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MeerKAT Observations of the Abell 141 Galaxy Cluster

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Galaxy clusters are one of the largest, gravitationally bound structures in the universe, hosting a hot, tenuous gas that permeates their volume, known as the intracluster medium. A fraction of the intracluster medium is composed of relativistic electrons that, when accelerated in magnetic fields, radiate synchrotron emission. Synchrotron emission occurs on scales ranging between individual galaxies to ∼Mpc scales and beyond, with two examples of radio emission observed on Mpc scales, "bridging" between cluster pairs. A possible third system to host radio emission on such large scales is the Abell 141 (hereafter, A141) cluster, a system composed of two subclusters, where X-ray emission has been seen in the connecting region. Radio observations at 150 MHz and 943 MHz detected diffuse emission from the two systems, although the limited angular resolution prevented a detailed picture of the system.

In this thesis, we present observations at 1.28 GHz of the A 141 system, taken with the MeerKAT telescope, with the aim to further characterize its diffuse radio emission. We obtain an image with a $5.1'' \times 4.4''$ angular resolution with an RMS noise of 9 μJy~beam^{-1} that we use to identify and subtract compact sources. Subsequently, we generate a
$19'' \times 17''$ angular resolution with an RMS noise of 8.8 μJy~beam^{-1} where we detect diffuse radio emission extending over 0.9~Mpc. We find its integrated flux density to be 10.8 ± 0.3~mJy.

The radio surface brightness peaks at the location of the Northern subcluster, although, it is offset by a few arcmin with respect to the peak of the X-ray emission. The radio morphology extends over both subclusters, and, thanks to the angular resolution of our observations, we can clearly see radio emission in the region between the two subclusters, though it does not closely follow the X-ray morphology.

In this respect, A141 remains a somewhat unique system. We find tentative evidence for "bridge"-like radio emission at GHz frequency, which closely matches the morphology of the X-ray/thermal emission. Notably, previous "bridges" were detected at low frequency only (< 200~MHz). We confirmed the spectral index of the integrated radio emission to be -1.06 ± 0.09, which would somewhat disfavour a scenario where particles are accelerated by turbulence in the early merger state. This scenario is, conversely, the preferred explanation for the bridges detected at low frequencies. Further observations at lower frequencies may be able to shed light on the nature of this system.

keywords

galaxy clusters, calibration, imaging, galaxy merger, intra cluster medium, radio continuum

In-person or online?

in-person

Career level

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