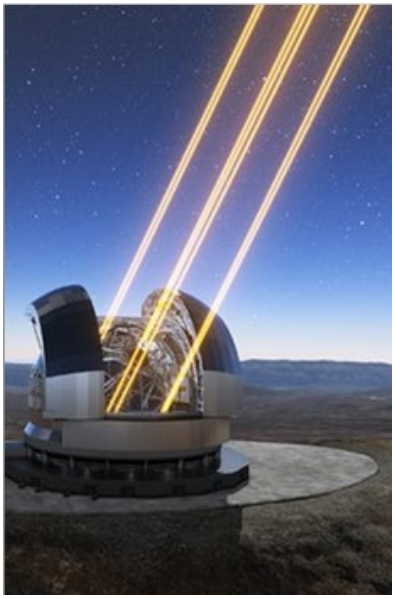
It's time to join Europe in Chile!

Astronomical Society of Australia

And give Australian astronomers access to the Extremely Large Telescope

Media briefing, 30 November 2022



Europe is building the Extremely Large Telescope in Chile.

It will be 15 times sharper than Hubble. Its main mirror will be 39 metres in diameter, nearly ten times the diameter of Australia's largest optical telescope. Eight lasers will shoot into the sky to create guidestars to 'tune' the telescope in real time.

It will be the jewel in the crown of a suite of modern telescopes already operating in the Atacama Desert, which gets, on average, less than 10 millimetres of rain per year. It's the driest place on Earth outside the polar regions.

The telescopes are operated by the European Southern Observatory (ESO).

This week, the Director General of ESO is touring Australia to discuss how Australia can become a Member State of ESO, giving Australian astronomers full access to the Extremely Large Telescope and ESO's other telescopes.

Australia is already reaping the benefits of hosting the world's largest radio telescope, the Square Kilometre Array (SKA), under development in Western Australia and South Africa.

Australian astronomers are also working with the James Webb Space Telescope (JWST).

And they're already developing technology for ESO's Very Large Telescope that will make it sharper than Hubble.

Full access to ESO's optical telescopes, together with SKA and JWST, will transform our knowledge of the Universe over the coming decades, revealing the secrets of planets around nearby stars, galaxies near and far, the early Universe, dark matter, dark energy, and, inevitably, introducing new questions for us to solve, such as the mystery of fast radio bursts.

It will also provide opportunities for Australian industry to develop and supply new optical technologies. The benefits from these technologies will flow from astronomy to engineering, space science, industry and defence.

Available for interview

Professor Orsola De Marco, Macquarie University astronomer and chair of the board of Astronomy Australia Limited.

Professor John Lattanzio, President of the Astronomical Society of Australia

ESO Director General, **Professor Xavier Barcons**

Media contact: Niall Byrne, niall@scienceinpublic.com.au, 0417-131-977.

Attached: Australia's relationship with ESO; why do we need optical telescopes in Chile; removing the twinkle from stars; big instruments working together.

Supporting information

Building on success

In 2017, the Australian Government facilitated and funded a Strategic Partnership with ESO. It's already led to great outcomes for astronomy with, for example, two teams receiving 490 hours of time on ESO's VLT to make deep observations of the Milky Way's galactic cousins and reveal the physics of star formation and galaxy evolution.

Through the partnership, Australia is leading the development of technology for the VLT that will allow it to produce sharper images than JWST and look further back in time than Hubble.

Australia can now build on these achievements and secure access to the Extremely Large Telescope (ELT) and a suite of other powerful telescopes by becoming a Member State of ESO.

Australian investment in ESO will complement the global investment in building the SKA in Australia and South Africa.

