ESO – European Southern Observatory

ESO is the pre-eminent intergovernmental science and technology organisation in astronomy. It carries out an ambitious programme focused on the design, construction and operation of powerful ground-based observing facilities for astronomy to enable important scientific discoveries.

Created in 1962, ESO is supported by thirteen member states: Belgium, the Czech Republic, Denmark, Finland, France, Germany, Italy, the Netherlands, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Whilst the headquarters are located in Germany, ESO operates three observational sites in the Chilean Atacama desert.

At La Silla, near La Serena, ESO operates several medium-sized telescopes.

The Very Large Telescope is located on Paranal, which also hosts the VLT Interferometer, and, soon, two survey telescopes, the VST and VISTA.

The third site is the 5 000 m high Llano de Chajnantor, near San Pedro de Atacama, where APEX is in operation, and a giant array of 12-m submillimetre antennas (ALMA) is being constructed in collaboration with North America, East Asia and Chile.

ESO is also currently engaged in design studies for a 42-m Extremely Large Telescope.

ESO employs around 600 staff members.

www.eso.org

The Very Large Telescope

The Very Large Telescope (VLT) array is the flagship facility for European astronomy at the beginning of the third Millennium. Sitting atop the Paranal Mountain, its design, instrument complement and operating principles set the standard for ground-based optical and infrared astronomy.

It is the world's most advanced optical instrument, consisting of four Unit Telescopes (UTs) with main mirrors of 8.2-m diameter and four movable 1.8-m Auxiliary Telescopes (ATs). The telescopes can work together, in groups of two or three, to form a giant 'interferometer', allowing astronomers to see details corresponding to those from a much larger telescope. The 8.2-m Unit Telescopes can also be used individually. With one such telescope, one can see objects that are four billion times fainter than what can be seen with the unaided eye.

Adaptive Optics technology allows the instruments on the VLT to overcome the blurring effects of the atmosphere, producing images almost as sharp as if taken from space. In theory, Adaptive Optics allows the VLT to read a newspaper headline at a distance of more than 10 kilometres.

The first of the Unit Telescopes, 'Antu', had 'First Light' in May 1998 and went into routine scientific operations on 1 April 1999. Today, all four Unit Telescopes and all four Auxiliary Telescopes are operational. Already, the VLT has made an unquestionable impact on observational astronomy. Publication statistics show that the VLT provides data for a scientific paper every day, all year round.

Moving Telescopes

In order to exploit the VLTI each night, four smaller, dedicated 'Auxiliary Telescopes' (ATs) are available. The ATs are mounted on tracks and can be moved between precisely defined observing positions. From these positions, their light beams are combined in the VLTI.

The ATs are very unusual telescopes. In their ultra-compact protective domes, they carry their own electronics, ventilation, hydraulics and cooling systems. Each AT has a transporter that lifts the telescope and moves it from one position to the other. Almost like a snail, it moves around with its own housing.

The Names of the Unit Telescopes

The Unit Telescopes were given names from the indigenous Mapuche language:

Antu (UT1; The Sun)
Kueyen (UT2; The Moon)
Melipal (UT3; The Southern Cross)
Yepun (UT4; Venus – or 'evening star')

