

BBC

SHOULD YOU UPGRADE YOUR BRAIN?

Science Focus

IF YOU DON'T READ THIS, YOU'LL BE GUTTED

Could we divert an
EARTH-BOUND ASTEROID?

Big ideas for
GREENER, FASTER TRANSPORT

The way to
SAVE OUR WILD BEES

EAT YOURSELF HAPPY

**How the microbes in your gut hold the
key to health and happiness**
(and what you can do to nourish them)



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Amazon on fire

Could the world's biggest
rainforest become a desert?

Space atlas

The telescope that will
map the Milky Way

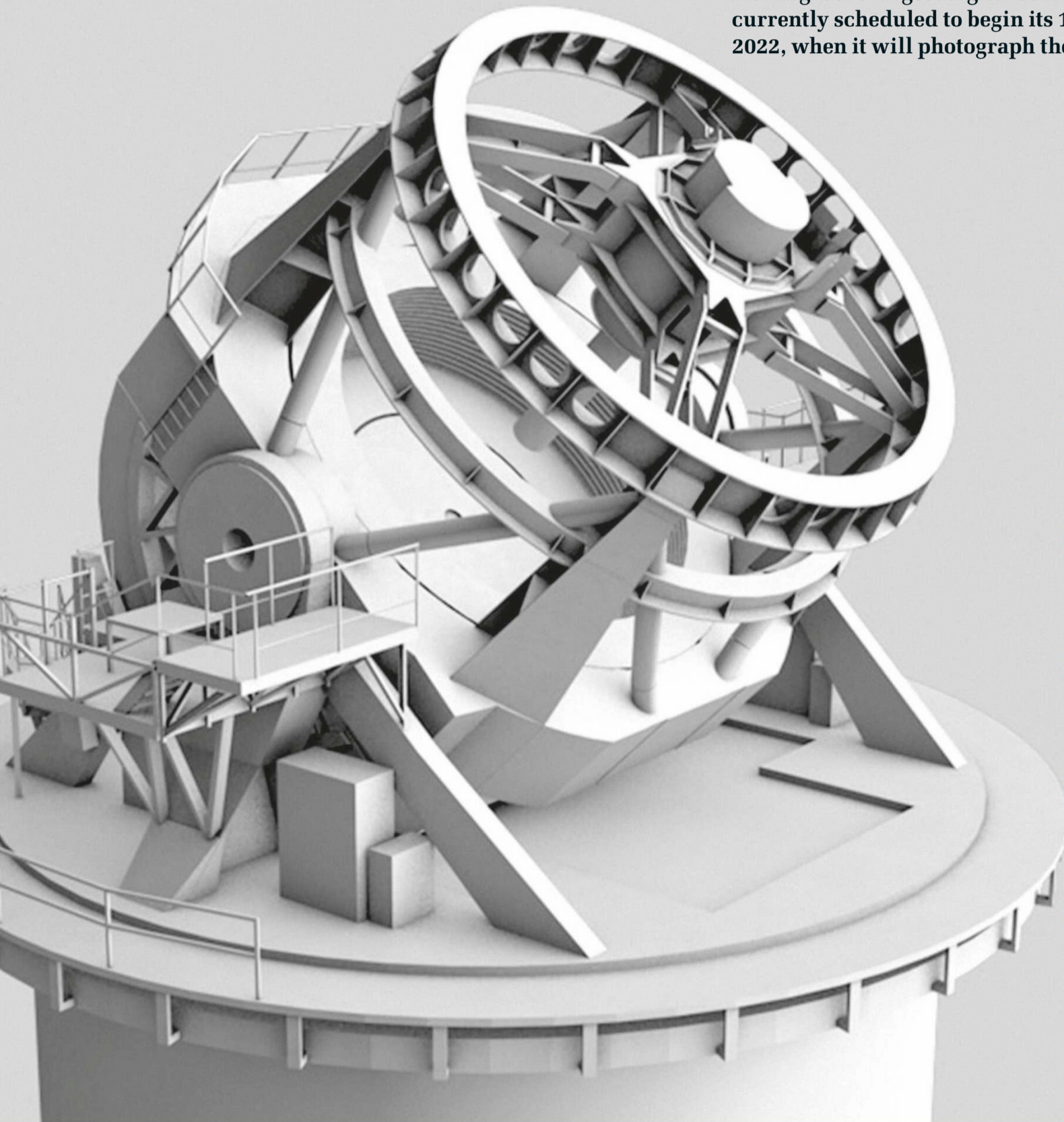
Heart repair

New technique fixes
damage after heart attack

Data crunch

ASTRONOMY'S BIG PICTURE

At the summit of Cerro Pachón mountain in northern Chile, work is underway to build what will be one of the biggest optical telescopes ever created – the Large Synoptic Survey Telescope. After 16 years' of planning, scientists at Brookhaven National Laboratory recently completed the telescope's 3.2 gigapixel sensor array, effectively making it the largest digital camera ever built. The telescope is currently scheduled to begin its 10-year survey in January 2022, when it will photograph the entire sky every few nights.



