

Through the Frontiers Science and Technology

To Obtain a picture of a 'Black Hole'



Scientists are building a Earth-sized "Virtual Telescope" by linking a large array of radio receivers - from the South Pole, to Hawaii, to the Americas and Europe with the hope of obtaining the first ever picture of a black hole. In the sights of the so-called "Event Horizon Telescope" will be the monster black hole at the centre of our galaxy.

Although never seen directly, this object, catalogued as Sagittarius A*, has been determined to exist from the way it influences the orbits of nearby stars. These race around a point in space at many thousands of km per second, suggesting the hole likely has a mass of about four million times that of the Sun. But as colossal as that sounds, the "edge" of the black hole - the horizon inside which an immense gravity field traps all light - may be no more than 20 million km or so across. And at a distance of 26,000 light-

years from Earth, this makes Sagittarius A* a tiny pinprick on the sky.

There is optimism that observations to be conducted during 5-14 April could finally deliver the long-sought prize. The Event Horizon Telescope (EHT) team is nonetheless hopeful.

The EHT's trick is a technique called very long baseline array interferometry (VLBI).

This combines a network of widely spaced radio antennas to mimic a telescope aperture that can produce the resolution necessary to perceive a pinprick on the sky.

The EHT is aiming initially to get down to 50 microarcseconds. Team-members talk in analogies, describing the sharpness of vision as being the equivalent of seeing something the size of a grapefruit on the surface of the Moon. They emphasise the still complex years of work ahead, but

also trail the prospect of an imminent breakthrough.

The scientists certainly have an expectation of what they ought to see, if successful.

Simulations rooted in Einstein's equations predict a bright ring of light fringing a dark feature. The light would be the emission coming from gas and dust accelerated to high speed and torn apart just before disappearing into the hole. The dark feature would be the shadow the hole casts on this maelstrom.

Over the years, more and more radio astronomy facilities have joined the project. A key recent addition is the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile.

Its extraordinary state-of-the-art technology has at a stroke increased the EHT's sensitivity by a factor of 10. Hence, the optimism ahead of April.

Even so, scientists have had to install special equipment at all the radio facilities involved in the observations. This includes big hard drives to store colossal volumes of data, and atomic clocks to precisely timestamp it all.

Nothing happens on the spot - the hard drives must first be flown to a large computing facility at MIT Haystack Observatory in Westford, just outside Boston, Massachusetts.

"Our hard-drive modules hold the capacity of about 100 standard laptops," said Haystack's Vincent Fish.

"We have multiple modules at each telescope and we have numerous telescopes in the array. So, ultimately, we're talking about 10,000 laptops of data."

Looking to the future, the scientists are already thinking about how to extend their techniques. For example, the matter closest to the event horizon and about to disappear into Sagittarius A* should take about 30 minutes to complete an orbit.

Katie Bouman, from MIT's Computer Science and Artificial Intelligence Laboratory, thinks it might be possible to capture this movement.

First and foremost, the team needs good weather at the participating observing stations in April.

The strategy is to view the galactic centre at a wavelength of 1.3mm (230GHz). This has the best chance of piercing any obscuring gas and dust in the vicinity of the black hole. But if there is too much water vapour above the array's receivers, the EHT will struggle even to see through Earth's atmosphere.

Just getting a resolved view of Sagittarius A* would be a remarkable triumph in itself. But the real objective here is to use the imaging capability to go test aspects of general relativity.

If there are flaws to be found in Einstein's ideas - and scientists suspects there are more complete explanations of gravity out there waiting to be discovered - then it is in the extreme environment of black holes that limitations should be exposed.

Australian 'Angry Summer'

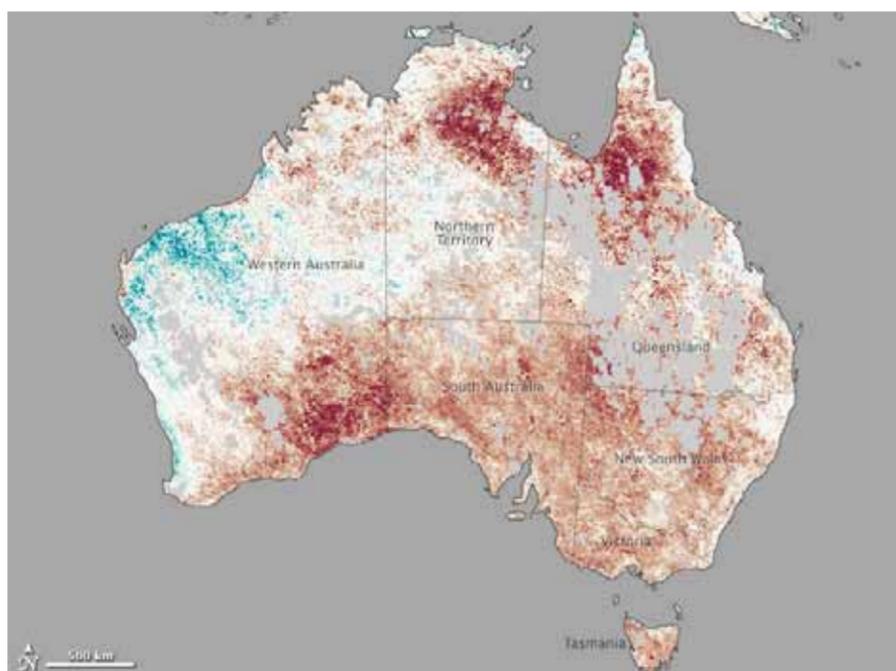
The Climate Council which was formed in 2013, after Australia abolished the Climate Commission, reported that More than 200 weather records were broken during Australia's most recent summer.

The Climate Council report, titled "Angry Summer", said the season was defined by intense heatwaves and bushfires in eastern Australia but heavy rain and flooding in the west.

The report showed that climate change was being felt across Australia. The report also warned that electricity networks were likely to be strained by increased demand in the future.

Some of the key records of this summer were;

- Hottest summer on record for Sydney, Brisbane and Canberra
- Moree, a town in New South Wales, experienced 54 consecutive days above 35°C
- Adelaide endured its hottest Christmas Day in 70 years (41.3°C)
- Perth had its highest summer rainfall on record (192.8mm; 7.6in)



- News South Wales temperatures were 2.57C above average, a summer record

At least 205 records were broken over the three-month period, the Climate Council said.

Lead author Will Steffen, a climate scientist, said the extreme weather was driven by climate change.

"We're experiencing unprecedented extreme heat and setting new records at an alarming rate, with every part of Australia feeling the impact," he said.

"Extreme weather will continue to intensify through this century if we continue to sit on our hands and fail to

move rapidly to get fossil fuels out of our economy."

The authors said Australia's "ageing, inefficient and polluting" energy system would come under more pressure from extreme weather.

Based on reports from Journals Nature, The economist, Scientific American and BBC
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