A Science Machine

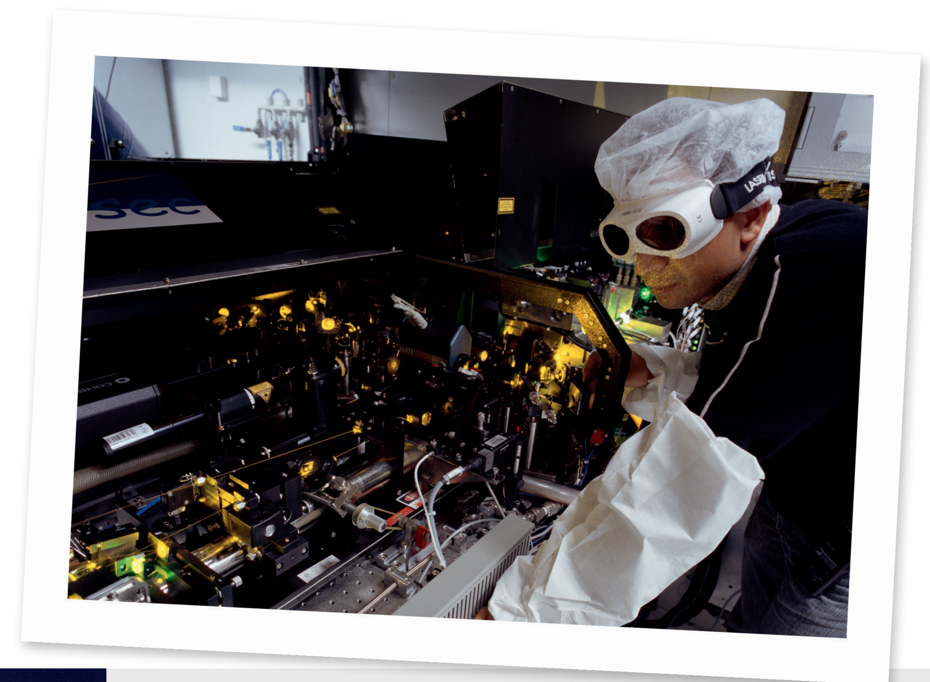
Astronomy tackles vast questions that challenge our minds and our imagination: Is there life elsewhere in the Universe? What lies at the centre of the Milky Way? How old is our Universe? The VLT's arsenal of sophisticated instruments enables observations that are essential to investigate key issues, helping us better understand the world we live in.

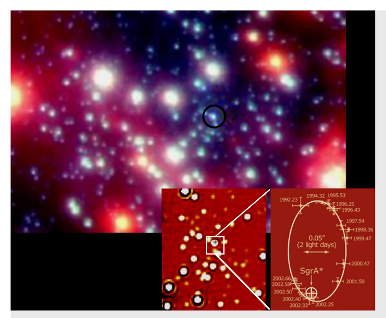
In 2005, the VLT provided a major breakthrough, allowing astronomers to spot the faint glow of a planet outside our Solar System and thus to take the first ever picture of an exoplanet. This new world is a giant one, some five times more massive than Jupiter.

Scientists have long suspected that a black hole lurks at the heart of our Galaxy, the Milky Way, but could not be sure. The VLT finally provided conclusive evidence of a supermassive black hole, almost three million times more massive than our Sun, and discovered that it emitted powerful flashes. Scientists also use the VLT to peer into the centre of galaxies far beyond our own.

The VLT has also detected the light of a cosmic fireball that took place when the Universe was a mere infant, only 7% of its current age, setting a new record for the discovery of the oldest and farthest explosion of a star yet seen.

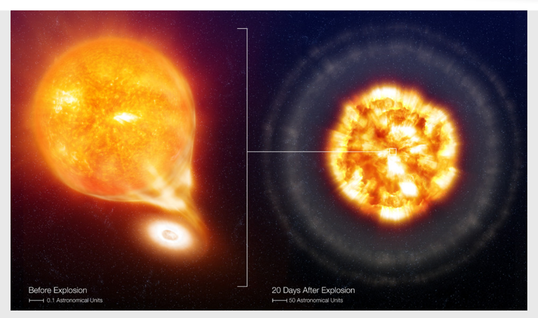
Every year, thousands of astronomers carry out research using data collected at the ESO observatories. The results of their work are published in several hundred scientific articles each year.





Surfing a Black Hole

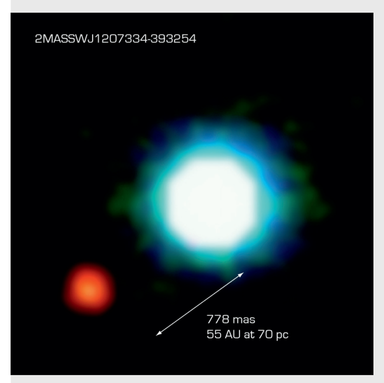
Astronomers have directly observed an otherwise normal star orbiting the supermassive black hole at the centre of the Milky Way galaxy. Ten years of painstaking measurements have been crowned by a series of unique images obtained with the Adaptive Optics NAOS-CONICA instrument on the ESO VLT. Observations in 2002 showed that the star approached the central black hole to within 17 light-hours while travelling at no less than 5000 km/sec.



