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GMRT reveals a fast radio burst progenitor born in a galaxy merger.

Astronomers from the National Centre of Radio Astrophysics (NCRA-TIFR) in Pune, and the University of California, Santa Cruz, in California, have used the Giant Metrewave Radio Telescope (GMRT) to map the distribution of atomic hydrogen gas from the host galaxy of a fast radio burst (FRB) for the first time, revealing exciting clues about the origin of the burst. The GMRT results indicate that the FRB host galaxy has undergone a recent merger, and that the FRB progenitor is most likely a massive star formed due to this merger event. This is the first case of direct evidence for a recent merger in an FRB host, a major step towards understanding the progenitors of FRBs.

FRBs are extremely bright radio pulses from distant galaxies that last for only a few milliseconds. Although FRBs were first detected fifteen years ago, and more than a thousand have been found so far, we still don't know what kind of astronomical objects can produce so much energy in so little time. Observations of the gas and stars in the vicinity of FRBs, within their host galaxies, are critical to understand how the bursts were formed.

"Our target, FRB20180916B, produces repeated very short bursts, and these have been found to arise in the outskirts of a spiral galaxy just half a billion light years away. FRB20180916B is thus one of the closest known FRBs, an ideal candidate to study the local burst environment.", said Balpreet Kaur, a Ph.D. student at NCRA-TIFR and the lead author of the study.

The authors used GMRT observations of the 21cm line of atomic hydrogen to study the gas distribution in the FRB host galaxy. "The GMRT is really nice for such a study", said Nissim Kanekar, also of NCRA-TIFR and a co-author, "because we can use different combinations of the 30 GMRT antennas to both map the atomic hydrogen within the FRB host galaxy in detail, and also search for hydrogen in nearby companion galaxies. The GMRT 21cm image shows that the FRB host has four companions, one of which is just 70,000 light years from the FRB location.".

Kaur said "The first surprise was the amount of atomic hydrogen in the FRB galaxy, around ten times more than that found in similar nearby galaxies. Since atomic gas is the primary fuel for star formation, one would expect a galaxy with a high gas mass to have high star-formation activity. However, though it has lots of gas, the FRB galaxy is not actively forming stars. This suggests that it has acquired the gas quite recently, probably in a merger with a smaller companion."

The Hubble Space Telescope (HST) optical image shows that the FRB arises in a beautiful spiral disk galaxy. Remarkably, the GMRT images shows that the gas distribution in the FRB galaxy is highly disturbed. There is a hole in the gas between the optical galaxy centre and the FRB location, substantial amounts of gas outside the galaxy to the north and north-east, a gas tail towards the south, as well as a high gas concentration close to the FRB position. “In fact”, Kaur said, “the galaxy doesn’t look like a spiral disk in the 21cm images at all! It seems pretty clear that another galaxy or gas cloud collided with the FRB galaxy a few tens of millions of years ago. This would have disturbed the gas distribution, producing the gas tails seen in the GMRT image. The collision is likely to have also compressed the gas in the galaxy outskirts, giving rise to a burst of star formation near the FRB position. Overall, the GMRT images suggest that the FRB progenitor is likely to be a massive star, formed due to the merger event.”

This is the first case of direct evidence for a recent merger in an FRB host and showcases the ability of the GMRT to identify such mergers via disturbances in the gas distribution. The authors plan to carry out similar GMRT 21cm studies of more FRB host galaxies, to test whether merger events might be a common trigger for FRB formation.

The results have been published in the February 2 issue of The Astrophysical Journal Letters (https://iopscience.iop.org/article/10.3847/2041-8213/ac4ca8). The research was carried out by Balpreet Kaur and Nissim Kanekar of NCRA-TIFR, and J. Xavier Prochaska of the University of California, Santa Cruz, USA. The Giant Metrewave Radio Telescope was built and is operated by NCRA-TIFR. The research was funded by the Department of Atomic Energy, India, and the National Science Foundation, USA.