LSST in numbers

THIS TELESCOPE WILL PRODUCE THE DEEPEST, WIDEST IMAGES OF THE UNIVERSE TO DATE

- 8.3** The size of LSST's mirror (in metres); the width of a singles tennis court
- 3,200** The number of megapixels in its digital camera, the largest ever created
- 37bn** The number of stars and galaxies that will be studied during the project
- 10yrs** The duration of the LSST's operational period, concluding in around 2033
- 10m** The rough number of alerts each night showing astronomical changes
- 20TB** The colossal amount of data generated by the LSST over a single night

INFOGRAPHIC BY JAMES ROUND

Objectives

Cataloguing the Solar System

The LSST is the latest in a long line of efforts to catalogue the Solar System, starting with Persian astronomer Abd al-Rahman al-Sufi's *Book Of Fixed Stars*, which was written in 964 AD. The LSST is one of the biggest optical telescopes ever created and imaging the night sky in order to catalogue it will take up 90 per cent of the telescope's time.

Exploring the changing sky

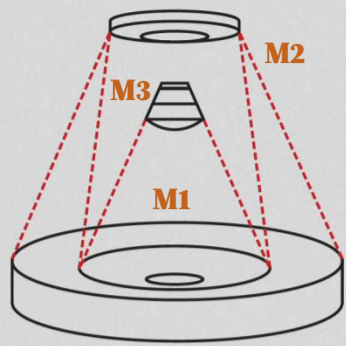
As it will be producing 200,000 images a year, taken at set locations at different times, the LSST is ideally placed to spot 'transient' phenomena such as supernovae and gamma-ray bursts. Boasting far greater image resolution than other telescopes, it is also expected to identify thousands of new objects in the Kuiper Belt beyond Neptune.

Milky Way formation

Because the LSST will produce clear images of more, smaller objects than ever before, it will help scientists produce the most complete 3D map of the Milky Way to date. This will shed new light on how the Milky Way was formed – which, as the Milky Way is a fairly typical spiral galaxy, will teach us more about galaxy formation generally.

Dark matter and dark energy

By mapping galaxies through time and space, while cataloguing their masses, it is hoped the LSST will be able to provide more clues as to the nature of the mysterious dark matter and dark energy. Scientists hope, in particular, to learn more about how dark matter affects the shape of galaxies when they first begin to form.



Anatomy

Mirrors

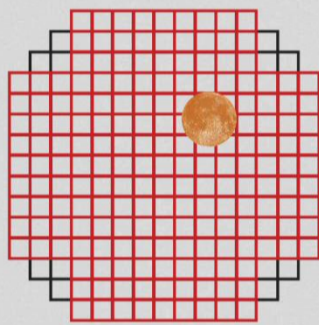
The Large Synoptic Survey Telescope uses a three-mirror system, based on a type of telescope known as a 'Paul-Baker three-mirror anastigmat'. Three-mirror telescopes aren't subject to as much visual distortion as one- and two-mirror 'scopes. In the case of the LSST, mirrors 1 and 3 are actually made from a single piece of glass, which reduces the telescope's overall length.

Field of view

The LSST will be able to provide sharp images of an area of sky measuring 3.5° across. For comparison the Sun and Moon each measure roughly 0.5° across as seen from Earth, while the field of view of a typical domestic telescope, as used by amateur astronomers to observe the night sky, is less than 1°. By providing high-quality images with such a broad field of view, the LSST will enable astronomers to piece together a more complete picture of the stars above than ever before.

Camera

The LSST will capture around 200,000 images of the sky every year. It will do this using a 3.2-gigapixel camera that captures a 15-second exposure every 20 seconds. The camera, which is believed to feature the biggest sensor ever built, is being constructed by the SLAC National Accelerator Laboratory, who will make use of the LSST as part of their hunt for dark matter.



Other large telescopes



Extremely Large Telescope CHILE / OPERATIONAL 2025

This five-mirror anastigmat, operated by the European Southern Observatory and located in Chile's Atacama desert, will be the largest optical/infrared 'scope in the world, boasting a 39.3m primary mirror. measures a whopping 393m across.



500m Aperture Spherical Telescope CHINA / OPERATIONAL 2016

Known as FAST for short, this radio telescope sits in a natural basin and has a dish antenna measuring 500m across, making it the largest filled-aperture radio telescope in the world.



