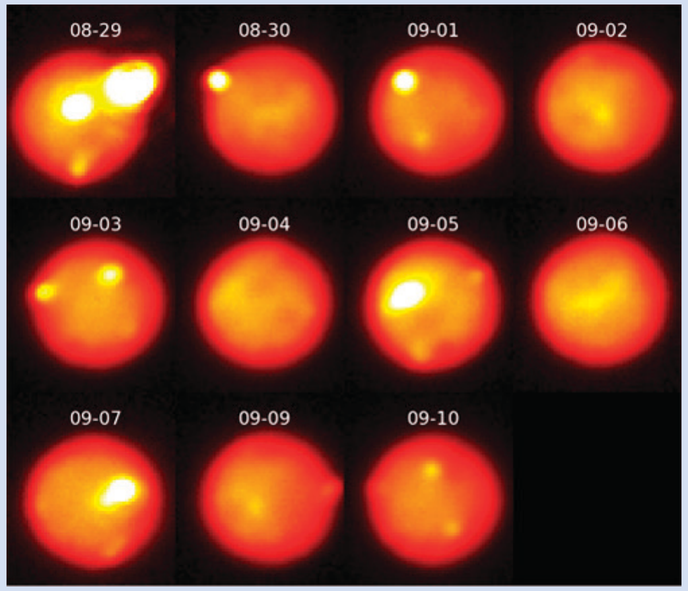
GEMINI OBSERVATORY
Exploring the Universe, Sharing its Wonders

Instrument Science Highlights

NIRI *(Near-InfraRed Imager and spectrometer)*



Left: NIRI + Altair Natural Guide Star adaptive optics observations of the August 29, 2013, volcanic outburst on Jupiter's moon Io over a two-week period. Due to Io's rotation, a different area of the surface is viewed on each night; the outburst is visible with diminishing brightness on August 29-30 and September 1, 3, and 10.

Credit: K. de Kleer & I. de Pater (2016)

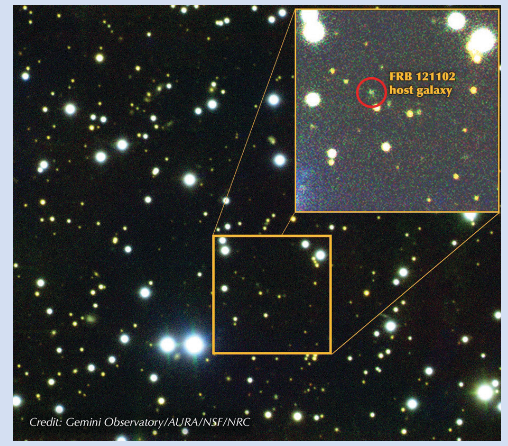
Right: Gemini NIRI J- and K-band image of lensed quasar HE 0435-1223 and its gravitationally lensing galaxy. They are located at image center and look like a quincunx (the five on 6 sided dice); the lensing galaxy is at the center of the quincunx. This image helped lead to an independent high-precision measurement of the Hubble constant.

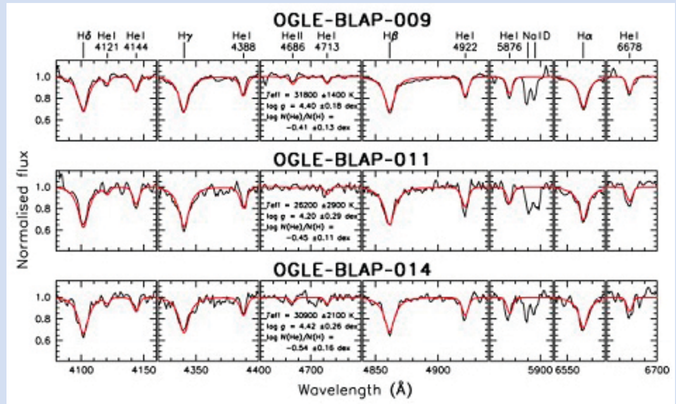
Credit: S. Suyu, V. Bonvin, F. Courbin, C. Fassnacht, et al. (2017) / H0LiCOW collaboration

GMOS *(Gemini Multi-Object Spectrograph) North & South*

Right: GMOS-North image of the Fast Radio Burst (FRB) FRB 121102 and its host galaxy. The origin of FRBs, their distance from our Galaxy, and the nature of their host galaxies have been a puzzle since their discovery in 2007. GMOS optical and spectroscopic data, however, have recently provided us with the first details: FRB 121102 is hosted by a dwarf galaxy about 3 billion light years away.