Why invest in telescopes in Chile

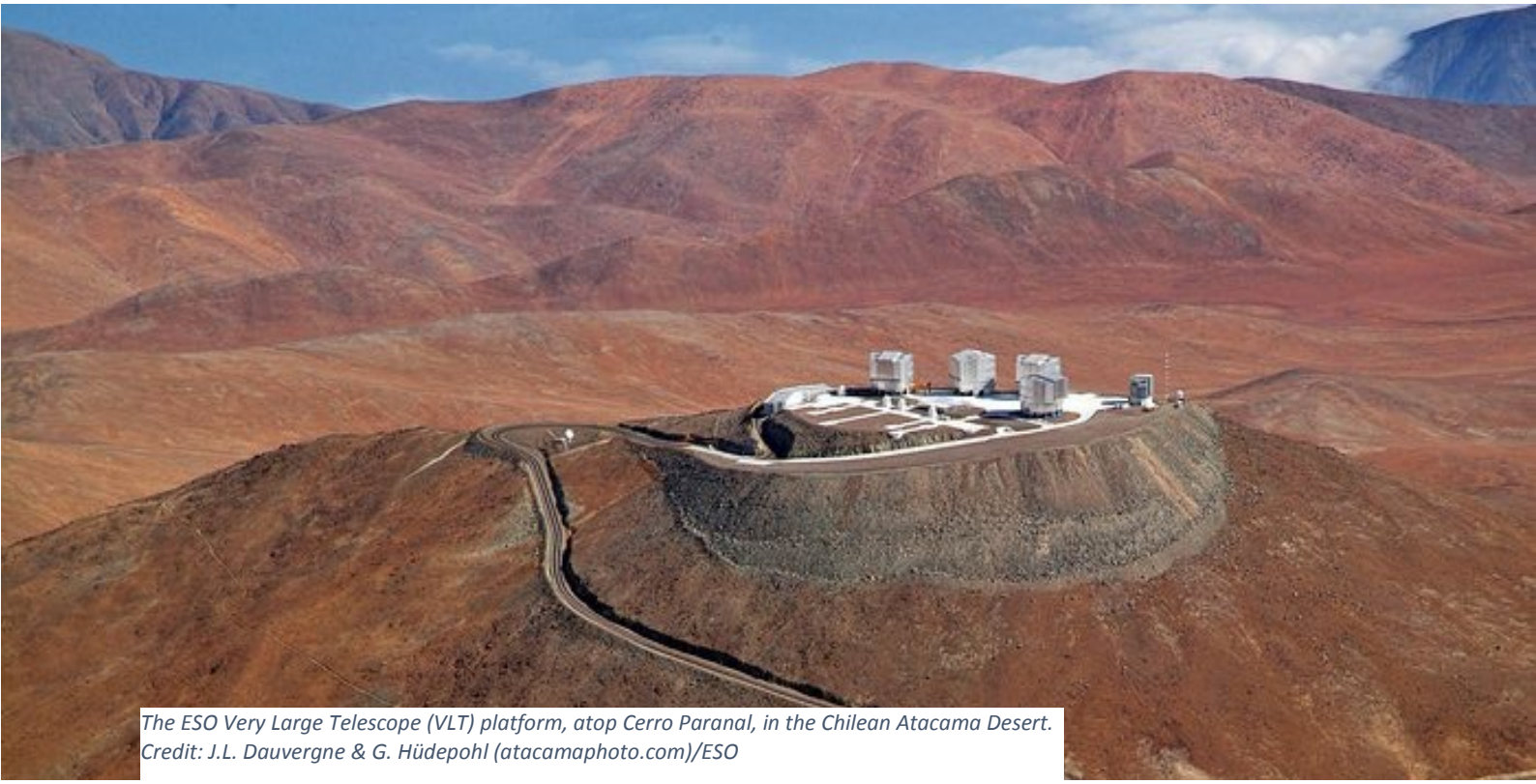
Australia has several good sites for radio astronomy: wide open remote spaces with little radio noise – no mobile coverage, no personal electronics and no vehicles.

But we have no good locations for modern optical telescopes, which require high, dry sites.

The Atacama Desert in Chile, home of ESO's telescopes, is the driest place on Earth outside the polar regions. It averages less than 10 mm of rain per year. Some parts of the desert have had no rain for 500 years. The ESO site is 2,635 metres above sea level.

By comparison, Siding Springs, home of Australia's largest optical telescope, the Anglo-Australian Telescope (AAT) is 1,165 metres above sea level and surrounded by (often) wet forest.

The AAT was built in 1974 and is just 3.9 metres in diameter. It has done sterling service and will have a continuing role, but its age and location now limit optical astronomy in Australia.



The ESO Very Large Telescope (VLT) platform, atop Cerro Paranal, in the Chilean Atacama Desert. Credit: J.L. Dauvergne & G. Hüdepohl (atacamaphoto.com)/ESO

Membership of ESO will give Australia access rights to telescopes at ESO's three sites in the Atacama Desert including:

- the four 8-metre telescopes comprising the VLT
- the 39-metre ELT
- the 4-metre VISTA survey telescope
- the Atacama Large Millimeter Array (ALMA), the world's largest high-frequency radio telescope (complementing the low-frequency SKA).

The ESO scientific, technical, and administrative headquarters are in Garching, Germany.

Why do we need big telescopes on Earth?

Over the past 30 years, the Hubble Space Telescope has given us a crystal-clear view of the Universe, observing some of the most distant stars and galaxies yet seen, as well as the planets in our solar system. It uses a 2.4 metre mirror to capture ultraviolet, visible and infrared light.

