.; Fischer, D.; Ida, S.; et. al.
A Substellar Companion in a 1.3 yr Nearly Circular Orbit of HD 16760
ApJ 703 671 2009 September

Sato, T.; Martin, C.; Noeske, K.; et. al.
AEGIS: The Nature of the Host Galaxies of Low-Ionization Outflows at z < 0.6
ApJ 696 214 2009 May

Sawicki, M.; Lemaux, B.; Guhathakurta, P.; et. al.
The DEEP2 Redshift Survey: Lyα Emitters in the Spectroscopic Database
ApJ 687 884 2008 November

Schneider, N.; Burger, M.; Schaller, E.; et. al.
No sodium in the vapour plumes of Enceladus
Nature 459 1102 2009 June

Schuh, S.; Kruspe, R.; Lutz, R.; Silvotti, R.
Time-resolved spectroscopy of the planet-hosting sdB pulsator V391 Pegasi
CoAst 159 91 2009 March

Schulz, R.; Jehin, E.; Manfroid, J.; et. al.
Isotopic abundance in the CN coma of comets: Ten years of measurements
P&SS 56 1713 2008 November

Seo, H.; Kim, S.; Kim, J.; et. al.
Titan at 3 microns: Newly identified spectral features and an improved analysis of haze opacity
Icarus 199 449 2009 February

Shetrone, M.; Siegel, M.; Cook, D.; Bosler, T.
Chemical Abundances of the Leo II Dwarf Galaxy
AJ 137 62 2009 January

Shkolnik, E.; Liu, M.; Reid, I.
Identifying the Young Low-mass Stars within 25 pc. I. Spectroscopic Observations
ApJ 699 649 2009 July

Silverman, J.; Mazzali, P.; Chornock, R.; et. al.
Optical Spectroscopy of the Somewhat Peculiar Type IIb Supernova 2001ig
PASP 121 689 2009 July

Simon, J.; Gal-Yam, A.; Gnat, O.; et. al.
Variable Sodium Absorption in a Low-extinction Type Ia Supernova
ApJ 702 1157 2009 September

Smith, N.; Foley, R.; Bloom, J.; et. al.
Late-Time Observations of SN 2006gy: Still Going Strong
ApJ 686 485 2008 October

Smith, N.; Chornock, R.; Li, W.; et. al.
SN 2006tf: Precursor Eruptions and the Optically Thick Regime of Extremely Luminous Type IIn Supernovae
ApJ 686 467 2008 October

Smith, N.; Silverman, J.; Chornock, R.; et. al.
Coronal Lines and Dust Formation in SN 2005ip: Not the Brightest, but the Hottest Type IIn Supernova
ApJ 695 1334 2009 April

Smith, N.; Ganeshalingam, M.; Chornock, R.; et. al.
SN 2008S: A Cool Super-Eddington Wind in a Supernova Impostor
ApJ 697 L49 2009 May

Sozzetti, A.; Torres, G.; Charbonneau, D.; et. al.
A New Spectroscopic and Photometric Analysis of the Transiting Planet Systems TrES-3 and TrES-4
ApJ 691 1145 2009 February

Sozzetti, A.; Torres, G.; Latham, D.; et. al.
A Keck HIRES Doppler Search for Planets Orbiting Metal-Poor Dwarfs. II. On the Frequency of Giant Planets in the Metal-Poor Regime
ApJ 697 544 2009 May

Sromovsky, L.; Fry, P.; Hammel, H.; et. al.
Uranus at Equinox: Cloud Morphology and Dynamics
Icarus 203 265 2009 September

Stark, C.; Kuchner, M.; Traub, W.; et. al.
51 Ophiuchus: A Possible Beta Pictoris Analog Measured with the Keck Interferometer Nuller
ApJ 703 1188 2009 September

Stark, D.; Swinbank, A.; Ellis, R.; et. al.
The formation and assembly of a typical star-forming galaxy at redshift z<3
Nature 455 775 2008 October

