National Centre for Radio Astrophysics (NCRA)-TIFR, Pune
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GMRT spots extremely rare phenomenon of 'cosmic-tango' of radio galaxies

An international team led by Indian radio astronomers has discovered an extremely rare cosmic spectacle of two radio galaxies performing an act of tango dance. The discovery was recently made using the upgraded Giant Metrewave Radio Telescope (uGMRT), which is located near the Khodad village about 80 km north of Pune. This front-ranking radio telescope was built and is being operated as an international facility by the National Centre for Radio Astrophysics (NCRA) of the Tata Institute of Fundamental Research (TIFR). The discovery has been reported in the May 17 (2022) issue of a leading international journal, Monthly Notices of the Royal Astronomical Society (Letters), published by the Oxford University Press. The team of researchers consists of Profs. Gopal Krishna (CEBS, Mumbai), Ravi Joshi (IIA, Bengaluru), Dusmanta Patra (SNBSCBS, Kolkata), X. Yang (SHAO, Shanghai), L. C. Ho (KIAA, Beijing), P. J. Wiita (TCNJ, Ewing) and A. Omar (ARIES, Nainital).

Our universe is known to contain billions of large galaxies each of which is itself an assembly of billions of stars. A sizable fraction of galaxies occur in pairs or small groups, all held together by their mutual gravity. Secondly, all large galaxies are now believed to harbour deep within the stellar core a supermassive black hole (SMBH), typically of mass equivalent to several million to billions of suns. Upon entering an ‘active’ state, such a black holes ejects in opposite directions two collimated ‘jets’ of magnetised relativistic plasma, along the spin axis of the black hole. Over the active lifespan of the galaxy, which can last tens of millions of years, the two relativistic jets grow out to millions of light-years from the parent galaxy, on opposite sides. Usually these jets of relativistic electrons/positrons, also carrying magnetic field, are detected with radio telescopes since they intensely radiate radio-waves by a mechanism called ‘synchrotron’.

Given that so many large galaxies occur in pairs (called 'dumb-bells') and each of them is, in principle, capable of ejecting relativistic plasma jets, one would expect to observe many cases where both member galaxies of a dumb-bell system are ejecting their own pair of radio-wave-emitting jets. However, for reasons not yet fully understood, this expectation is realized extremely rarely. The first pair of twin-radio-jets, famously called the Twin-Radio-Galaxy (TRG) 3C 75, was discovered by american radio astronomers in 1985 using the 'Very Large Array' (VLA) radio telescope situated in New Mexico (USA). The

discovery of a second TRG was reported in 1991, by a team of european/american radio astronomers, again using the VLA. The discovery of a third TRG, named J104454+354055, has come this year, after a gap of 3 decades, through the use of uGMRT by the above mentioned international team led by Indian radio astronomers. The fact that this 3rd such system has been discovered after a gap of 3 decades testifies to the extreme rarity of the phenomenon of Twin-Radio-Galaxies. In this case, too, the two bright elliptical galaxies are orbiting around their gravitational centre, along with their pairs of relativistic jets. The consequent wiggling of both jet pairs presents a rare spectacle of 'cosmic tango' (see the figure attached). These radio jets are seen to extend over at least 1.5 million light-years. Further study of this rare object is in progress. From this, we can expect to learn how these giagantic jets of relativistic plasma respond to the orbital motion of their parent galaxies and how they maintain their identity despite their side-way collisions. Compared to both its predecessors found 3-4 decades ago, this newly discovered third Twin-Radio-Galaxy is much better suited for quantitative modeling. This is because of its morphological purity, as it is apparently not encountering any environmental crosswind which would have distorted its jets.

