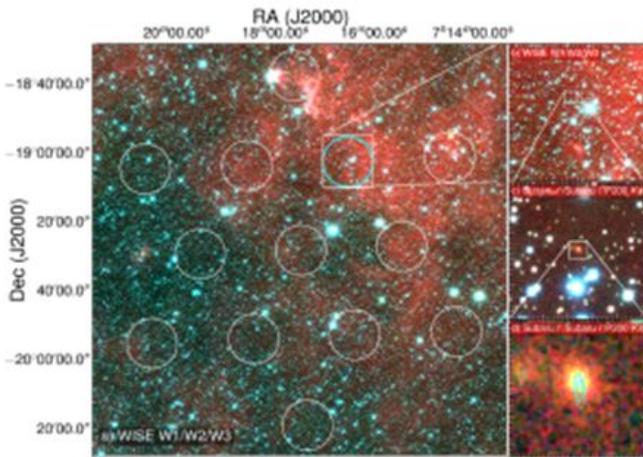


New fast radio burst discovery finds 'missing matter' in the universe

24 February 2016



This image shows the field of view of the Parkes radio telescope on the left. On the right are successive zoom-ins in on the area where the signal came from (cyan circular region). The image at the bottom right shows the Subaru image of the FRB galaxy, with the superimposed elliptical regions showing the location of the fading 6-day afterglow seen with ATCA. Image Credit: D. Kaplan (UWM), E. F. Keane (SKAO).

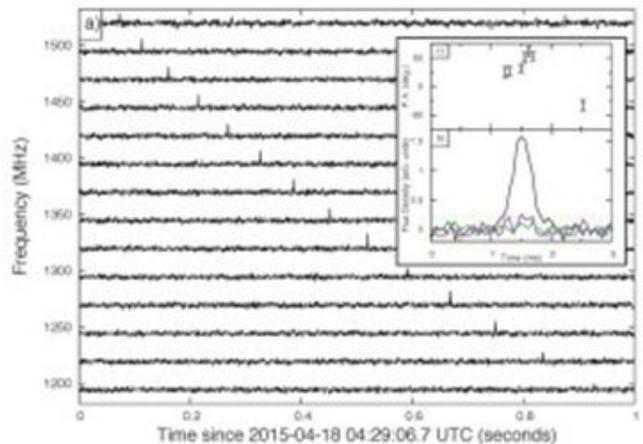
An international team of scientists using a combination of radio and optical telescopes has for the first time managed to identify the location of a fast radio burst, allowing them to confirm the current cosmological model of the distribution of matter in the universe.

On April 18, 2015, a fast radio burst (FRB) was detected by the Commonwealth Scientific and Industrial Research Organisation (CSIRO)'s 64-m Parkes radio telescope in Australia. An international alert was triggered to follow it up with other telescopes and within a few hours, a number of telescopes around the world were looking for the signal, including CSIRO's Australian Telescope Compact Array (ATCA).

FRBs are mysterious bright radio flashes generally

lasting only a few milliseconds. Their origin is still unknown, with a long list of potential phenomena associated with them. FRBs are very difficult to detect; before this discovery only 16 had been detected.

"In the past FRBs have been found by sifting through data months or even years later. By that time it is too late to do follow up observations." says Dr Evan Keane, Project Scientist at the Square Kilometre Array Organisation and the lead scientist behind the study. To remedy this, the team developed their own observing system to detect FRBs within seconds, and to immediately alert other telescopes, when there is still time to search for more evidence in the aftermath of the initial flash.



This image shows the increased delay in the arrival time of the Fast Radio Burst as a function of the frequency. The delay in the signal is caused by the material it goes through between its point of origin and Earth. Image Credit: E. F. Keane (SKAO).

Thanks to the ATCA's six 22-m dishes and their

combined resolution, the team was able to pinpoint the location of the signal with much greater accuracy than has been possible in the past and detected a radio afterglow that lasted for around 6 days before fading away. This afterglow enabled them to pinpoint the location of the FRB about 1000 times more precisely than for previous events.

"The key to this project was the rapid localisation of the FRB and identifying the host galaxy" said Benjamin Stappers, Professor of Astrophysics at The University of Manchester. "Discovering more FRBs will allow us to do even more detailed studies of the missing matter and perhaps even study [dark energy](#). To do this, we are starting projects with arrays of telescopes like eMerlin and MeerKAT, which will allow us to have a localisation directly from the burst itself."

The team then used the National Astronomical Observatory of Japan (NAOJ)'s 8.2-m Subaru optical telescope in Hawaii to look at where the signal came from, and identified an elliptical galaxy some 6 billion light years away. "It's the first time we've been able to identify the [host galaxy](#) of an FRB" added Dr Keane. The optical observation also gave them the redshift measurement (the speed at which the galaxy is moving away from us due to the accelerated expansion of the universe), the first time a distance has been determined for an FRB.

FRBs show a frequency-dependent dispersion, a delay in the radio signal caused by how much material it has gone through. "Until now, the dispersion measure is all we had. By also having a distance we can now measure how dense the material is between the point of origin and Earth, and compare that with the current model of the distribution of matter in the universe" explains Dr Simon Johnston, co-author of the study, from CSIRO's Astronomy and Space Science division. "Essentially this lets us weigh the universe, or at least the normal matter it contains."

In the current model, the universe is believed to be made of 70% dark energy, 25% dark matter and 5% 'ordinary' matter, the matter that makes everything we see. However, through observations of stars, galaxies and hydrogen, astronomers have only been able to account for about half of the

ordinary matter, the rest could not be seen directly and so has been referred to as 'missing'.

"The good news is our observations and the model match, we have found the missing matter" explained Dr Keane. "It's the first time a fast radio burst has been used to conduct a cosmological measurement."

Looking forward, the Square Kilometre Array, with its extreme sensitivity, resolution and wide field of view is expected to be able to detect hundreds of FRBs and to pinpoint their host galaxies. A much larger sample will enable precision measurements of cosmological parameters such as the distribution of [matter](#) in the universe, and provide a refined understanding of dark energy.

The study is published today in *Nature*.

More information: *Nature*, [DOI: 10.1038/nature17140](https://doi.org/10.1038/nature17140)

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