SALT SOUTH AFRICA / OPERATIONAL 2005

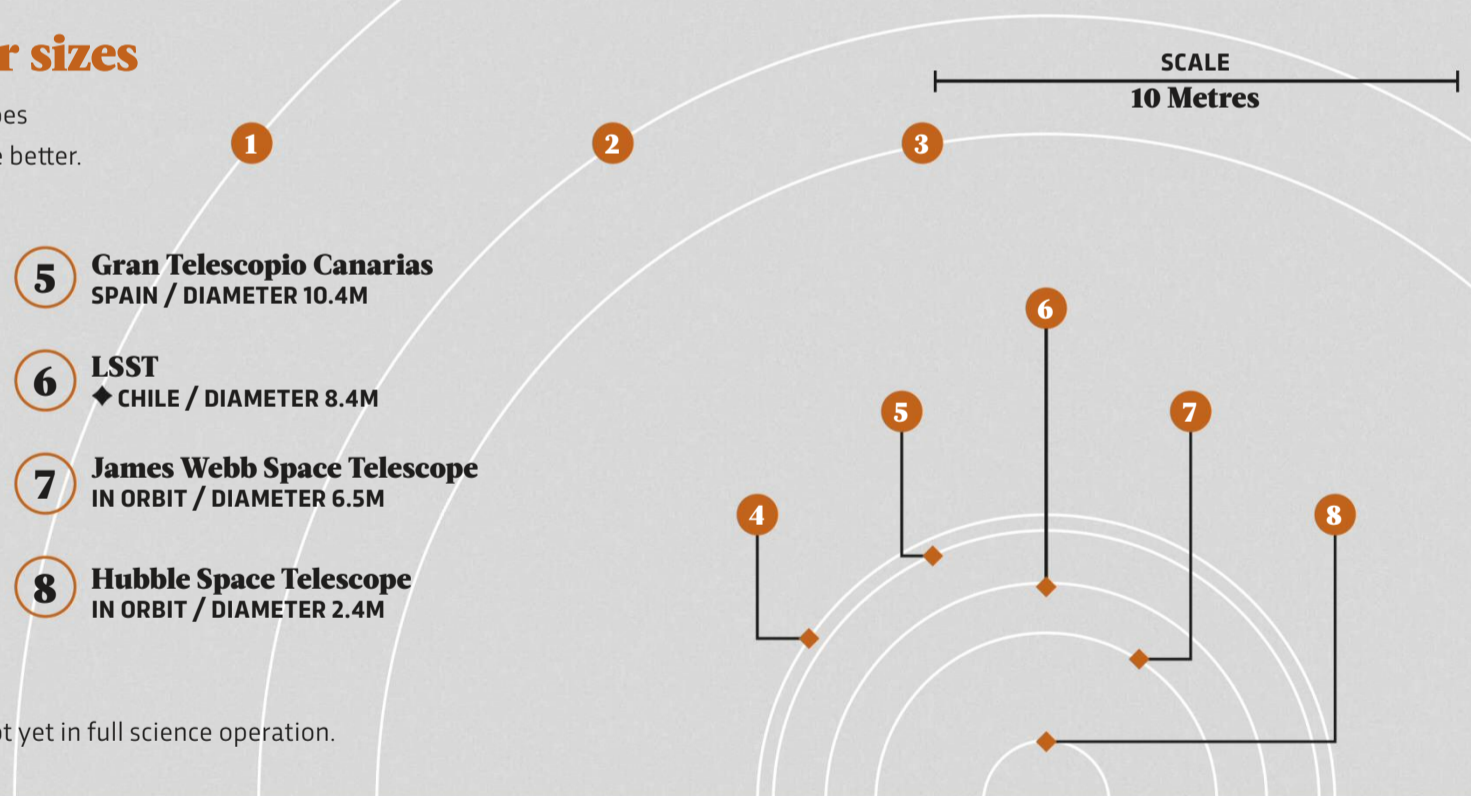
This 11m optical telescope has a primary made up of 91 hexagonal segments, each with a diameter of 1m. It is located inside a nature reservation, some 270km (230 miles) northeast of Cape Town.

Comparison of sensor sizes

When it comes to telescopes, size really does matter – the bigger the primary mirror, the better.

- | | |
|--|--|
| <p>1 Extremely Large Telescope
◆ CHILE / DIAMETER 39.3M</p> <p>2 Thirty Meter Telescope
◆ HAWAII / DIAMETER 30M</p> <p>3 Giant Magellan Telescope
◆ CHILE / DIAMETER 25.4M</p> <p>4 SALT
◆ SOUTH AFRICA / DIAMETER 11M</p> | <p>5 Gran Telescopio Canarias
SPAIN / DIAMETER 10.4M</p> <p>6 LSST
◆ CHILE / DIAMETER 8.4M</p> <p>7 James Webb Space Telescope
IN ORBIT / DIAMETER 6.5M</p> <p>8 Hubble Space Telescope
IN ORBIT / DIAMETER 2.4M</p> |
|--|--|

◆ Symbol denotes that the telescope is not yet in full science operation.



Timeline

