

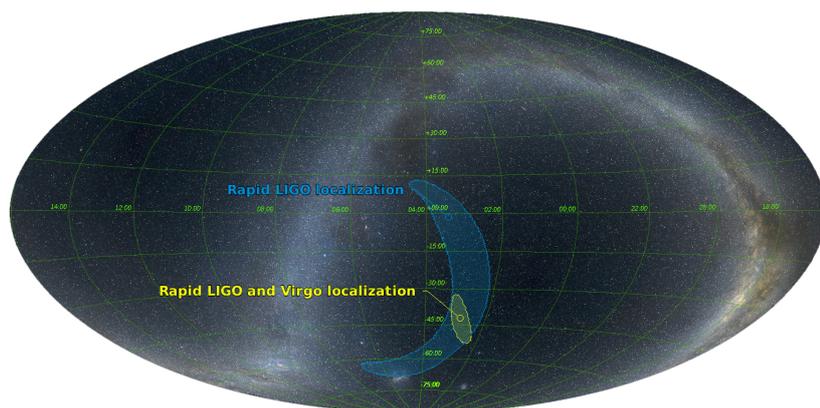


INSTITUTE OF ASTRONOMY PUBLIC OPEN EVENING

— 4 OCTOBER 2017 —



New detection of gravitational waves from merging black holes



Estimated location of the black hole merger as detected with LIGO and *Virgo*. *Credit: Virgo*

FOR the first time, three separate detectors have jointly tracked the gravitational waves emitted by a merger of two black holes – critically enabling scientists to locate its origin on the sky with previously unmatched precision.

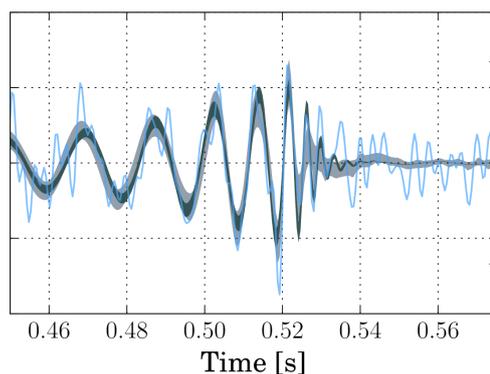
Gravitational waves are ripples in space and time created when two massive, compact objects – such as black holes – merge. They were detected for the first time last year using the LIGO observatories in the USA. The latest detection on August 14, 2017 is only the fourth one ever made, and was seen not only by the two LIGO detectors, but by *Virgo* in Europe. Three observations made with widely-spaced detectors allow a kind of triangulation and the opportunity to pin down the location of the black

hole merger on the sky much more closely than before. This is especially important because one day scientists hope to simultaneously observe the source of the gravitational waves with conventional means (i.e. using light) in order to learn even more about what causes the gravitational waves.

The detected gravitational waves were emitted during the final moments of the merger of two black holes with masses about 31 and 25 times the mass of the Sun and located about 1.8 billion light-years away. The newly produced spinning black hole has about 53 times the mass of our Sun, which means that about 3 solar masses were converted into energy in the form of gravitational waves radiated away during the black hole coalescence.

The signal measured by the LIGO Livingston observatory as a function of time. The increasing frequency is the characteristic “chirp” pattern created by the merging of two black holes. The peak occurs at different times in different detectors because the gravitational waves will take longer to reach a detector if it’s further away. This enables a form of triangulation.

Credit: LIGO/Virgo



TONIGHT'S SPEAKER



Matt Bothwell

A Beginner's guide to the Big Bang

Our weekly welcome

A very warm welcome to everyone at the first of our weekly public open evenings for the 2017/18 season. Each night there will be a half-hour talk beginning promptly at 7.15pm: tonight we are delighted to have **Matt Bothwell** giving us **A Beginner's guide to the Big Bang**, which seems an excellent way to start off the term!

The talk is followed by an opportunity to observe if (and only if...) the weather is clear. The **Cambridge Astronomical Association** will provide a floorshow outdoors on the Observatory lawns, relaying live images from modern telescopes with a commentary. The IoA's historical Northumberland and Thorrowgood telescopes will be open for unaided eye observations, along with the 16-inch telescope. If we're unlucky and it's cloudy, we'll offer you a cup of tea as compensation after the talk, with perhaps some more astro-information in the lecture theatre for those who want to stay on.