The JWST is taking us further. It has a 6.5 metre mirror collecting mainly infrared light. JWST can see objects that would be lost in the background infrared glow of the Sun, Earth, and the Moon.

Why mainly infrared? Because the latest ground-based optical telescopes can now outperform space telescopes due to the development of adaptive optics and other technologies. First conceived in the 1950s, adaptive optics became mainstream with the advances in fast computing, deformable mirrors and laser technology over the past two decades.

Removing the twinkle from stars

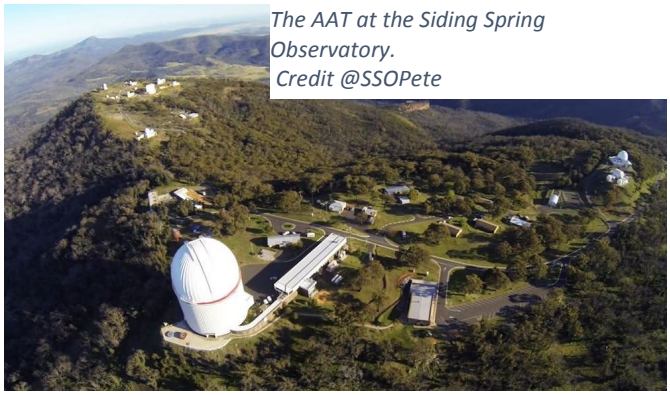
Since 1989, ESO has led the development of adaptive optics in astronomy, removing the distortion caused by atmospheric variation, literally removing the twinkle from starlight.

In 2018 ESO's VLT matched the image sharpness of Hubble and reached the theoretical limit of image quality for one of its 8-metre mirrors.

Four lasers projected columns of intense orange light, each 30 centimetres in diameter. The lasers stimulated sodium atoms in the upper atmosphere, creating artificial guide stars. Computers responded in real time, changing the shape of the VLT's secondary mirror to remove the twinkle, correcting the distorted light.

Today, Australia is working with ESO to develop new adaptive optical technologies for the VLT including MAVIS – the MCAO-Assisted Visible Imager and Spectrograph – built in a partnership led by Australia with France and Italy.

MAVIS demonstrates that Australia can not only participate in the scientific life of ESO, but can also be a core player in helping ESO maintain its leadership by developing unique and competitive instruments using Australian expertise.



The AAT at the Siding Spring Observatory. Credit @SSOPete

The ELT will go further. It will achieve images 15 times sharper than Hubble for visible and near-infrared light. The ELT's 39-metre mirror will be coupled with the latest adaptive technologies such as laser tomography, scanning layers of atmosphere much like a CT-scan.

Big instruments working together

Nearby galaxies taken with the Multi-Unit Spectroscopic Explorer (MUSE) on ESO's Very Large Telescope (VLT) by an international team including University of Sydney, UWA and ICRAR. Credit: ESO/ALMA (ESO/NAOJ/NRAO)/PHANGS

It's unlikely that one telescope will solve the biggest mysteries of astronomy. What is the Universe made of? Most of it seems to be dark matter and dark energy – both poorly understood. How did the Universe form? How do galaxies form? Is there life out there?
These questions will require multiple levels of investigation and coordinating observations from telescopes operating across the spectrum: from radio to infrared, visible and ultraviolet light, and beyond to X-rays and gamma-rays. For example:

Fast radio bursts

A single fast radio burst (FRB) emits more energy in a millisecond than the Sun emits in 80 years. We've detected over 800 fast radio bursts, but we still don't know what creates them.

Australia's ASKAP radio telescope has contributed to the hunt for these FRBs. Now, the VLT in Chile is helping radio astronomers to visualise the galaxies that are the source of these bursts, to try to solve the mystery, and to determine how these events can be used as research tools in astronomy.

Neutron star mergers

The mergers of pairs of neutron stars – the unbelievably dense remnants left behind by some supernova explosions – can now be detected in gravitational waves.

Follow-up observations with radio and optical telescopes have revealed that these mergers make many of the heavy metals in the Universe, including large fractions of all the gold. A single neutron star merger can make more than one Earth mass of gold!

This discovery was only made possible by 'multi-messenger' astronomy, combining the information from gravitational waves and electromagnetic waves.

Investing in astronomy

Twenty-four countries are partnering to build the SKA in Australia and Africa, with a total investment of about $3 billion AUD (about €2 billion).

JWST has cost about $15 billion AUD to date, with investment largely from the USA, Canada and Europe.

ESO's operating budget is €240 million per annum (about $370 million AUD).

We're hosting SKA with financial support from many nations. Joining ESO will reinforce Australia's role as a trusted and equal partner in global science infrastructure investments.