Credit: S. Tendulkar, C. Bassa, J. Cordes, G. Bower et al. (2017)





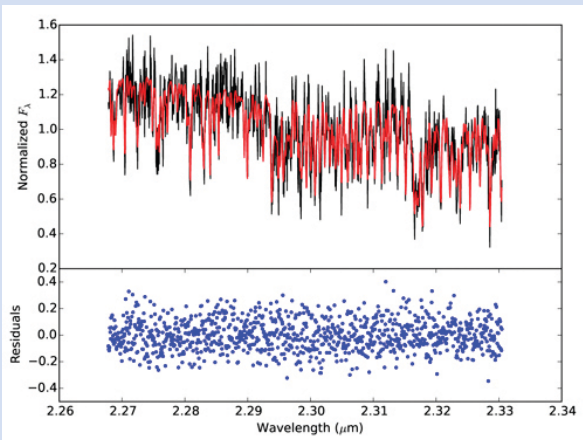
Left: Gemini South GMOS spectra for three Blue Large-Amplitude Pulsators (BLAPs; a new class of variable stars) with best fits of stellar atmosphere models shown with red lines. BLAPs are significantly bluer than main sequence stars of the same luminosity demonstrating that they are relatively hot. The new pulsating stars vary with periods ranging from 20 to 40 minutes and amplitudes spanning 0.2 – 0.4 magnitude. The Gemini data confirmed these stars have helium-rich atmospheres and high surface temperatures of about 30,000 K, comparable with hot subdwarfs. These characteristics have not been observed in any known hot pulsators.

Credit: P. Pietrukowicz, W. Dziembowski, M. Latour, R. Angeloni, et al. (2017)

GNIRS *(Gemini Near-InfraRed Spectrometer)*

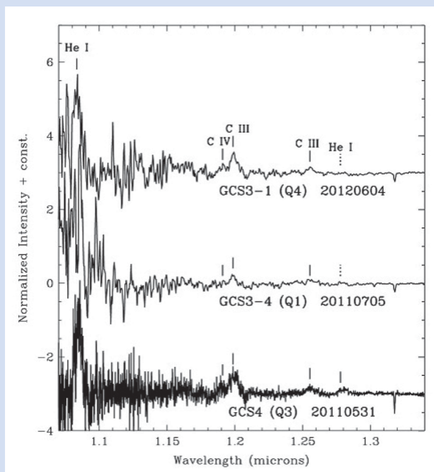
Left: GNIRS high-resolution K-band spectrum of the free-floating planetary-mass brown dwarf PSO J318.5–22 (black) compared to a model that best fits the observations (red). It reveals that the star is within the β Pictoris Moving Group — a young moving group of stars within our Galaxy—and has a mass and temperature between the directly-imaged planets β Pictoris b and 51 Eridani b.

Credit: K. Allers, J. Gallimore, M. Liu, & T. Dupuy (2016)



Right: GNIRS J-band spectra of three of the members of the IR Quintuplet in the Galactic center (GC), showing emission lines of helium and carbon, confirming their identifications as dusty Wolf-Rayet stars. Due to the high extinctions to the GC and through their dust shells, at these wavelengths only one photon in 1,000 emitted toward Earth by each star reaches the Earth.