If you have any questions, suggestions or comments about the IoA Open Evenings please contact **Carolyn Crawford** at csc@ast.cam.ac.uk. We tweet current astro-news and events as [@cambridge_astro](https://twitter.com/cambridge_astro)

www.ast.cam.ac.uk/public

The talk schedule for this term can be viewed at: www.ast.cam.ac.uk/public/public_observing/current

Searching for distant worlds with a flying telescope



SOFIA on board the Boeing 747
Credit: NASA/USRA

RESEARCHERS have successfully detected a planet using a telescope flying on board a jumbo jet! The observations were made with SOFIA (Stratospheric Observatory for Infrared Astronomy), a 2.5-metre telescope built into a modified Boeing 747-SP which flies slightly higher than commercial aeroplanes.

But why observe with a telescope on board an aeroplane instead of one on the ground? By transporting a telescope high up into the sky, the light that reaches the observatory doesn't have to pass through so much of the Earth's atmosphere, where water vapour readily absorbs infrared light. This is especially important for observations taken when a planet passes in front of its host star, causing a kind of

mini-eclipse known as a transit. This is how SOFIA was used to detect the extrasolar Planet GJ 1214b.

Some of the starlight detected has also passed through the planet's atmosphere, where it is imprinted with information about its characteristics, such as its composition, pressure and temperature, which is expected to be around 2000 degrees!

The big question is whether these observations will reveal whether GJ 1214b is more of a large rocky planet (a 'super-Earth') or a 'mini-Neptune' made of gas or ice. Most importantly, SOFIA has proven that it is well suited to the observation of planets outside the solar system.

Solar eclipse in the US



The crescent sun as seen through a straw sun hat
Credit: C. Crawford, IOA

ON August 21, 2017, lucky observers across a vast swathe of the United States had the opportunity to observe a total solar eclipse.

During a solar eclipse, the Moon casts its shadow onto the Earth as it passes between the Earth and the Sun, blocking the sunlight. The event in August this year was a total eclipse, where the disc of the Sun is fully obscured by the Moon at the maximum of the eclipse. Shortly before this, the Sun will become crescent as it is more and more occulted and is eventually completely obscured.

The reason why there isn't a total solar eclipse every month is that the Moon's orbit is tilted by a few degrees with respect to the orbit of the Earth around the Sun – so its shadow usually travels above or below the Earth's precise location.

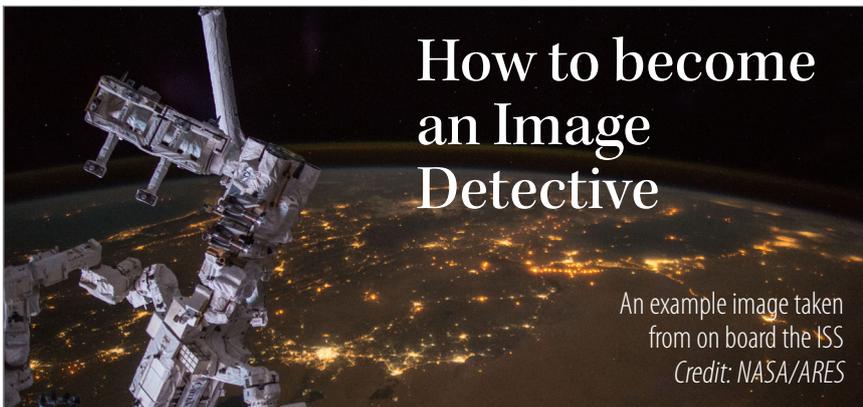
You should never look at the Sun with unprotected eyes, even during an eclipse. But even if dedicated eclipse glasses are not to hand, there are other ingenious ways to project the image of the Sun – our picture above shows how the holes in a sun hat can act as pinhole cameras to produce multiple images of the crescent Sun.

Unfortunately you're going to have a long wait to see the next total solar eclipse visible from the UK, as it's not until 2090. If you can't wait that long then you'll just have to make the effort to travel to South America in either July 2019 or December 2020.

Joke of the Week

I'm reading a book about anti-gravity. It's impossible to put down.

How to become an Image Detective



An example image taken from on board the ISS
Credit: NASA/ARES

IF YOU have always wanted to browse through an astronaut's photo album, here's your chance!

CosmoQuest's Image Detective is a NASA-funded citizen science project which invites the public to identify Earth features in photographs taken by astronauts from the International Space Station (ISS). Members of the general public are being asked to help identify geographic features (natural or human-made) in astronaut photo-

graphs and determine their location on Earth. This is especially important in order that these images can be used to monitor changes on the Earth (such as erupting volcanoes, seasonal flooding etc.). To correctly label and analyse the 1.5 million plus photos, the scientists need your help!

You can become an Image Detective and explore NASA's database of images taken by ISS astronauts by visiting cosmoquest.org/ImageDetective