

Unusual structure of giant radio galaxy J0133–1302 detected by astronomers

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Radio image of the GRG J0133–1302. Credit: Mhlahlo et al., 2021.



Using the Giant Metrewave Radio Telescope (GMRT), astronomers from South Africa and Poland have conducted radio observations of a giant radio galaxy (GRG) known as J0133–1302. The observational campaign revealed that the galaxy has an unusual complex structure. The finding is reported in a paper published September 17 on arXiv.org.

GRGs are radio galaxies with an overall projected linear length exceeding at least 2.28 million light years. They are rare objects grown in low-density environments. GRGs are important for astronomers to study the formation and the evolution of radio sources.

GRG J0133–1302 was discovered at a redshift of approximately 0.3 by the 7-dish Karoo Array Telescope (KAT-7) in the field of the cluster of galaxies ACO209 at a frequency of 1.83 GHz. KAT-7 observations also detected extended emission from J0133–1302 in the form of two symmetric lobes. Further monitoring of the field of this GRG, mainly as part of the NRAO VLA Sky Survey (NVSS), identified four peculiar sources that received designations: S1 (southern-east SE lobe), S2 (core), S3 and S4 (northern-west NW lobe).

However, due to poor resolution of the KAT-7 radio telescope and small collecting area, it was difficult to resolve the detected components of J0133–1302 into distinct sources. That is why astronomers led by Nceba Mhlahlo of the University of the Witwatersrand in Johannesburg decided to perform follow-up radio observations of this GRG with GMRT, hoping to shed more light on these sources.

"For a deeper and detailed analysis, there was a need for high-resolution observations, which we obtained from the Giant Metrewave Radio Telescope (GMRT; Swarup et al. 1991). For the first time, our GMRT observations have resolved the extended sources in Colafrancesco et al. (2016) into new sources which were not previously observed in the KAT-7 and NVSS structures," the researchers wrote in the paper.



Using GMRT, Mhlahlo's team has analyzed the radio core and lobes of J0133–1302. The lobes, designated L1 and L2, turned out to have a steep spectrum, what is contrasted by the flat inverted spectrum of the core. L1 and L2 have spectral index values of about -0.92 and -0.79, respectively, while the spectral index of the core is approximately 0.7. This suggests decaying emission of the lobes and restarting core activity for J0133–1302.

The research found that the two lobes are not symmetric as previously thought but exceptionally asymmetric—the upper lobe is much further from the core when compared to the lower lobe. The observations also revealed that the upper lobe has a complex structure.

According to the astronomers, the complex structure of the upper lobe suggests the presence of another unidentified source. This source, located in the proximity to the upper lobe's edge resembles a bent-double, or distorted bent tail (DBT) radio galaxy.

Summing up the results, the authors of the paper noted that J0133–1302 is restarting activity in the nucleus, which makes it one of only few known sources with episodic activity in an active galactic nucleus (AGN). The collected data also suggest that J0133–1302 may be GigaHertz Peaked Spectrum (GPS) radio galaxy; however, further observations of this object are required in order to confirm this.

More information: Nceba Mhlahlo, Marek Jamrozy, Revealing the Unusual Structure of the KAT-7-Discovered Giant Radio Galaxy J0133–1302. arXiv:2109.08443v1 [astro-ph.GA], arxiv.org/abs/2109.08443

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