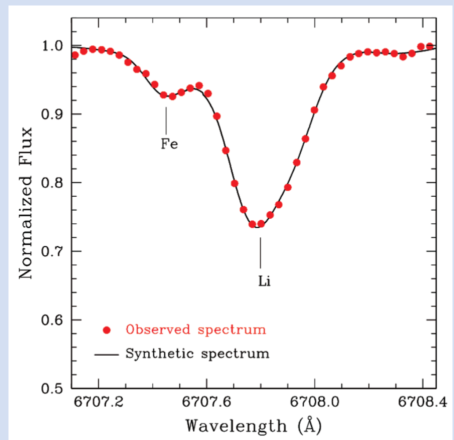
Credit: F. Najarro, T. Geballe, D. Figer, & D. de la Fuente (2017)

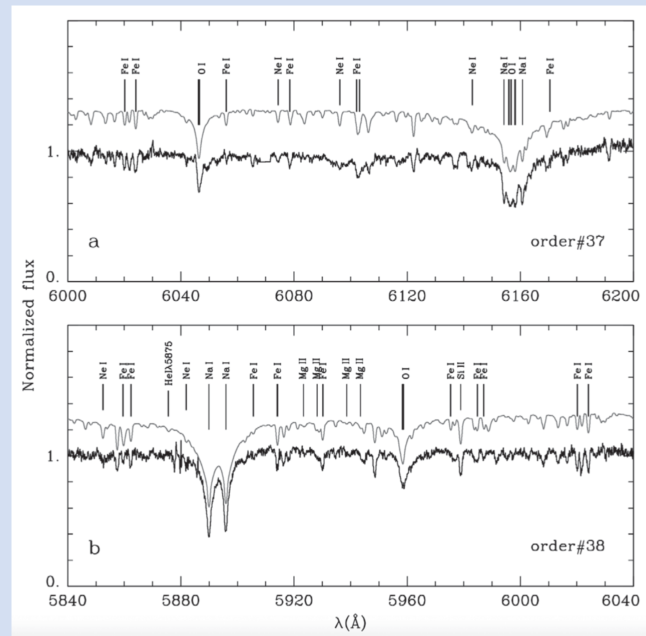


GRACES *(Gemini Remote Access to CFHT ESPaDOnS Spectrograph)*

Left: GRACES spectrum of the exceptional young lithium-rich giant KIC 9821622 found in the Kepler field. The star exhibits an unusually large enhancement of α, Fe-peak, and r-process elements, opening the possibility of external contamination by material enriched by a supernova explosion. The figure shows the best fit obtained between the synthetic and observed spectrum around the 6,707.8 Å lithium line.

Credit: E. Jofré, R. Petrucci, L. García, & M. Gómez (2015)



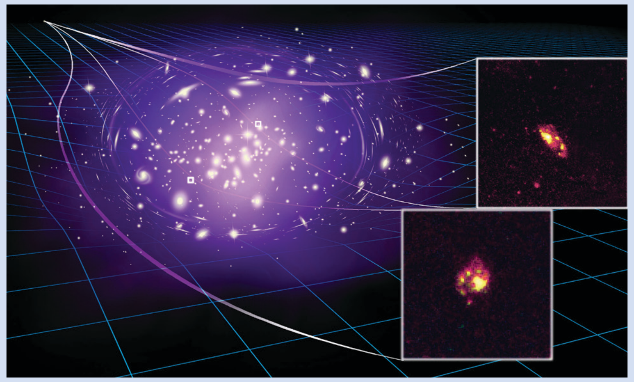


Right: High-dispersion spectra of the unusual white dwarf star LP40-365, which may be a surviving remnant of a Type Ia supernova explosion. These peculiar events can leave a partially burnt remnant that is instantly ejected at high velocity; indeed, LP40-365 is moving faster than the escape velocity of the Milky Way. The figure shows the spectral orders 37-38 (lower lines), normalized to unity with main spectral features marked. The best-fitting model spectra are shown in gray, offset set for clarity.

Credit: S. Vennes, P. Nemeth, A. Kawka, J. Thorstensen, et al. (2017)

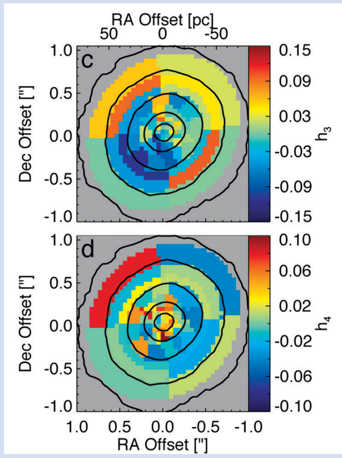
Instrument Science Highlights

NIFS and ALTAIR *(Near-infrared Integral Field Spectrometer and Gemini North Adaptive Optics System)*



Left: NIFS three-dimensional spectroscopy enabled a structural study of the most distant known spiral galaxy. The galaxy A1689B11 existed 11 billion years in the past, and its light is gravitationally lensed by a massive foreground cluster of galaxies. The highly magnified images in the figure inset show the formation of the first, primitive spiral arms of a galaxy, only a few billion years after the Big Bang.

