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Deriving plasma parameters of large coronal magnetic loops using J-burst observation from LOFAR

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Solar type J radio bursts are the signatures of electron beams travelling along closed magnetic loops in the solar corona. Type J bursts provide diagnostics for observing and understanding coronal loops geometry and electron beams dynamics. Due to the observational limitations, large loops around 1 solar radius in height are ill-defined. Whilst J-bursts at meter-wavelengths are well suited for the analysis of coronal loops at these solar altitudes, applying standard empirical solar plasma density distributions have limitations as they are designed for flux tubes extending into the solar wind and do not capture the curvature of such coronal loops.

We analysed over 20 type J bursts observed by the LOw-Frequency ARray (LOFAR) on the 10th of April 2019. Using a reference height, we derived the ambient plasma density models that varied along the ascending leg of coronal loops, and also with solar altitude. By estimating the density scale height, we inferred physical parameters of large coronal magnetic loops, roughly 0.7 to 1.5 solar radii above the photosphere. These coronal loops had temperatures around 2 MK and pressures around 5 dyn cm^{-2} . We then inferred the minimum magnetic field strength of these closed loops to be around 0.3 G. These large coronal loops' plasma conditions are significantly different to smaller coronal loops and loops that extend out into the solar wind.