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High fidelity spectroscopic imaging at low radio frequencies to estimate plasma parameters of solar coronal mass ejections at higher coronal heights

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Coronal Mass Ejections (CMEs) are large-scale explosive eruptions of magnetised plasma from the Sun into the Heliosphere. Measuring the physical parameters of CMEs is crucial for understanding their physics and for assessing their geo-effectiveness. Radio observations offer the most direct means for estimating these plasma parameters when gyrosynchrotron (GS) emission is detected from the CME plasma. However, since the first detection by Bastian et al.2001, only a handful of studies have successfully detected GS emission from CME plasma. This is usually attributed to the challenges involved in obtaining the high dynamic range imaging required for observing this faint gyrosynchrotron emission in the vicinity of active solar emissions.

The newly developed imaging pipeline (Mondal et al., 2019) designed for the data from Murchison Widefield Array (MWA) marks a significant improvement in metrewave solar radio imaging. Our work suggests that we should now be able to routinely detect GS emission from CME plasma. We present an example where we have successfully detected radio emission from CME plasma and modelled it as GS emission, leading to reliable estimates of CME magnetic field as well as the distribution of energetic electrons (Mondal et al. 2020). In a different example we are able to detect the radio emission from the CME plasma out to as far as 8.3 solar radii. We find that the observed spectra are not always consistent with simple GS models. This highlights that more complicated physics might be at play and points to the need for building more detailed models for interpreting these emissions. We hope that with the availability of polarimetric imaging capability, which we are in the process of developing, this technique will provide a robust way to routinely measure CME magnetic fields along with its other physical parameters. We note that these are the weakest detections of GS emissions from CME plasma reported yet.