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First images from exoplanet hunter SPHERE

The European SPHERE instrument has been successfully installed on ESO's Very Large Telescope (VLT) and has achieved first light. This powerful new facility can directly image gas-giant exoplanets and dust discs orbiting nearby stars (up to 300 light years away) with unparalleled precision and contrast. SPHERE (the Spectro-Polarimetric High-contrast Exoplanet REsearch) instrument was developed by a European consortium (1) led by the Institut de Planétologie et Astrophysique de Grenoble (IPAG, CNRS/Université Joseph Fourier) with the French Aerospace Lab ONERA, Laboratoire d'Astrophysique de Marseille (CNRS/AMU), Laboratoire d'Etudes Spatiales et d'Instrumentation en Astrophysique (Observatoire de Paris/CNRS/UPMC/Université Paris Diderot), Laboratoire Lagrange (Observatoire de la Côte d'Azur/CNRS/Université Nice-Sophia Antipolis), together with institutes in Germany, Italy, Switzerland and the Netherlands, in partnership with ESO (European Southern Observatory). The instrument will be made available to the astronomical community in 2015.

During its first light observations, SPHERE validated its various observation modes and captured unprecedented images, demonstrating its impressive ability to suppress the glare of the bright star at the center of the image. Led by the Principal Investigator Jean-Luc Beuzit, CNRS senior researcher at IPAG, the researchers were able to obtain one of the best images to date of the ring of dust around the star HR 4796A, very high definition images of Titan, and the first examples of detection of faint companions to nearby stars. These first images confirm the impressive performance of the instrument.

The existence of over a thousand planets orbiting stars other than the Sun has already been established. Most of them were discovered by observing the variations in brightness caused by a planet passing in front of its host star (planetary transit technique) or by observing the motion of a star caused by planets in orbit around it (radial velocity technique). Until now, only a few planets have been detected by direct imaging of the planet next to its host star.

SPHERE's main goal is to detect and characterize giant exoplanets orbiting nearby stars by direct imaging. This is a major challenge as such planets are both very close to their host stars and also very faint. SPHERE will be able to detect the signal from a planet up to a million times fainter than its host star, which is more than an order of magnitude better than existing instruments. In a normal image, even if obtained under the best conditions, the light from the star completely swamps the weak glow from the planet. The whole design of SPHERE is therefore based on the need to obtain the highest possible contrast in the immediate neighborhood of the star. By analogy, if SPHERE were in Paris, it would be able to detect the light of a candle 50 cm from a lighthouse in Marseille.

Meeting both technological and scientific challenges, SPHERE is one of the most complex ground-based astronomical instruments ever built. In particular, it includes an advanced adaptive optics system that uses a deformable mirror comprising over 1300 actuators that correct the effects of atmospheric turbulence, on the nanometer scale, more than 1200 times per second. SPHERE also includes coronographic masks to block out the light from the central star, and three light detection modules using differential imaging, spectroscopic and polarimetric techniques at visible and near infrared wavelengths. SPHERE's powerful performance was achieved through the early development of new technologies, particularly in the areas of adaptive optics, special detectors and coronographic components.

It took more than twelve years for all the laboratories and organizations involved to design and build SPHERE. Around 120 researchers, engineers and technicians took part in the various stages of the project. SPHERE's materials budget amounts to €10 million, funded by ESO, the European OPTICON program, and national agencies, including €1 million for CNRS.

Members of the SPHERE consortium

[1] SPHERE was designed and built by an international consortium led by the Institut de Planétologie et Astrophysique de Grenoble (CNRS/Université Joseph Fourier) at the Observatoire des Sciences de l'Univers de Grenoble. Consortium members in France:

- the French National Aerospace Lab (ONERA)
- Laboratoire d'Astrophysique de Marseille (LAM, CNRS/AMU) at the Observatoire des Sciences de l'Univers – Institut Pythéas
- Laboratoire d'Etudes Spatiales et d'Instrumentation en Astrophysique (LESIA, Observatoire de Paris/CNRS/UPMC/Université Paris Diderot)
- Laboratoire Lagrange (CNRS/Observatoire de la Côte d'Azur/Université de Nice Sophia-Antipolis)

And in Europe:

- Max-Planck-Institut für Astronomie, Heidelberg,
- Observatoire de Genève,
- Italian National Institute for Astrophysics (INAF) coordinated by the Osservatorio Astronomico di Padova,
- Institute for Astronomy, ETH Zurich,
- Astronomical Institute of the University of Amsterdam,
- Netherlands Research School for Astronomy (NOVA),
- Netherlands Institute for Radio Astronomy (ASTRON)
- ESO.

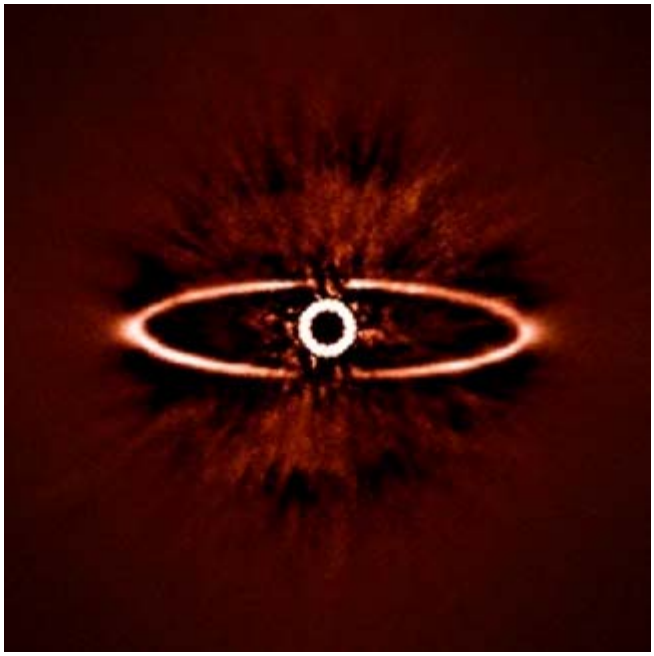
To find out more:

