MeerKAT radio telescope catches a 'Mini Mouse' in the sky

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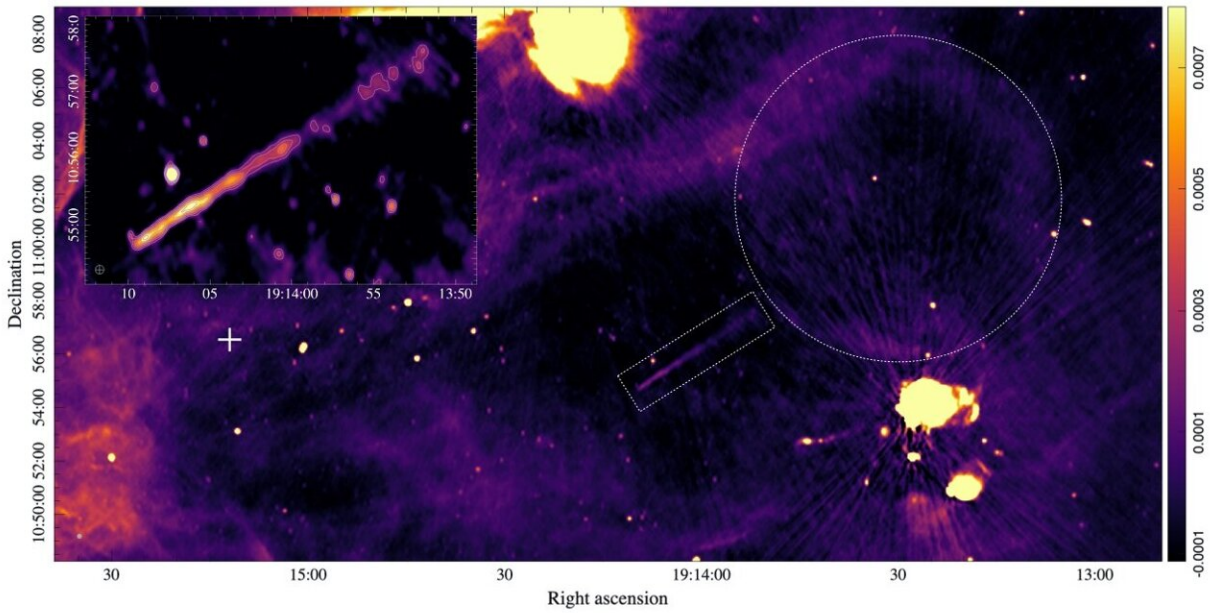

A portion of the field centered on GRS 1915+105 as seen by the MeerKAT radio telescope at 1.28 GHz. Credit: Motta et al., 2023.

Using the MeerKAT radio telescope, European astronomers have serendipitously discovered a new radio nebula during observations of the black hole binary GRS 1915+105. The newfound object, dubbed "the Mini Mouse," is a young radio pulsar escaping its birth site and therefore

creating a radio nebula with a cometary-like morphology. The finding was reported in a paper published May 10 on the *arXiv* preprint server.

Pulsars are highly magnetized, rotating neutron stars emitting a beam of electromagnetic radiation. They are usually detected in the form of short bursts of radio emission; however, some of them are also observed via optical, X-ray and gamma-ray telescopes.

A team of astronomers led by Sara Elisa Motta of the Brera Observatory in Italy, has recently performed MeerKAT observations of a black hole binary system known as GRS 1915+105 and its surroundings. During the observational campaign, conducted as part of the ThunderKAT Large Survey Program, they serendipitously spotted a feature that closely resembles "the Mouse"—a radio nebula detected in 1987.

"Based on the resemblance with the Mouse, we named the newly identified feature in the GRS 1915+105 field 'the Mini Mouse,'" the researchers explained.

The observations found that the Mini Mouse radio nebula is produced by the supersonic pulsar PSR J1914+1054g (or J1914 for short), recently discovered by MeerKAT, escaping the location of its birth. The nebula points back towards the previously unknown faint supernova remnant (SNR) candidate G45.24+0.18. The geometrical center of G45.24+0.18 is located within 30 arcseconds from the extension of the Mini Mouse axis of symmetry, and 12 arcminutes away from the head of the nebula.

The pulsar J1914 has a spin period of approximately 138.9 milliseconds and dispersion measure of about 418.9 pc/cm^3. Observations show that J1914 has a spin-down luminosity at a level of 400 decillion erg/s and its characteristic age is some 82,000 years. The distance to the pulsar was estimated to be 26,700 light years.

The astronomers noted that if the characteristic age of J1914 is close to its actual age, then the projected pulsar velocity should be between 320 and 360 km/s. This would be well within the kick velocity distribution for young, isolated pulsars, centered at approximately 300 km/s, with a dispersion of approximately 190 km/s.

"If the connection between J1914 and the faint SNR is correct, then we may have a faint, fast-spinning, distant young pulsar with a high kick velocity, i.e., a member of an under-sampled population, which could help extrapolating the local young pulsar velocity distribution to the wider Galactic one," the researchers concluded.

Summing up the results, the authors of the paper underlined that Mini Mouse is the fourth case of a bow shock associated with an escaping pulsar, for which both the pulsar signal and the SNR associated with its birth have been observed.

More information: S. E. Motta et al, MeerKAT caught a Mini Mouse: serendipitous detection of a young radio pulsar escaping its birth site, *arXiv* (2023). DOI: 10.48550/arxiv.2305.06130