Astronomers set sights on Earth-like planets and the first starlight

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Astronomers from across Europe today took a step closer to making their plans for a giant telescope a reality when they unveiled the scientific case for an Extremely Large Telescope (ELT) â€“ a monster telescope with a light capturing mirror of between 50 and 100 metres, dwarfing all previous optical telescope facilities.

The announcement was made at a meeting in Dwingeloo, the Netherlands and initiates the design phase of the project. Astronomers plan to use the ELT to search for planets like the Earth in other star systems and to find out when the first stars in the Universe began to shine.

The first step when selecting the specifications and design options for a new telescope is for astronomers to establish the science that could be achieved with the facility. The science case launched today will be used in a Design Study funded by the European Unionâ€™s Framework 6 Programme and a Europe-wide consortium of partners, including industry, aimed at evaluating critical technologies needed to build a giant telescope, and led by the European Southern Observatory (ESO). The UK part of this â‚¬30M programme is led by the UK Astronomy Technology Centre (UK ATC) and partly funded by the Particle Physics and Astronomy Research Council (PPARC).

Roberto Gilmozzi, ESOâ€™s coordinator of the ELT Design Study said, "The ELT Design Study initiative, a 31 MEuro activity partially funded by the FP6, shows the willingness of Europe to pursue a common path towards the eventual construction of an ELT. It is a design independent study of enabling technologies that brings together European institutes and industry to define a palette of ELT "building blocks" that indicate the way in which the telescope design should evolve to take advantage of the directions industry believes are most appropriate and cost effective.â€?

Bigger is better

The power of optical telescopes is limited by the size of the mirror that is used to collect light, which in turn determines how well they can distinguish between faint objects â€“ the bigger the mirror, the fainter the object that the telescope will be able to see. For example, a 100m telescope with perfect compensation for atmospheric disturbances would be able to separate two points on the moon two metres apart, compared with 95m apart for the Hubble Space Telescope.

The quest for bigger mirrors has pushed current technologies to their limits. Some of the most advanced 8-10 metre telescopes now rely on mirrors constructed from smaller mirror segments, controlled by computers to act as a single large surface. These new techniques offer astronomers the opportunity for an unprecedented step-up in size. A 100m telescope would use a greater area of precision mirrors than has been made for all the previous telescopes ever built!

Dr Isobel Hook from the University of Oxford has led the working group producing the science case. She says â€œAn Extremely Large Telescope is a very exciting prospect for astronomers. Something with a 50 or even 100 metre mirror could completely change our understanding of the Universe and answer truly fundamental questions such as â€˜Is the Earth unique?â€™ and â€˜How did the first stars and galaxies form?â€™. We will have much more information than ever before â€“ it will be a bit like being there when the first telescopes were pointed at the sky.â€?

The next step

The European ELT Design Study is a five year project to explore the challenges of building an ELT, with most of the work being done in the initial three years. Every aspect of the ELT project will be examined, from site selection to instrumentation. It is due to report in 2008 at which time it will present a range of options to funding agencies.

The design study will provide the crucial technical information needed to make tough decisions at the next stage. This will involve balancing the size and design of the telescope against cost and time of first operation. Building work is likely to start in the next decade and the telescope could start scientific operations from 2015!

Professor Gerry Gilmore of the Institute of Astronomy Cambridge and Chair of the EU OPTICON network, said â€œDevelopment of the ELT science case has involved over 100 European astronomers, and 3 years of work. All this happened because the astronomers want it: an ELT is overwhelmingly the scientifically favoured next major astronomy development, with widespread and strong community support. Turning this bottom-up support into a science case and a design study proposal needed some resources, and a trans-national support structure, both naturally available and provided by the EC-funded OPTICON infrastructure network. This proves that European astronomers are becoming a single community, and as such are now international leaders in astronomy.â€?

PPARC, the UK funding agency for astronomy, has earmarked Â£2million for research and development of an ELT for the period to April 2008. Â£500,000 of this is to support the design study concentrating on UK strengths in instrumentation and adaptive optics led by the UK ATC, in partnership with Durham and Oxford Universities. The remainder of the programme is under evaluation, but will concentrate on key technologies such as lightweight and adaptive mirrors to enable the science goals to be met at an affordable cost.

Colin Cunningham, Director of Technology Development at the UK ATC says â€œA telescope of 50 to 100m in diameter will have outstanding sensitivity and resolution â€“but to reach this performance at an affordable cost requires us to address many engineering and technology challenges. The UK will be at the heart of these efforts through its part in the EU-supported ELT Design Study and our UK R&D programme which will bring together academic and industrial partners in preparation for the design and construction phase of this exciting project.â€?

Is the Earth unique?

The first planets outside the Solar System were only detected ten years ago, using indirect methods of observation. Using an ELT, astronomers believe that not only will they be able to directly detect the light from extra-solar planets, but that they will be able to identify planets like the Earth which have a parent star similar to the Sun and are in an orbit within the â€˜habitable zoneâ€™ (or â€˜goldilocks zoneâ€™ - not too hot and not too coldâ€¦) where life as we know it could comfortably exist. They will then be able to analyse the atmosphere of these planets for signs of life, called biomarkers, such as water and oxygen features that would suggest vegetation.

How did the various types of galaxies form?

Galaxies come in a variety of shapes and sizes, believed to reflect the differing ways they form. To understand the evolution of a galaxy,

astronomers need to be able to study the individual stars it is formed from, comparing their ages and composition.
Our own Milky Way galaxy and its nearest neighbours represent only a small fraction of the diverse range of galaxy types seen throughout the Universeâ€“ to understand further away or denser galaxies, such as giant elliptical galaxies, astronomers will require an ELT.

When did stars first start to shine?

At the moment astronomers cannot look far enough back in time to see the first stars. Since light takes time to travel through space towards Earth, the further away astronomers look, the further back in time the light was emitted. While the first stars will not be visible even to an ELT, the most extreme supernovae of these stars may just be. Since all massive stars explode as supernovae, counting supernovae counts massive stars, from which astronomers can deduce the total number of stars forming as a function of time, the star formation history of the universe. Supernovae are also used as standard candles to help measure the size of the Universe. ELTs will study supernovae to much larger distances (corresponding to earlier times) than currently possible. This is vital to our understanding of the mysterious 'dark energy' that seems to make up most of the Universe.

Source: PPARC

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