Credit: T. Yuan, J. Richard, A. Gupta, C. Federrath et al. (2017)
Picture credit: James Josephides



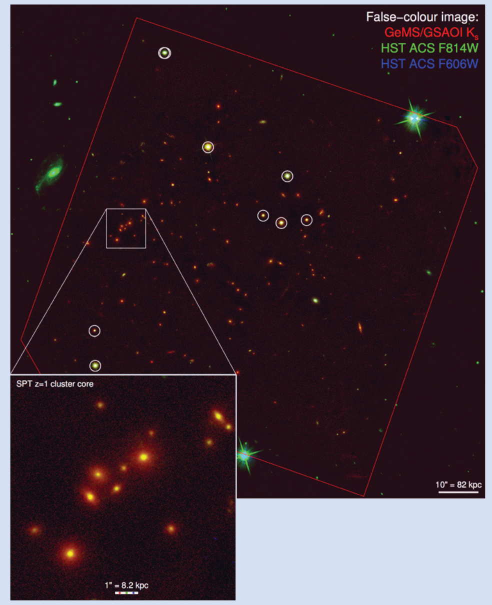
Right: NIFS and the Gemini North adaptive optics system ALTAIR were used in 2014 to discover the smallest galaxy yet known to harbor a supermassive black hole, M60-UCD1. The upper panel shows the measured radial velocities and a clear rotation pattern. Black contours show isophotes in the K-band stellar continuum. The lower panel shows the velocity dispersions of the stars in M60-UCD1, a black hole is required to explain the central dispersion peak.

Credit: A. Seth, R. van den Bosch, S. Mieske, H. Baumgardt et al. (2014)

GeMS and GSAOI *(Gemini Multi-Conjugate Adaptive Optics System and Gemini South Adaptive Optics Imager)*

Left: GeMS+GSAOI near-infrared image of the N159W field in the Large Magellanic Cloud. The image resolves stars to about 0.09 arcsec. Deep and high angular resolution images are needed to study HII regions in nearby galaxies. These observations yielded the luminosity function of the star cluster, its initial mass function, and more than 100 candidate young stellar objects. These objects were found to be younger than the central cluster, pointing to sequential star-formation in N159W, probably influenced by interactions with the expanding HII bubble.

Credit: A. Bernard, B. Neichel, M. Samal, A. Zavagno, et al. (2016) / T. Rector



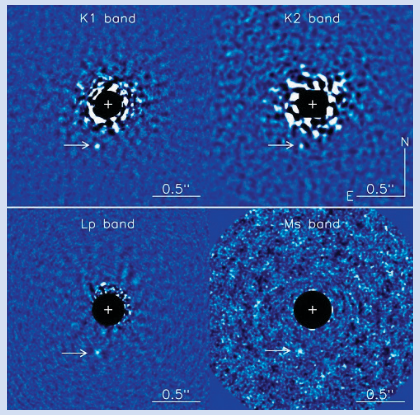
Right: False-color image of SPT-CL J0546–5345 at z = 1:067. The Gemini South telescope on Cerro Pachón (Chile) propagates a high power laser beam to create five 'artificial stars' used to correct the blurring effects of Earth's atmosphere. The inset is a zoom-in of the cluster core, imaged by GeMS+GSAOI at an average spatial resolution 0.095 arcsec. For the first time, the stellar mass-size relation for several galaxies in the cluster environment was studied with an average spatial resolution of 450 parsecs in radius at the cluster redshift of 1, showing that the most massive galaxies in the early universe grow through minor mergers.