The Gobbling Dwarf that Exploded

A unique set of observations, obtained with ESO's VLT, has allowed astronomers to find direct evidence for the material that surrounded a star before it exploded as a Type Ia supernova. This strongly supports the scenario in which the explosion occurred in a system where a white dwarf is fed by a red giant.

The team of astronomers studied in great detail SN 2006X, a Type Ia supernova that exploded 70 million light-years away from us, in the splendid spiral Galaxy Messier 100. The astronomers deduce from the observations the existence of several gaseous shells (or clumps) ejected as stellar wind from the giant star in the recent past. The material is moving with a velocity of 50 km/s, a velocity typical for the winds of red giants. This is the first time that clear and direct evidence for material surrounding the explosion has been found.



First Image of an Extrasolar Planet

Using NACO on the VLT, astronomers detected a faint and very red point of light, very near a brown dwarf object designated 2M1207. The feeble object is more than 100 times fainter than 2M1207 and its near-infrared spectrum, obtained with great efforts, shows the signatures of water molecules. Further observations over a period of one year convincingly demonstrate that the two objects are bound. This is thus the first image of a 5 Jupiter-mass planet in orbit around 2M1207.

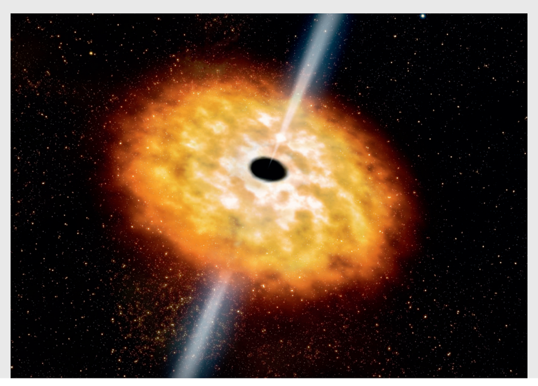
The Impossible Siblings

Combining precise observations obtained by ESO's Very Large Telescope with those gathered by a network of smaller telescopes, astronomers have described in unprecedented detail the double asteroid Antiope, which is shown to be a pair of rubble-pile chunks of material, of about the same size, whirling around one another in a perpetual *pas de deux*. The two components are egg-shaped despite their very small sizes.

The two objects are separated by 171 km. Their orbital period, known with a precision of better than half a second, is 16.5 hours. Moreover, the two asteroids rotate in the same plane as they orbit each other and have the shape of ellipsoids, almost similar in size: 93.0 x 87.0 x 83.6 km and 89.4 x 82.8 x 79.6 km, respectively. In fact, they have a shape close to the one predicted by the French scientist Edouard Roche in 1849 for self-gravitating, rotating fluid objects orbiting each other and tidally locked.

Feeding the Monster

Near-infrared images of the active galaxy NGC 1097, obtained with the NACO adaptive optics instrument on ESO's Very Large Telescope, disclose with unprecedented detail a complex central network of filamentary structure spiralling down to the centre of the galaxy. The resolution achieved with the images is about 0.15 arcsec, corresponding to about 30 light-years across. For comparison, this is only 8 times the distance between the Sun and its nearest star, Proxima Centauri. The curling of the spiral pattern in the innermost 300 light-years seems to confirm the presence of a supermassive black hole in the centre of NGC 1097. Such a black hole in the centre of a galaxy causes the nuclear spiral to wind up as it approaches the centre.



Exploding Stars at the Edge of the Universe

Gamma-Ray Bursts (GRBs) are bursts of highly energetic gamma rays lasting from less than a second to several minutes –the blink of an eye on cosmological timescales. They are known to occur at huge distances from Earth, towards the limits of the observable Universe. Such bursts occur when a massive star explodes or when two very dense objects merge.

The VLT has observed the afterglow of a Gamma-Ray Burst that is the farthest known ever. With a measured redshift of 6.3, the light from this very remote astronomical source has taken 12.8 billion years to reach us. It is thus seen when the Universe was less than 900 million years old, or less than seven per cent its present age. It must have released 300 times as much energy in a few seconds as our Sun will in its entire lifetime of more than 10 billion years. GRBs are therefore the most powerful explosions in the Universe since the Big Bang.

A UNIVERSE of DISCOVERIES