Steinbring, E.; Melbourne, J.; Metevier, A.; et. al.
CATS: Optical to Near-Infrared Colors of the Bulge and Disk of Two z = 0.7 Galaxies Using Hubble Space Telescope and Keck Laser Adaptive Optics Imaging
AJ 136 1523 2008 October

Strader, J.; Smith, G.; Larsen, S.; et. al.
Mass-to-Light Ratios for M31 Globular Clusters: Age Dating and a Surprising Metallicity Trend
AJ 138 547 2009 August

Stratta, G.; Pozanenko, A.; Atteia, J.-L.; et. al.
A multiwavelength study of Swift GRB 060111B constraining the origin of its prompt optical emission
A&A 503, 783 September 2009

Sullivan, M.; Ellis, R.; Howell, D.; Riess, A.; et. al.
The Mean Type Ia Supernova Spectrum Over the Past Nine Gigayears
ApJ 693 L76 2009

Tanaka, M.; Finoguenov, A.; Kodama, T.; et. al.
The environmental dependence of properties of galaxies around the RDCSJ0910+54 cluster at z = 1.1
A&A 489 571 2008 October

Tannirkulam, A.; Monnier, J.; Harries, T.
A Tale of Two Herbig Ae Stars, MWC 275 and AB Aurigae: Comprehensive Models for Spectral Energy Distribution and Interferometry
ApJ 689 513 2008 December

Tolstoy, E.; Hill, V.; Tosi, M.
Star-Formation Histories, Abundances, and Kinematics of Dwarf Galaxies in the Local Group
ARA&A 47 371 2009 September

Trouille, L.; Barger, A.; Cowie, L.; et. al.
The OPTX Project. I. The Flux and Redshift Catalogs for the CLANS, CLASXS, and CDF-N Fields
ApJS 179 1 2008 November

Tylenda, R.; Kaminski, T.; Schmidt, M.
An analysis of a spectrum of V838 Monocerotis in October 2005
A&A 503 899 2009 September

Urrutia, T.; Becker, R.; White, R.; et. al.
The FIRST-2MASS Red Quasar Survey. II. An Anomalously High Fraction of LoBALs in Searches for Dust-Reddened Quasars
ApJ 698 1095 2009 June

Valenti, J.; Fischer, D.; Marcy, G.; et. al.
Two Exoplanets Discovered at Keck Observatory
ApJ 702 989 2009 September

van Breukelen, C.; Simpson, C.; Rawlings, S.; et. al.
Evidence of a link between the evolution of clusters and their AGN fraction
MNRAS 395 11 2009 May

van der Wel, A.; Holden, B.; Zirm, A.
Recent Structural Evolution of Early-Type Galaxies: Size Growth from z = 1 to z = 0
ApJ 688 48 2008 November

Veras, D.; Ford, E.
Secular Evolution of HD 12661: a System Caught at an Unlikely Time
ApJ 690 L1 2009 January 1

Vinkó, J.; Sárneczky, K.; Balog, Z.; et. al.
The Young, Massive, Star Cluster Sandage-96 After the Explosion of Supernova 2004dj in NGC 2403
ApJ 695 619 2009 April

Walkowicz, L.; Hawley, S.
Tracers of Chromospheric Structure. I. Observations of Ca II K and Hα in M Dwarfs
AJ 137 3297 2009 February

Wang, X.; Li, W.; Filippenko, A.; et. al.
The Golden Standard Type Ia Supernova 2005cf: Observations from the Ultraviolet to the Near-Infrared Wavebands
ApJ 697 380 2009 May

Weiner, B.; Coil, A.; Prochaska, J.; et. al.
Ubiquitous Outflows in DEEP2 Spectra of Star-Forming Galaxies at z = 1.4
ApJ 692 187 2009 February

West, A.; Basri, G.
A First Look at Rotation in Inactive Late-Type M Dwarfs
ApJ 693 1283 2009 March

