Europe to the Stars (English)

1. Going south

1.

This is the story of an epic adventure.

A story of cosmic curiosity, courage and perseverance...

The story of how Europe went South to explore the stars.

2.

Welcome to ESO, the European Southern Observatory… Europe’s portal to the stars.

3.

At ESO, astronomers and engineers from sixteen countries join forces to unravel the secrets of the Universe.

How?

By building the largest telescopes on Earth.

Designing sensitive cameras and instruments.

Scrutinising the heavens.

4.

Seeing comets traversing the Solar System

stellar nurseries ...

distant galaxies at the edge of space and time ...

Giving us fresh insights and an unprecedented view of the Universe.

5.

The idea for a joint European observatory came in 1953.

Twelve astronomers from six countries gathered in the Netherlands to formulate a plan. Individually, no one European country could compete with the United States. But together, they might.

6

Nine years later, the European Southern Observatory started out with five founding member states.

They began to search for the perfect location for their observatory.

7

Despite its beauty, Europe is not a prime location for astronomy. European astronomers were hindered by light pollution and poor weather. And from Europe, only part of the sky can be seen. To fill in the gaps, you have to travel south.

8

From here, the centre of the Milky Way, our home galaxy, passes high overhead, and also the Magellanic Clouds – two small companion galaxies to the Milky Way.

Invisible from the North, but very conspicuous if you're south of the equator.

9

In 1960, the astronomers turned their attention to South America...

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In 1963, the die was cast: Chile it would be!

Six months later, Cerro La Silla, a mountain in the arid Atacama Desert, was picked as the future site of the European Southern Observatory.

11

ESO was no longer a distant dream.

Europe had embarked on a grand voyage of cosmic discovery.

12

Soon, other European countries followed and joined ESO.

2. Looking up

1.

167,000 years ago, a star exploded in a small galaxy orbiting the Milky Way.

2.

At the time of the distant explosion, Homo sapiens started to roam the African savannah.

But no one could have noticed the cosmic fireworks, as the blast of light had only just embarked on its long journey towards Earth.

3.

By the time light from the supernova had completed 98 percent of its journey, Greek philosophers had just started to think about the nature of the cosmos.

4.

Just before the light reached Earth, Galileo Galilei trained his first primitive telescopes on the heavens

5.

And on 24 February 1987, when photons from the explosion finally rained down on our planet, astronomers at La Silla were ready to observe the supernova in great detail.

6.

Supernova 1987A flared up in the southern sky – unobservable from Europe or the United States.

But by this time, ESO had already built its first big telescopes at La Silla.

A front-row seat to a cosmic spectacle!

7.

The telescope is the central tool that allows us to unravel the secrets of the Universe.

8.

Using lenses or mirrors, telescopes collect far more light than the unaided human eye, so they reveal fainter stars and let us peer deeper into space.

9.

Like magnifying glasses, they also show finer detail.

10.

And, when equipped with sensitive cameras and spectrographs, they provide us with a wealth of information about planets, stars and galaxies.

11.

ESO’s first telescopes at La Silla were a mixed bunch.

12.

They ranged from small national telescopes to large astrographs and wide-field cameras.

13.

The 3.6-metre telescope, sitting atop Cerro La Silla, was the biggest achievement of ESO’s early years.

Although built in 1976, it now leads a second life as a planet hunter.

14.

Since the discovery of the first alien world orbiting another star, planet hunters have found thousands of such exoplanets.

And these exoplanets vary in size, mass, temperature, and they have a variety of orbits.

15.

The 3.6-metre telescope hosts HARPS, one of the most efficient planet-hunting instruments. So far, it has discovered hundreds of exoplanets.

16.

Its biggest trophy so far: a rich system containing at least five and maybe as many as seven alien worlds.

17.

Finding planets around other stars is a new frontier in astronomy. Imagine if we could find a planet similar to our Earth?

18.

Another key player was the 2.2-metre telescope – although it was built in 1983, it still produces some of the most dramatic views of the cosmos.

19.

Swedish astronomers built a shiny dish fifteen metres across to study invisible microwaves from cool cosmic clouds.

20.

Together, these telescopes have helped to unveil the Universe in which we live.

3. Seeing Sharp

1.

Modern telescopes use large mirrors to collect the faint light of distant objects. Bigger is better - at least when it comes to telescope mirrors.

But larger mirrors have to be thick, so that they don’t deform under their own weight.

