FIRST J141918.9+394036 is an 'orphan' long gamma-ray burst, study finds

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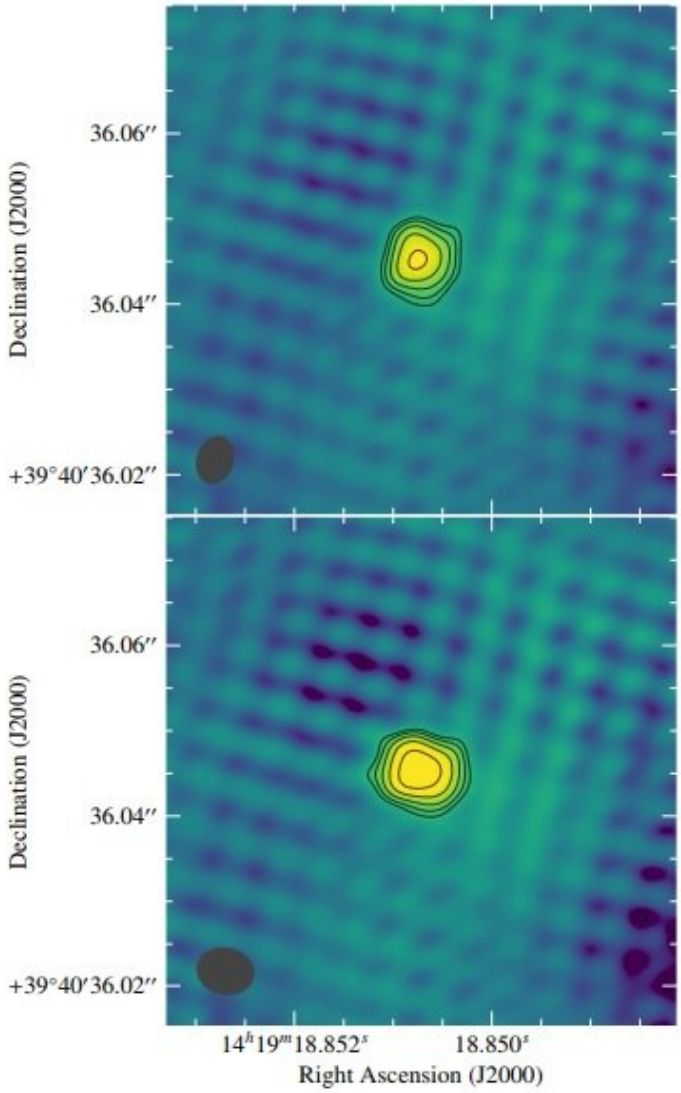

Images of FIRST J1419+3940 at 1.6 GHz with the EVN on September 18, 2018 derived from the two gain calibrations performed in Tianma (original, top, and

scaled, bottom). Credit: Marcote et al., 2019.

Using a network of radio telescopes, European astronomers have investigated a decade-long transient known as FIRST J141918.9+394036. Results of this study, presented in a paper published February 18 on arXiv.org, provide important insights into the nature of this mysterious source, confirming that it is an "orphan" long gamma-ray burst.

FIRST J141918.9+394036 (or FIRST J1419+3940 for short) is a slowly evolving, extragalactic radio transient. It has decayed in brightness over the last few decades. Recent observations of this object have revealed that it could be an afterglow of a powerful gamma ray burst (GRB) that produced no gamma rays detectable on Earth. FIRST J1419+3940 was therefore classified as the first known "orphan" GRB.

However, the fading radio emission from FIRST J1419+3940 could also be interpreted as coming from a new-born nebula powered by a young magnetar. Given that this transient shares similar properties and host galaxy type to the radio source associated with the first known fast radio burst (FRB), FRB 12102, some astronomers assume that FIRST J1419+3940 is a young, rapidly spinning magnetar.

In order to verify which of the two hypotheses is true, a team of astronomers led by Benito Marcote of Joint Institute for VLBI ERIC in the Netherlands, has employed the European VLBI (very-long-baseline interferometry) Network to conduct radio observations of FIRST J1419+3940.

"To distinguish between these hypotheses, we conducted radio observations using the European VLBI Network at 1.6 GHz to resolve

the emission spatially and to search for millisecond-duration radio bursts," the astronomers wrote in the paper.

In result, Marcote's team found that FIRST J1419+3940 is a compact radio source with a flux density at a level of 620 μJy. With a luminosity distance of about 283 million light years, the size of the source was estimated to be approximately 5.2 light years. Moreover, the observations detected no millisecond-duration bursts of astrophysical origin from this object and confirmed that the radio emission from it is non-thermal.

According to the paper, the properties of FIRST J1419+3940 and lack of short-duration bursts from it are consistent with jet expansion from a putative "orphan" long GRB. The researchers noted that although this object shows similar properties as the persistent source associated with FRB 121102, it exhibits significant differences such as much faster expansion and stronger luminosity decay. This disfavors the magnetar birth nebula theory.

"A flux density lower than expected is reported, suggesting a faster decline after 2015. This decay could be explained by a change in the post-shock microphysical parameters following the transition to the non-relativistic phase, or by a drop in the ISM [interstellar medium] density (e.g. due to the shock reaching the outer edge of the star-forming region where the GRB exploded)," the paper reads.

Although the study confirms the RGB status of FIRST J1419+3940, the researchers noted that it could be still a site of potential FRB production. To verify this, future observations of this source at higher radio frequencies are required.

More information: B. Marcote et al. Resolving the decades-long transient FIRST J141918.9+394036: an orphan long gamma-ray burst or

a young magnetar nebula? arXiv:1902.06731 [astro-ph.HE]. arxiv.org/abs/1902.06731