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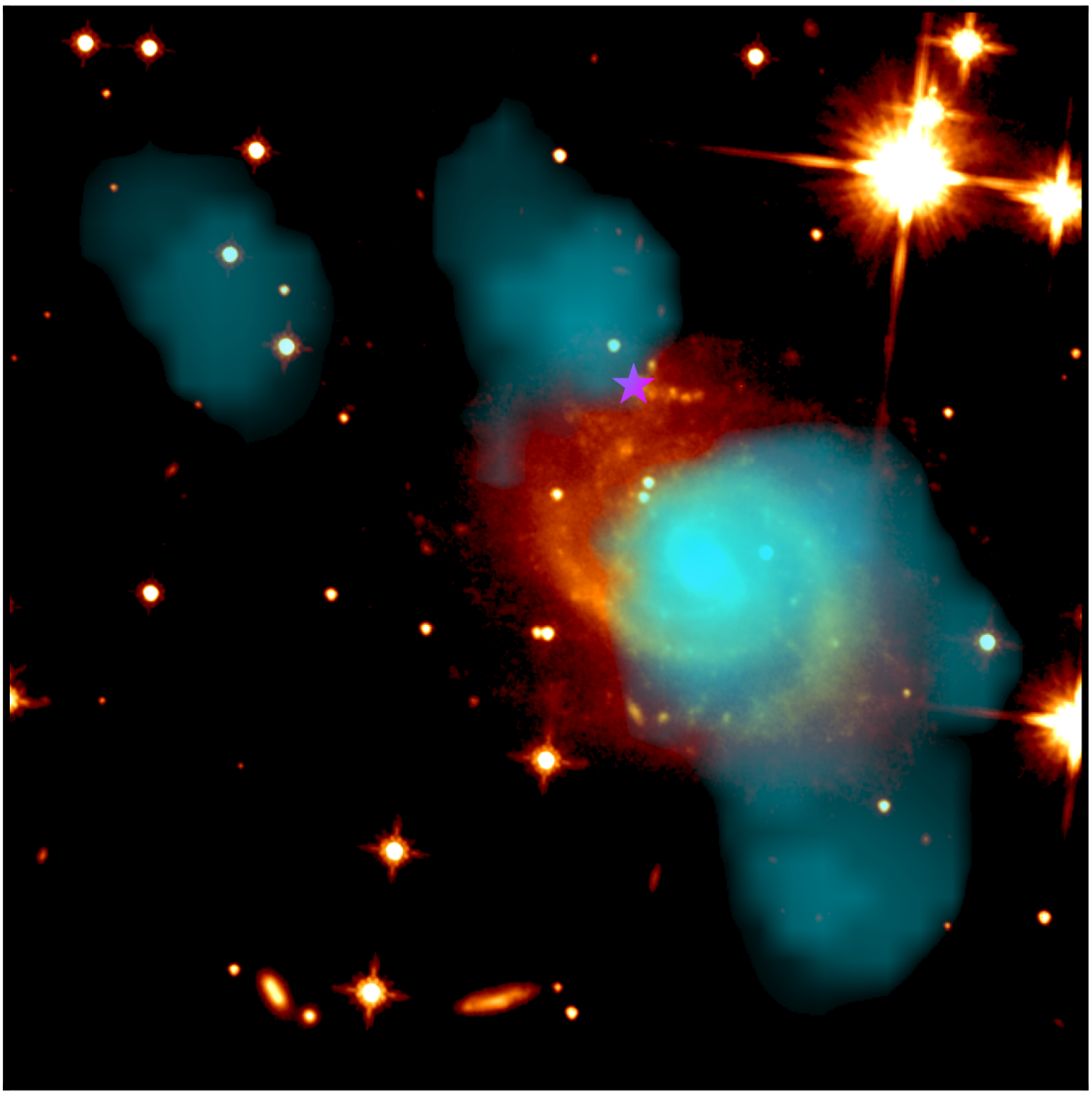

The GMRT image of the atomic hydrogen distribution (in blue) overlaid on the HST image of the FRB host galaxy (in red). The magenta star indicates the FRB location, at the upper edge of the hole in the gas distribution. (Image credit: Balpreet Kaur, Aditya Chowdhury)