And really large mirrors deform anyway, no matter how thick and heavy they are.

2.

The solution? Thin, lightweight mirrors - and a magic trick called active optics.

ESO pioneered this technology in the late 1980s, with the New Technology Telescope, the NTT — a ground-breaking feat of engineering and design.

3.

NTT was the frontrunner for the Very Large Telescope, or VLT.

Built in the 1990s, the VLT is ESO’s flagship visible-light facility.

Four identical 8.2-metre telescopes, perched high on Cerro Paranal in northern Chile. In the middle of the Atacama Desert, ESO created an astronomer’s paradise.

4.

Scientists stay in La Residencia, a guest house partly buried under the dirt and rubble of one of the driest places on the planet.

But inside are lush palm trees, a swimming pool …

Of course, the unique selling point of the Very Large Telescope is not its swimming pool, but its unequalled view of the Universe.

5.

And this is the state of the art for mirror technology.

The mirrors of the Very Large Telescope – the VLT – are 8.2 metres across, but only 17 centimetres thick.

6.

And here's the magic: a computer-controlled support system ensures that the mirror keeps its desired shape at all times to nanometre precision.

7.

Without thin mirrors and active optics, the VLT would not be possible.

But there's more.

8.

Stars appear blurry, even when observed with the best and largest telescopes.

The reason? The Earth's atmosphere distorts the images.

9.

Enter the second magic trick: adaptive optics.

On Paranal, laser beams shoot out into the night sky to create light patterns in the upper atmosphere which look similar to stars. Sensors use these artificial stars to measure atmospheric distortions. And hundreds of times per second, the image is corrected by computer-controlled deformable mirrors.

10.

And the end effect? As if the turbulent atmosphere was completely removed.

Just look at the difference!

11.

Adaptive optics allows us to peer deeper into space, chasing after answers to some of the most fundamental questions of science.

12.

At the core of the Milky Way – our home galaxy – lies a mystery that ESO's Very Large Telescope helped to unravel.

13.

Massive dust clouds block our view of the Milky Way's core, 27 000 light years away.

But sensitive infrared cameras can peer through the dust and uncover what lies behind.

14.

Assisted by adaptive optics, they reveal dozens of red giant stars.

And over the years, these stars are seen to move!

They orbit an invisible object at the very centre of the Milky Way.

15.

Judging from the stellar motions, the invisible object must be extremely massive.

A monstrous black hole, weighing in at 4.3 million times the mass of our Sun.

Astronomers have even observed energetic flares from gas clouds falling into the black hole.

All exposed by the sheer power of adaptive optics.

16.

Adaptive optics also allows for sharp views of exoplanets — planets outside our own Solar System. In 2004, the VLT took the first image ever of an exoplanet.

The red dot in this image is a giant planet orbiting a brown dwarf star.

17.

A few years later, the atmosphere around another exoplanet has been analysed for the first time using the VLT. As the planet transits in front of its parent star, starlight passes through the planet's atmosphere and its chemical composition is revealed.

The findings suggest that the atmosphere might consist of water in the form of steam. Is there water, the foundation of life, on a distant world?

18.

In 2011, two independent research teams were awarded with the Nobel Prize in Physics. Their work has been based on observations with ESO telescopes. They showed that the expansion of the Universe is accelerating due to huge amounts of dark energy. But we still have no clue what this might be...

19.

So thin mirrors and active optics make it possible to build giant telescopes.

And the adaptive optics take care of the atmospheric turbulence, providing us with extremely sharp images.

But we're not done yet with our magic tricks. There's a third one. And it's called interferometry.

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By combining the light the VLT telescopes each collect, they can act as a virtual telescope measuring 130 metres across!

21.

This technique, known as interferometry, gives us the eagle-eyed vision of an imaginary telescope as large as fifty tennis courts.

22.

Optical interferometry is something of a miracle.

Starlight magic, wielded in the desert!

And the results are exciting.

23.

The Very Large Telescope Interferometer reveals fifty times more detail than the Earth-orbiting Hubble Space Telescope, and it has shown us some incredible things in the Universe around us...

24.

For instance, it gave us a close-ups of vampire double stars — stars stealing material from each other.

25.

Irregular puffs of stardust have been detected around Betelgeuse — a stellar giant about to go supernova.

26.

And in dusty discs surrounding newborn stars, astronomers have found ... the raw material of future Earth-like worlds.

