Adaptive Optics and the Laser Guide Star

In astronomy, the Earth's atmosphere blurs images even at the best sites. The effects of atmospheric blurring can be avoided by observing from space, but this is costly, thus limiting the size and scope of the telescope.

Sophisticated computer-controlled deformable mirrors can correct the distortion caused by the turbulence of the Earth's atmosphere, making them almost as sharp as images taken from space. This method is called adaptive optics and allows corrected systems to observe finer details in astronomical objects and also much fainter objects from the ground.

Adaptive optics requires a reference star that is very close to the object being studied. The star is used to measure the blurring introduced by the atmosphere so that the instrument can correct it. Unfortunately, such stars are not available everywhere. Artificial guide stars are created by shining a powerful laser beam into the Earth's upper atmosphere to dramatically increase the portion of the sky observable with adaptive optics.

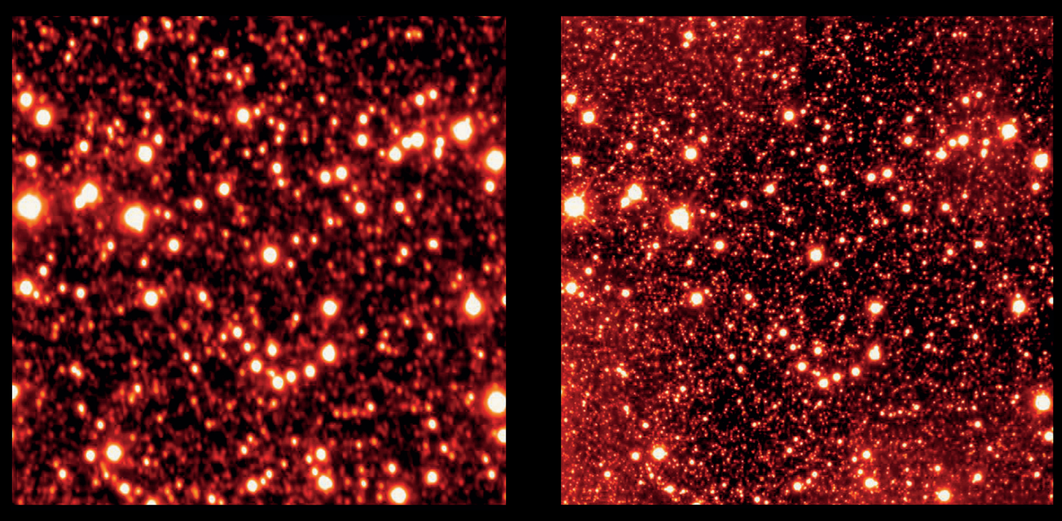
Since 1989, the European Southern Observatory has led the way in developing adaptive optics and laser guide star technologies to overcome the effect of the atmosphere on images from ground-based telescopes. ESO, in collaboration with several European institutes and industries, has an advanced adaptive optics programme that defines its position as a world leader in this field. **The Paranal Observatory has the most adaptive optics systems in operation in the world.** The Very Large Telescope Laser Guide Star Facility was the first of its kind in the southern hemisphere.

World-class scientific results have been obtained using ESO's adaptive optics facilities, such as the first direct observation of an exoplanet near a bright star or the characterisation of the black hole at the centre of the Milky Way.

The next generations of the VLT and E-ELT adaptive optics facilities have also benefited from European Commission research funding contracts. The next generation for the VLT will use several laser guide stars and advanced adaptive optics instruments such as the SPHERE planet finder are currently under development.

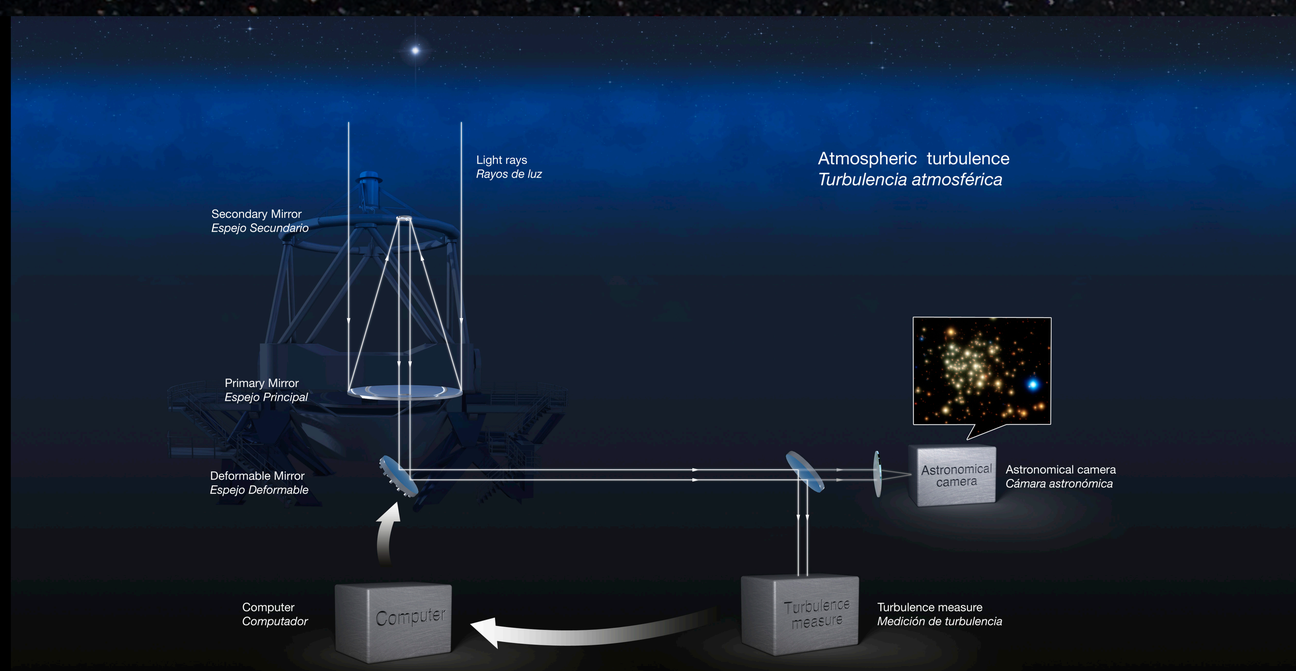
Advanced systems are being produced to meet the challenges of the 40-metre-class E-ELT.

Significant recent progress has also opened the way to attaining a wider corrected field of view, which will certainly influence the design of future VLT and E-ELT adaptive optics facilities.



Omega Centauri before and after adaptive optics is turned on.

Omega Centauro antes y después de encender la óptica adaptativa.



The principle of adaptive optics.

El principio de la óptica adaptativa.