National Centre for Radio Astrophysics (NCRA), Pune
Press Note – 29th July 2021

Discovery of a Remnant Radio Galaxy Using the GMRT

Dr. Dharam Vir Lal, a scientist working at the National Centre for Radio Astrophysics of the Tata Institute of Fundamental Research (NCRA-TIFR), Pune, India has discovered a remnant radio galaxy at the peripheral region of a cluster of galaxies named Abell2065, using the upgraded Giant Metrewave Radio Telescope (uGMRT) and the Chandra X-ray Observatory. The research has been published in the 16th July 2021 issue of the Astrophysical Journal.

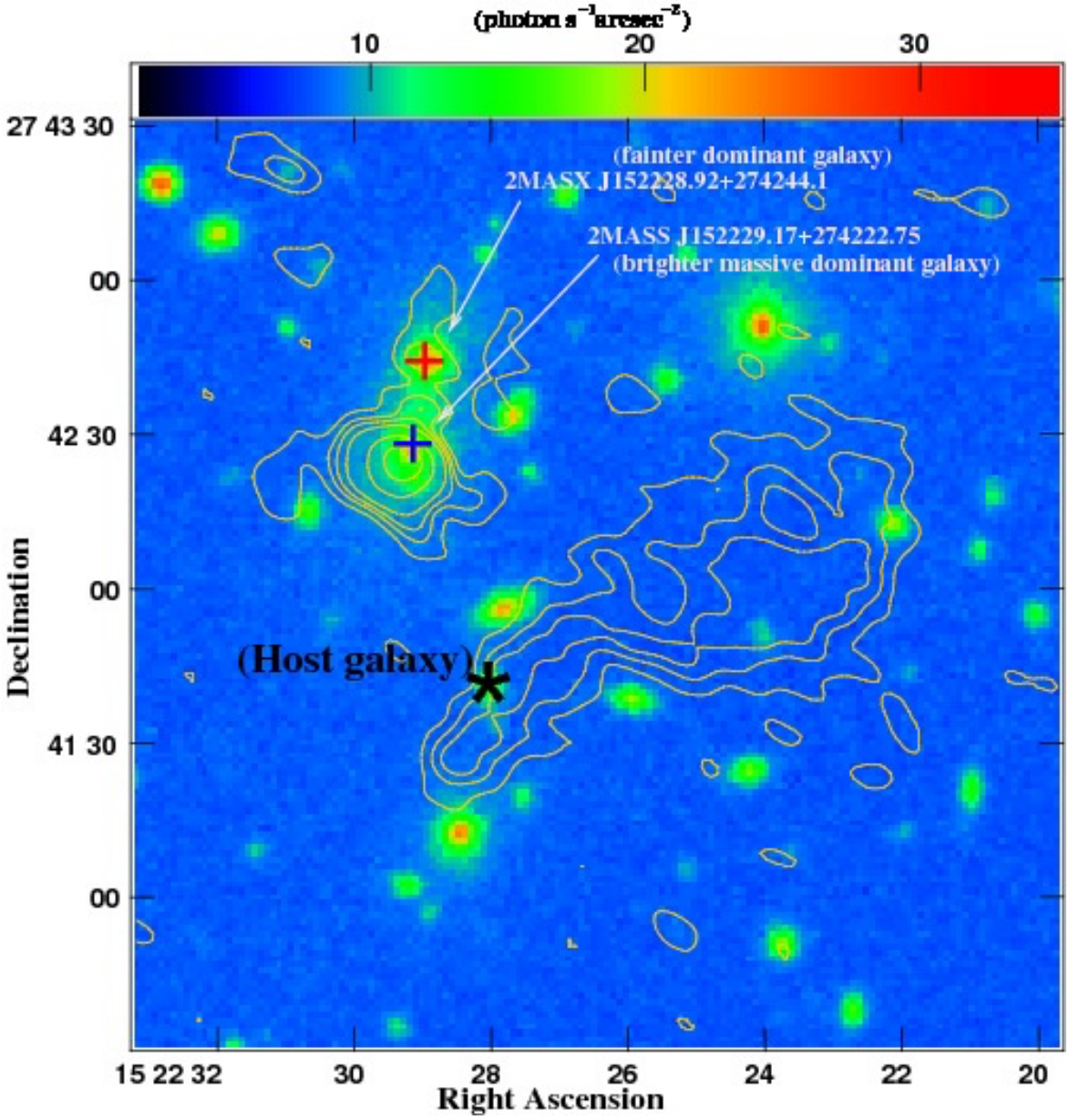
A galaxy is a system of stars, gas, and dust bound together by their mutual gravity. These galaxies come in different shapes, but the basic structure is the same, a dense core of stars called a nucleus surrounded by stars and gas. However, in a small fraction of galaxies, the core is bright, shining with power equivalent to trillions of suns, easily outshining the rest of the light of the galaxy combined. A galaxy that emits such tremendous amounts of energy is called an active galaxy. It is believed that at the centre of these active galaxies lies a supermassive black hole with mass million to billion times the mass of the Sun. As this supermassive black hole attracts more material from its neighbourhood, it also streaks away long jets of matter and energy from the core up to a distance of millions of light years. These special, active galaxies exhibit strong emission in the radio wavelengths with size much larger than seen in the optical wavelength. The long powerful jets responsible for radio emission can also have a substantial energetic impact on both their host galaxy and the surrounding medium beyond the host galaxy.

The active phase of such galaxies can last several tens of million years, after which the nuclear activity stops, and the radio emission starts to fade away. This phase of a radio galaxy represents the final dying phase of the active galaxy, often termed the remnant or dying phase, and begins once the nuclear activity switches off. This dying phase is relatively short-lived and is difficult to detect. Fortunately, it remains observable for many tens of million years at low radio frequencies, using a sensitive low frequency radio telescope such as the upgraded GMRT.

Dharam Vir Lal,says, “the remnant phase of a radio galaxy is short and only a few such remnants are known in the sky. This discovery showcases the capability of upgraded GMRT to discover more such objects”. Finding more remnant and restarted radio galaxies is important to shed light on their dynamics and evolution, and hence the duty cycle of active galaxies. We know that active galaxies are rare (about 10% of all galaxies) and that remnant radio galaxies are even more rare, because they are short lived. As a result of their rarity, this dying phase remains poorly understood phenomenon. By increasing the detection of these rare sources, we will be able to understand different evolution histories of active galaxies and of different mechanisms that drive the evolution of the remnant, i.e. dying phase of the active galaxy.

Combining the images in radio band using the upgraded GMRT and in X-ray band using the Chandra X-Ray observatory, a hint of possible shock is seen across the remnant radio galaxy. It is likely that the radio emission is re-energised by the passage of possible shock front, and that shows the expected change in radio emission characteristics of the newly discovered remnant radio galaxy.

The GMRT is an array of thirty 45-m antennas spread over 25 sq-km area in Khodad village, Narayangaon, India, built and operated by NCRA-TIFR, Pune. Currently it is one of the most sensitive low frequency radio telescope in the world.



The Figure shows the central region of the clusters of galaxies named Abell2065 observed with the band-3 (250-500 MHz) of the upgraded GMRT. The radio image is shown in surface-brightness contours overlaid on the visible band image. The two massive galaxies, in the north (+) and the south (+) are shown. The remnant radio galaxy shows an elongated, bar-shaped structure, whose size is approximately million light years. The position of the host galaxy is marked (*).

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