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Unveiling the Galactic Centre with New, Deep, Wide-field Radio Observations

Abstract: The Galactic Centre (GC) hosts a diverse population of radio-emitting structures that trace its complex and energetic environment. Among these, non-thermal radio filaments (NTFs) are long, narrow synchrotron-emitting structures uniquely associated with the GC, providing valuable probes of its magnetic fields and energetic processes. We have made a new deep wide-field 400 MHz mosaic of the GC region obtained with the uGMRT, covering approximately $\pm 2^\circ$ around the GC. With a resolution of $6.8'' \times 4.8''$ and a sensitivity of $250 \mu\text{Jy beam}^{-1}$, this is the highest-resolution and most sensitive low-frequency image of the region to date. We detect about 50 NTFs, including three newly discovered filaments from our image. All three exhibit steep radio spectra, confirming their synchrotron origin. Notably, one of the newly identified NTFs is the most distant filament in angular separation from the GC. Spectral index measurements for ~ 40 additional NTFs, derived using MeerKAT 1.3 GHz data, reveal predominantly steep-spectrum emission. We find evidence for a systematic steepening of NTF spectral indices with increasing absolute Galactic latitude, consistent with synchrotron aging and/or weaker shock acceleration at higher Galactic latitudes. We also present the first high-resolution low-frequency view of the Sgr E region and also identify several compact steep-spectrum sources as promising pulsar candidates. Our results provide new insights into the population and distribution of nonthermal structures in the GC region.

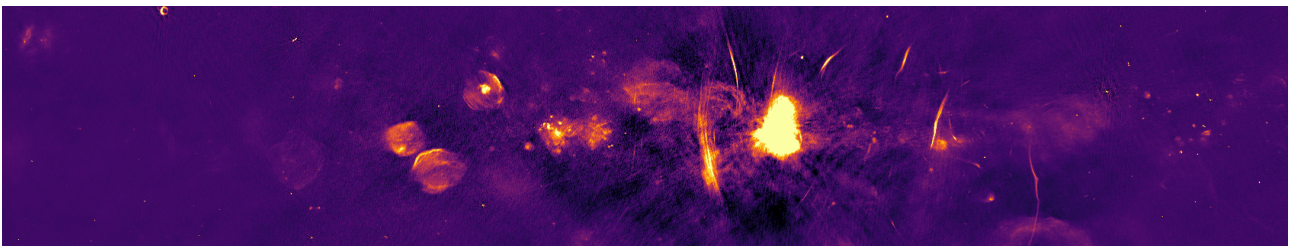


Fig: A portion of the Galactic plane showing the rich population of radio sources and structures, including NTFs, Supernova Remnants, H_{II} regions, and compact sources.