- SPHERE web pages at the website of the Observatoire des Sciences de l'Univers de Grenoble : http://sphere.osug.fr/?lang=fr

- Link to the SPHERE photo report at the Photo Library website at CNRS http://phototheque.cnrs.fr/front/baskets.php?userSession=776093*193.55.81.250*2456813.46219

Images

SPHERE images the dust ring around the star HR 4796A



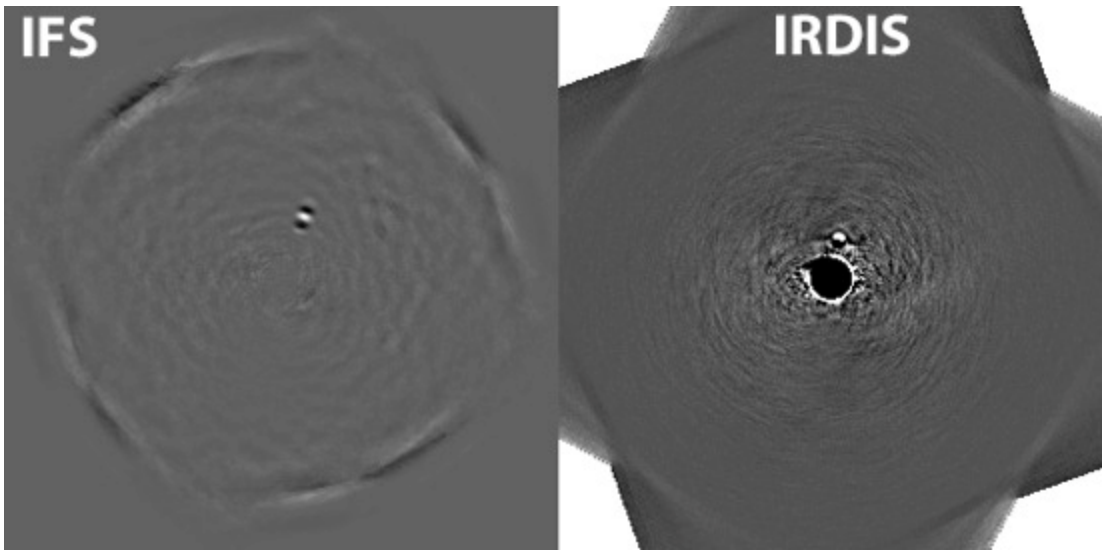
This infrared image shows the dust ring around the nearby star HR 4796A in the southern constellation Centaurus. It was one of the very first images produced by SPHERE, shortly after it was mounted on ESO's Very Large Telescope in May 2014. It reveals SPHERE's remarkable ability to reduce the glare from this very bright star—the key to finding and studying exoplanets in the near future.

Credits: ©ESO/SPHERE Consortium

Images of Saturn's moon, Titan, obtained by SPHERE.

These images of Titan, Saturn's largest moon, were obtained both at visible and infrared wavelengths. They were among the very first images produced by SPHERE, shortly after it was mounted on ESO's Very Large Telescope in May 2014. The infrared image (left) shows details of the moon's surface, which would be totally blurred and unresolved without correction by adaptive optics. Titan is Saturn's largest moon (around 1.5 times the diameter of our Moon). It has an extended atmosphere mainly made up of nitrogen, with traces (around 1.5%) of methane. Whereas at visible wavelengths the satellite's surface is hidden by a thick haze, this near-infrared image was obtained at a wavelength that makes it possible to penetrate the atmosphere and survey the surface. Titan was also used as a target to test SPHERE's observational capacity at visible wavelengths (two images at right). Titan's atmosphere contains a thick layer of haze that reflects the Sun's visible light. As a result, unlike at near infrared wavelengths, we cannot see the satellite's surface, and Titan appears as a featureless sphere (middle image). However, Titan's limb is very strongly polarized due to scattering by haze particles. SPHERE's polarimetric imaging mode is used to measure the limb polarization (right). This technique will be used by SPHERE to search for reflected, and therefore polarized, light from exoplanets. Credits: ©ESO/SPHERE Consortium

SPHERE releases its first images of the stellar companion of Iota Sgr (HR7581).



These images show the first direct images of the orbiting companion of the iota star in the constellation Sagittarius. They were obtained simultaneously by two of SPHERE's scientific detectors, the differential imaging camera (IRDIS) and the integral field spectrograph (IFS), both observing in the near infrared. The light from the central star was masked by a coronagraph. The companion detected is a very low mass star, 9 magnitudes dimmer than its host star, at a separation of 0.24". Credits: ©ESO/SPHERE Consortium

The SPHERE instrument during the phase of installation and testing at ESO's Paranal Observatory site.

A tense moment for the researchers and engineers who have worked on the SPHERE project for over 12 years as they wait for their instrument's first light. Credits: ©CNRS Photothèque/ESO/Claude Delhaye

Shown above, the SPHERE instrument, shortly after being installed on the third 8-meter telescope of ESO's VLT. Credits: ©CNRS/Jean-Luc Beuzit

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