Contact:
Gopal Krishna (gopaltani@gmail.com); Mob. 9850415719
Ravi Joshi (ravi.joshi@iiap.res.in); Mob. 9997456506
Dusmanta Patra (dusmanta@bose.res.in); Mob. 7003313962
Amitesh Omar (amoar@aries.res.in); Mob. 9012570011;
Xiaolong Yang (lho.pku@gmail.com)
Luis C. Ho, (yxl.astro@gmail.com)
Paul J. Wiita (paul.wiita@gmail.com)
Yashwant Gupta (ygupta@ncra.tifr.res.in) ; Phone: 020-25719242
Nissim Kanekar (nkanekar@ncra.tifr.res.in); Phone: 020-25719246
CH. Ishwara-Chandra (ishwar@ncra.tifr.res.in); Mobile: 9403136630
J. K. Solanki (solanki@ncra.tifr.res.in); Mobile: 9890447888
Anil Raut: (anil@gmrt.ncra.tifr.res.in); Mobile: 8605525945

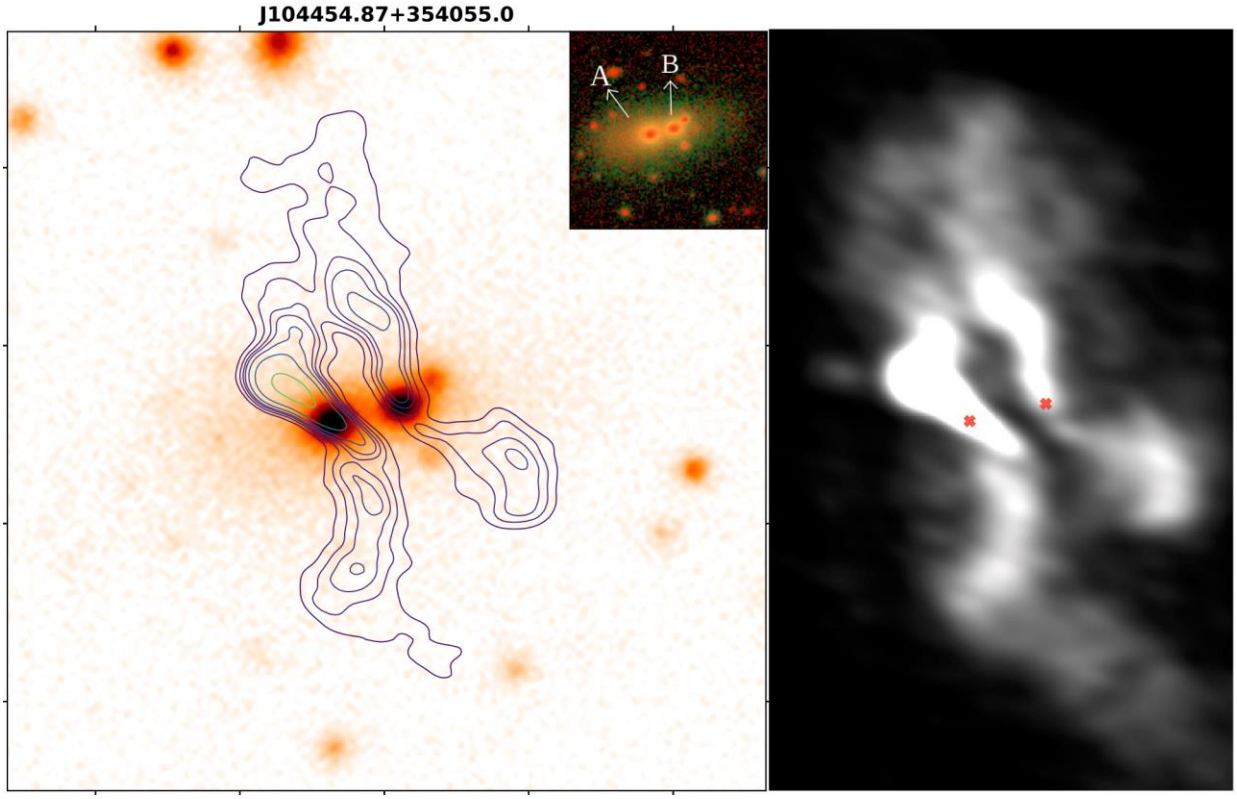

Fig.1: **Left panel:** The iso-intensity contours of 1.4 GHz emission from the two pairs of radio jets imaged with uGMRT, is shown overlaid on an optical photograph of their parent galaxies forming a ‘dumb-bell’ (also shown within the inset as A and B). The total extent of these jets is in excess of 1.5 million light-years. **Right Panel:** Photographic representation of the radio emission contours of the two jet pairs, apparently performing a ‘cosmic tango’. The positions of their parent galaxies are marked with two red dots.