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A Study of the Effect of the uGMRT RFI Filter using Cluster Observation

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Radio frequency interference (RFI) is a highly concerning issue during astronomical observations through ground-based radio telescopes such as the Giant Metrewave Radio Telescope (GMRT) [1]. Based on the effects of the RFI on any received signal from astrophysical sources, they are classified into two categories: narrowband RFI and broadband RFI. Narrow-band RFI is mostly a discrete frequency, arising from the TV or satellites, affecting only a narrow part of the frequency band. However, broadband RFI is a noisy signal that originates primarily from the sparking on power lines and causes an increase in the power level of the entire bandpass spectrum of the received signal. Over the years, several techniques have been developed to mitigate RFI, and have focused on narrowband RFI. The Upgraded GMRT (uGMRT), a radio telescope working in the low-frequency regime (150-1400MHz) with a wideband (400 MHz) backend [2], is affected by broadband RFI apart from narrowband RFI from satellites, and mobile phones. To deal with broadband RFI, a real-time RFI filter has been developed and implemented at uGMRT [3,4,5]. Here we present a comparative study between the observations taken with and without the RFI filter while observing a continuum radio source.

We recorded continuum radio observations of Abell 521, a massive galaxy cluster, at bands 3 (300-500 MHz) and 4 (550-850 MHz) using the uGMRT. For both the bands, observations were taken on consecutive days, one using the RFI filter and the other without. The observation time, the calibrators, and the other parameters are kept the same for both these observations; the RFI environment is expected to be similar. We have analyzed the radio data using the "CAPTURE" pipeline [6], written for the uGMRT continuum observation data analysis. We present the comparison of the flagging percentage of data with and without the filter. In the figure below, the flagging percentage vs the UVbaseline is shown for both bands 3 and 4. For the central antennas (<1kλ), the difference in flagging percentage is ~5 - 16% for band 3 and ~7-15% for band 4 between the filtered and unfiltered data. Longer baselines (>10kλ) also show a significant difference in the flagging percentage of ~8% for band 3 and ~ 9% for band 4. Thus, using an RFI filter has reduced the amount of bad data, which in turn improves the sensitivity of the radio images. We note here that the real-time filtering typically affected less than 2% of the samples and did not create any bias in the flux density measurement. The flagging also includes data lost to narrowband RFI, but overall, with the use of real-time filtering, we see that the flagging percentage is reduced for all the baselines.

Reference:
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[2]Y. Gupta et al., current science, 113, **4,** August2017, pp.
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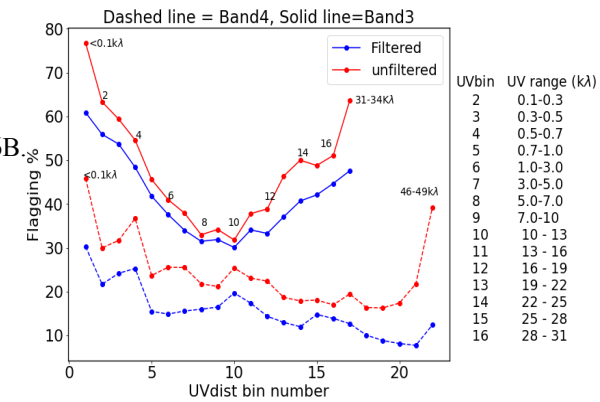

Figure.1. The plot shows the flagging percentage for different UV distances. The UVbin numbers and the corresponding UV range is also mentioned.