Williams, K.; Bolte, M.; Koester, D.
Probing the Lower Mass Limit for Supernova Progenitors and the High-Mass End of the Initial-Final Mass Relation from White Dwarfs in the Open Cluster M35 (NGC 2168)
ApJ 693 355 2009 March

Winn, J.; Holman, M.; Henry, G.; et. al.
The Transit Light Curve Project. X. A Christmas Transit of HD 17156b
ApJ 693 794 2009 March

Winn, J.; Johnson, J.; Fabrycky, D.; et. al.
On the Spin-Orbit Misalignment of the XO-3 Exoplanetary System
ApJ 700 302 2009 July

Wolf, M.; Sheinis, A.
Host Galaxies of Luminous Quasars: Structural Properties and the Fundamental Plane
AJ 136 1587 2008 October

Wolfe, A.; Jorgenson, R.; Robishaw, T.; et. al.
An 84-μG magnetic field in a galaxy at redshift z = 0.692
Nature 455, 638 2008 October

Woodruff, H.; Ireland, M.; Tuthill, P.; et. al.
The Keck Aperture Masking Experiment: Spectro-Interferometry of Three Mira Variables from 1.1 to 3.8 μm
ApJ 691 1328 2009 February

Wright, J.; Upadhyay, S.; Marcy, G.; et. al.
Ten New and Updated Multiplanet Systems and a Survey of Exoplanetary Systems
ApJ 693 1084 2009 March

Wright, J.; Fischer, D.; Ford, E.; et. al.
A Third Giant Planet Orbiting HIP 14810
ApJ 699 L97 2009 July

Wright, S.; Larkin, J.; Law, D.; et. al.
Dynamics of Galactic Disks and Mergers at z ~ 1.6: Spatially Resolved Spectroscopy with Keck Laser Guide Star Adaptive Optics
ApJ 699 421 2009 July

Yan, R.; Newman, J.; Faber, S.; et. al.
The DEEP2 Galaxy Redshift Survey: environments of post-starburst galaxies at z ~ 0.1 and ~0.8
MNRAS 398 735 2009 September

Zhu, G.; Moustakas, J.; Blanton, M.
The [O II] 3727 Luminosity Function at z ~ 1
ApJ 701 86 2009 August

EDITOR/WRITER
Debbie Goodwin

EDITORIAL CONSULTANT/WRITER
Frank Morgan

OTHER WRITERS AND CONTRIBUTORS
Taft Armandroff
Joan Campbell
Peggi Kamisato
Leslie Kissner
Jeff Mader
Margarita Scheffel
Ashley Yeager

GRAPHIC DESIGN
Waimea Instant Printing

PRINTING
Service Printers Hawaii, Inc.
Honolulu

PHOTO CREDITS
(t = top, b = bottom, l = left, m = middle, r = right)

Sarah Anderson/WMKO: *4t, 12, 13*
R. David Beales: *Cover*
Richard Cohen/WMKO: *24t*
Andrew Cooper/WMKO: *20t, 24-25, 25m, 25b*
Laurie Hatch: *6-13border*
Mansi Kasliwal/Iair Arcavi: *27b*
Christian Marois/Bruce Macintosh: *28*
Pablo McCloud: *5, 12-13, 14-15*
Moey, Inc.: *4b, 16, 24-26 border, 27tl*
Ric Noyle: *3*
Rick Peterson: *2, 6b, 11, 17, 19, 20b, 21, 22, 23, 26*
TED: *27r*
WMKO/Caltech: *18b*
WMKO/UCO: *18t*
William Youngblood: *6t*

W. M. KECK OBSERVATORY

On the summit of Mauna Kea, Island of Hawai'i

For more information contact:
Debbie Goodwin
Director of Advancement
65-1120 Mamalahoa Highway
Kamuela, Hawai'i 96743
808.881.3814
www.keckobservatory.org