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A combined JVLA, GMRT, and XMM study of Abell 795: a candidate radio phoenix?

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Diffuse non-thermal radio emission in galaxy clusters provides direct information on the relativistic particles and magnetic fields present in the intra-cluster medium (ICM). These sources have been classified as: radio halos (giant or mini), cluster radio shock, and revived AGN plasma. Phoenices belong to the category of revived AGN plasma. They are characterized by an ultra-steep synchrotron spectral index ($\alpha \leq$ -1.5) and typically are located near the centre of galaxy clusters. There are many open questions about these sources, e.g. the acceleration mechanism of the relativistic electrons, the polarization level. In this context, the X-ray detection of shocks or cold fronts in the ICM can give insight about the process in action. However, few phoenices have been studied in detail, due to their small size ($\lesssim$ 300-400 kpc) and the presence of the bright central BCG.

In the case of the galaxy cluster Abell 795 (z = 0.137), a previous work conducted by Ubertosi et al. (2021) found the presence of an extended radio emission surrounding the BCG, using an archival GMRT image at 150 MHz. New JVLA observations of Abell 795 at 1.4 GHz (L band) and configuration C were obtained (PI: Ubertosi), with the aim to investigate the radio extended emission detected. In this work this new data set was calibrated and analyzed, and a spectral index measurement of the source was obtained, combining the fluxes at 1.4 GHz with the ones obtained from a GMRT archival observation at 325 MHz.

In order to perform an accurate investigation of the system thermal and non-thermal properties, it was carried out a multi-wavelength study to reveal the presence of surface brightness discontinuities in the ICM, using an archival XMM-Newton data set of duration about 34 ks. In fact in their previous work, using Chandra data Ubertosi et al. (2021) found signatures of sloshing motion, identified through the detection of two cold fronts at distances $\approx$ 67 kpc and $\approx$ 170 kpc from the centre. From the XMM analysis, in this work it was detected an azimuthally asymmetric excess reaching around 650 kpc from the center. The excess appears to follow the sloshing spiral previously detected. However, it was not detected a jump in the surface brightness profile. This confirms that the enhancement found can not be classified as a discontinuity, but its identification corroborates the geometry of the sloshing motion. Furthermore, the analysis of the X-ray surface brightness has

revealed the presence of another excess at projected distance of 7.36 arcmin (1.02 Mpc) from the center. I extracted and fitted its profile with a single beta model, which proved to be a good fit. Together with the spectral analysis revealing the presence of thermal gas at a temperature of 1.08 ± 0.08 keV, this result identifies this source as a galaxy group. There are no previous mentions of this object in the literature, so it represents its first classification.

The analysis of JVLA images at 1.4 GHz and GMRT images at 325 MHz revealed the presence of extended radio emission with dimensions $\approx$ 200 kpc, along with a sub- component extending in the southwest direction (SW blob). The spectral index values obtained for the two components are: α(Ext.) = -2.24 ± 0.13 and α(SWb) = -2.10 ± 0.13. These ultra-steep spectral index values, coupled with the complex morphology and co-spatiality with the radio-loud AGN present in the BCG, suggest that this extended emission could be classified as a phoenix. The re-acceleration mechanism proposed involves adiabatic compression of the AGN radio bubble due to the presence of sloshing motion. The potential identification of a phoenix represents one of the few cases reported in the literature, emphasizing the importance of a thorough study of Abell 795.

keywords

clusters, diffuse radio emission, FR0

In-person or online?

in-person

Career level

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