Astronomers detect most distant fast radio burst to date

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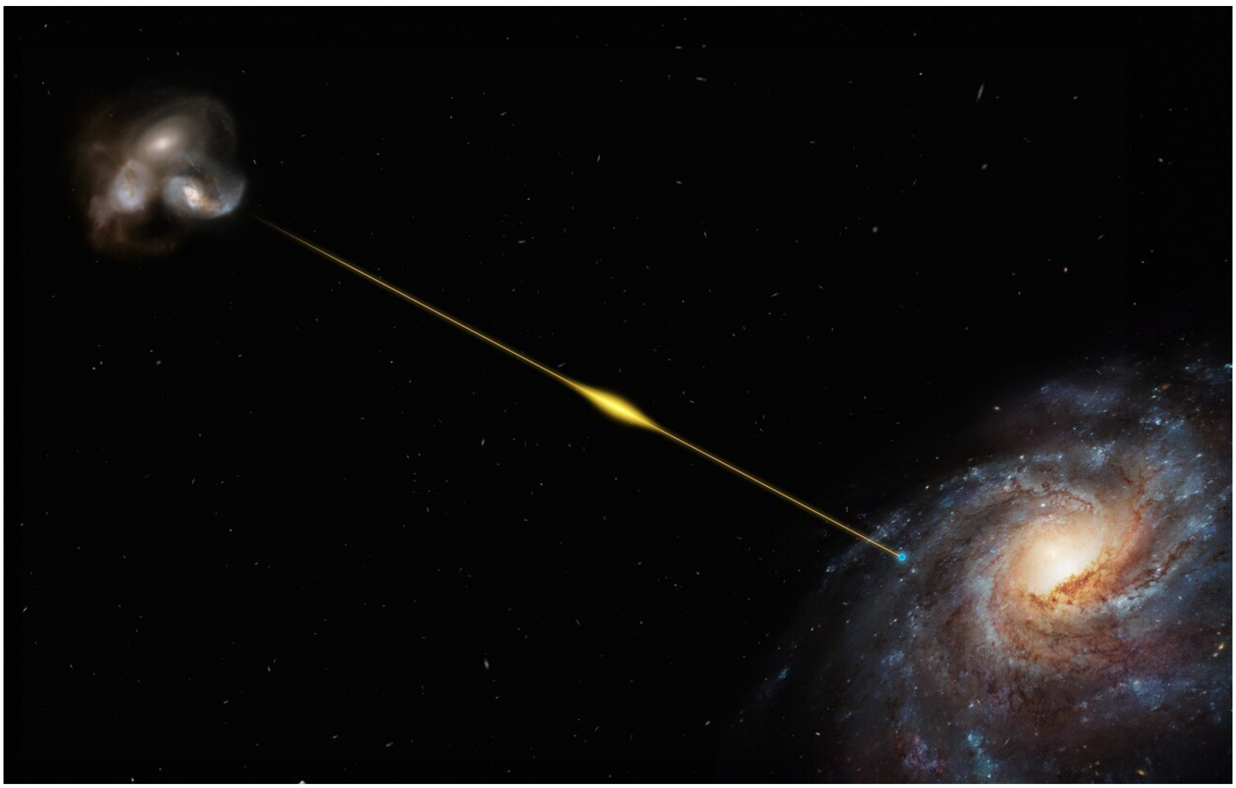

This artist's impression (not to scale) illustrates the path of the fast radio burst FRB 20220610A, from the distant galaxy where it originated all the way to Earth, in one of the Milky Way's spiral arms. The source galaxy of FRB 20220610A, pinned down thanks to ESO's Very Large Telescope, appears to be located within a small group of interacting galaxies. It's so far away its light took eight billion years to reach us, making FRB 20220610A the most distant fast radio burst found to date. Credit: ESO/M. Kornmesser

An international team has spotted a remote blast of cosmic radio waves lasting less than a millisecond. This 'fast radio burst' (FRB) is the most distant ever detected. Its source was pinned down by the European Southern Observatory's (ESO) Very Large Telescope (VLT) in a galaxy so far away that its light took 8 billion years to reach us. The FRB is also one of the most energetic ever observed; in a tiny fraction of a second it released the equivalent of our sun's total emission over 30 years.

The discovery of the burst, named FRB 20220610A, was made in June last year by the ASKAP radio telescope in Australia and it smashed the team's previous distance record by 50 percent.

"Using ASKAP's array of dishes, we were able to determine precisely where the burst came from," says Stuart Ryder, an astronomer from Macquarie University in Australia and the co-lead author of the study titled "A luminous fast radio burst that probes the Universe at redshift 1" and published in *Science*.

"Then we used [ESO's VLT] in Chile to search for the source galaxy, finding it to be older and further away than any other FRB source found to date and likely within a small group of merging galaxies."

The discovery confirms that FRBs can be used to measure the 'missing' matter between galaxies, providing a new way to 'weigh' the universe.

Current methods of estimating the mass of the universe are giving conflicting answers and challenging the standard model of cosmology.

"If we count up the amount of normal matter in the universe—the atoms that we are all made of—we find that more than half of what should be there today is missing," says Ryan Shannon, a professor at the Swinburne University of Technology in Australia, who also co-led the study.

"We think that the missing matter is hiding in the space between galaxies, but it may just be so hot and diffuse that it's impossible to see using normal techniques."

"Fast radio bursts sense this ionized material. Even in space that is nearly perfectly empty they can 'see' all the electrons, and that allows us to measure how much stuff is between the galaxies," Shannon says.

Finding distant FRBs is key to accurately measuring the universe's missing matter, as shown by the late Australian astronomer Jean-Pierre (J-P) Macquart in 2020.

"J-P showed that the further away a fast radio burst is, the more diffuse gas it reveals between the galaxies. This is now known as the Macquart relation. Some recent fast radio bursts appeared to break this relationship. Our measurements confirm the Macquart relation holds out to beyond half the known universe," says Ryder.

"While we still don't know what causes these massive bursts of energy, the paper confirms that fast radio bursts are common events in the cosmos and that we will be able to use them to detect matter between galaxies, and better understand the structure of the universe," says Shannon.

The result represents the limit of what is achievable with telescopes today, although astronomers will soon have the tools to detect even older and more distant bursts, pin down their source galaxies and measure the universe's missing matter.

The international Square Kilometer Array Observatory is currently building two radio telescopes in South Africa and Australia that will be capable of finding thousands of FRBs, including very distant ones that cannot be detected with current facilities. ESO's Extremely Large

Telescope, a 39-meter telescope under construction in the Chilean Atacama Desert, will be one of the few telescopes able to study the source galaxies of bursts even further away than FRB 20220610A.

More information: S. D. Ryder et al, A luminous fast radio burst that probes the Universe at redshift 1, *Science* (2023). DOI: 10.1126/science.adf2678.
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