27.

The Very Large Telescope is mankind’s sharpest eye on the sky.

28.

The VLT has dramatically changed our view on the world we live in -- and posed millions of new questions left to be answered.

4. Changing Views

2.

Many of us enjoy listening to music in our daily lives.

3.

But suppose you had a hearing impairment.

What if you couldn’t hear the low frequencies?

Or the high frequencies?

4.

Astronomers used to be in a similar situation.

The human eye is only sensitive to a very small fraction of all the radiation in the Universe.

5.

We just don’t perceive the whole cosmic symphony.

6.

In a dark room, you can’t see anything. But put on infrared goggles, and you can “see” body heat.

7.

Likewise, infrared telescopes reveal cosmic objects too cool to give off visible light, like dark clouds of gas and dust where stars and planets are born.

For decades, ESO astronomers were keen to explore the Universe at infrared wavelengths.

8.

But today, telescopes like the VLT can reveal more of the Universe than we can see with our eyes. It can see the sky using infrared light — like seeing body heat in a dark room.

9.

This dark blob is a cloud of cosmic dust. It blots out the stars in the background.

9b.

But in the infrared, we can look straight through the dust.

10.

And here’s the Orion Nebula, a stellar nursery. Most of the newborn baby stars are hidden by dust clouds. Again, infrared comes to the rescue, revealing stars in the making!

11.

Don’t forget the stars and gas clouds captured by the monstrous black hole in the core of our Milky Way galaxy.

Without infrared cameras we would never see them.

12.

Close to Paranal is a small mountain peak with an isolated building on top.

13.

Inside this building is the 4.1- metre VISTA telescope.

Unlike the VLT, VISTA only observes infrared. It uses a giant camera, weighing as much as a pickup truck, to give us incredible vistas of the infrared cosmos.

14.

ESO has been doing optical astronomy since its birth over fifty years ago. And infrared astronomy for over thirty years.

But there are more registers to the cosmic symphony.

15.

Five thousand metres above sea level, high in the Chilean Andes, is the Chajnantor plateau.

Astronomy doesn’t go higher than this. This site is so hostile, it’s even hard to breathe!

16.

ALMA is the world’s largest astronomical project and could only come to fruition in a global partnership between ESO, North America, and East Asia, in cooperation with Chile .

17.

But it is not a conventional telescope. It is an array of 66 state-of-the-art-antennas.

18.

Instead of collecting and analysing visible light, it looks at a different and largely unmapped part of the spectrum.

Millimetre and submillimetre waves from space. Light reaching us from some of the coldest and most distant objects in the Universe.

19.

ALMA is in search of answers to some of the deepest questions about our cosmic origins.

How do stars and planets form? How did the first galaxies form?

20.

ALMA is producing amazing results.

It can show us how planetary systems form and evolve.

21.

Take this view of the Antennae Galaxies, a pair of colliding galaxies with extremely distorted shapes.

The visible light shows us where the stars are, but ALMA now reveals the clouds of cold, dense gas out of which new stars are born in dramatic galactic mergers.

24.

By changing the way we look, we’re closing in on the origins of planets, stars and galaxies.

25.

On the full symphony of the cosmos!

5. Finding Life

1.

The Universe is full of deep mysteries, hidden secrets, and staggering beauty.

2.

Astronomy is big science.

And it’s a science of big mysteries.

3.

Is there life beyond Earth?

What is the origin of the Universe?

4.

ESO’s new monster telescope will help in our quest to understand.

That mountain down there is Cerro Armazones.

5.

Not far from Paranal, it will be home to the largest telescope in the history of mankind.

The Extremely Large Telescope, or ELT.

6.

Sporting a mirror almost forty metres across, the ELT simply dwarfs every telescope that preceded it.

Almost eight hundred computer-controlled mirror segments.

The world’s biggest eye on the sky.

7.

When it first blinks up at the sky in 2024, the ELT will tackle some of the biggest scientific challenges of our time and piece together a more complete picture of our Universe.

It will track down Earth-like planets around other stars, perhaps finding life.

8.

It will explore individual stars in nearby galaxies.

It will probe the 95% of the Universe that we currently can’t see — a mysterious, invisible substance called dark matter and the elusive dark energy that repels gravity.

9.

Working as a cosmic time machine, the giant telescope will let us look back billions of years, to learn how everything began.

Again Europe breaks the frontiers of astrophysics to venture into the unknown!