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Search for the diffuse emission in the low mass cluster Abell 3535

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Galaxy clusters are the most gravitationally bound objects in the Universe. Radio observations show that a fraction of clusters radiate synchrotron light, which indicates the presence of a magnetic field (~μG) and relativistic electrons (~Gev) in the intracluster medium (ICM), the largest baryonic part of the clusters [1,2]. The radio emission from clusters can be divided into two classes: radio halos and radio relics. The turbulent reacceleration model is of primary importance for the origin of radio halo, although the hadronic model is also possible. Observations indicate that radio power increases with cluster mass/luminance, implying that radio halos are found mostly in high mass clusters (detection rate > 60 - 80%, for $M_{cls} > 8 \times 10^{14} M_{\odot}$). Observing these diffuse emissions in low mass clusters is important for understanding the possible mechanism behind the radio emission. So far, very few radio halos have been detected in the low-mass clusters [3]. They are thought to have a very low turbulent energy budget, implying a less turbulent re-acceleration. Thus, it is crucial to study this population of objects in more detail in order to constrain the model of the radio emission from the clusters. Here we will be presenting the results by studying the radio emission from a very low mass cluster, Abell 3535.

Abell 3535 is a dynamically disturbed cluster, part of the Shapley supercluster, situated at a redshift of 0.065. This cluster has a very low mass of $5 \times 10^{13} M_{\odot}$ (using the mass and X-ray luminosity correlation). MWA (Murchison Widefield Array) (74-231MHz) and TGSS (TIFR-GMRT Sky Survey) (150MHz) observations have suspected some radio emission at the center of this cluster. We had taken a pointed observation on this cluster in the legacy GMRT at 150 MHz, 325 MHz, and also at VLA 1.4GHz with BnC configuration (P.I. R.Kale). The data reduction was done using the standard radio data analysis tasks in CASA v5.8. Only the 150 MHz data was analyzed using SPAM (in AIPS). Our full-resolution images have shown that there is no sign of diffuse emission at the cluster center at all three frequencies. To investigate further, we have made an image by subtracting the discrete point sources. Here also, we do not find any significant radio emissions at the cluster center. As the MWA has a very low resolution (~100 arcsec), some point sources may get blended in the central region. By using our high-resolution images (~12 arcsec), it is seen that four point sources are present in those regions. Combining our analysis and radio surveys (SUMSS, RACS), we have obtained the spectral indices of these point sources and extrapolated their flux densities to MWA observing frequencies. We then subtracted the total flux densities of these four point sources from the flux densities in that extended region in the MWA images. We have found that not much significant emission is present, except at 88 MHz, where we have 450 mJy of excess emission, which is still unexplained. We conclude that the extended emission that was suspected in the MWA image may be the blend of point sources due to the poor resolution of the MWA.

We have obtained an upper limit to the radio emission using UL-CALC [4], an automated script for the upper limit calculation of diffuse sources. Assuming an exponential surface brightness profile for the halo and a size of 700 kpc, we injected extended emission at the cluster center and then calculated the radio power of that extended emission, using the flux density, when the halo is detected at the 3σ level. By placing this upper limit in the radio power vs mass plane, it is seen that this cluster lies five times above the typical correlation. One explanation is that low mass cluster space is still unexplored, so whether this correlation will hold up at that mass level is also a big question. Maybe deep observations in the future can tell us more about this cluster.

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