Credit: S. Sweet, R. Sharp, K. Glazebrook, F. Rigaut, et al. (2016)

GPI *(Gemini Planet Imager)*

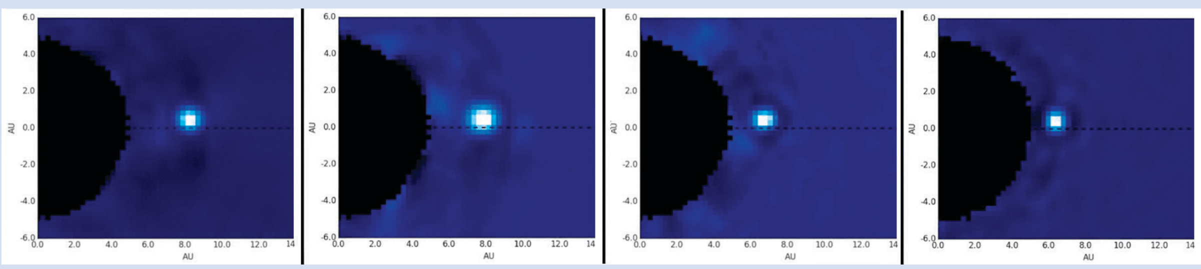
Left: The first exoplanet (named 51 Eridani b) discovered using GPI is a young, cool object between two to ten Jupiter masses. Its color is redder than similar brown dwarfs and might be due to clouds in its atmosphere. Observations suggest that the formation of this exoplanet is likely due to the collapse of icy disk materials followed by the accretion of a thick gas atmosphere – much like the process astronomers think probably formed the gas giants in our Solar System.

Credit: A. Rajan, J. Rameau, R. De Rosa, M. Marley, et al. (2017) / GPIES Team

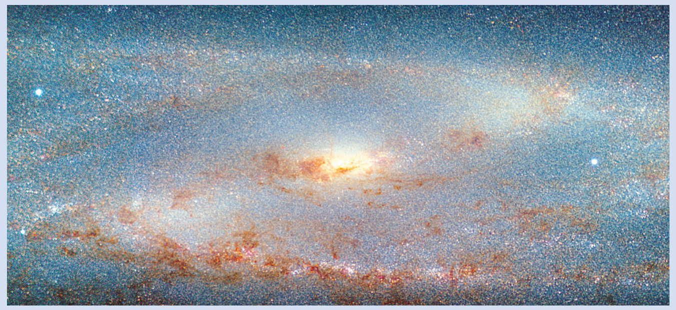


Right: First discovered in 2008, β Pic b is a gas giant planet ten to twelve times the mass of Jupiter, with an orbit roughly the diameter of Saturn's. It is part of a dynamic and complex system that includes comets, orbiting gas clouds, and an enormous debris disk. GPI has given our best view yet of an exoplanet moving in its orbit around a distant star. A series of images captured between 2013 and 2015 shows the exoplanet β Pic b as it moves through 1 ½ years of its 22-year orbital period.

Credit: M. Millar-Blanchaer, J. Graham, L. Pueyo, P. Kalas, et al. (2015) / GPIES Team



F-2 *(Flamingos-2 Near-Infrared Imaging Spectrograph)*



Left: NGC 253 is the nearest massive spiral galaxy with a nuclear starburst and its central region is shrouded by dust. The exact location and nature of its core remained unresolved for years. F-2 near infrared data pinpointed the galaxy's core through the dust, and the spectra showed the largest turbulence motions in the ionized gas at its location. The located nucleus would be a rapidly growing black hole and the main source of the huge galaxy-wide gaseous winds previously discovered with ALMA.

Credit: G. Günthardt, M. Agüero, J. Camperi, R. Díaz, et al. (2015)

Right: F-2 near-infrared images and spectra allowed multiple research teams to form a complete picture of the aftermath from the gravitational wave event (GW170817). The gravitational wave observatories LIGO and Virgo detected this collision of neutron stars on August 17, 2017. The observations taken with F-2 at Gemini South spanned a period of 25 nights – while the object's light gradually faded from view. These near infrared spectra revealed signatures of recently synthesized material, including gold and platinum, solving a decades-long mystery of where about half of all elements heavier than iron are produced.

Credit: R. Chornock, E. Berger, D. Kasen, P. Cowperthwaite, et al. (2017)