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Localizing the Source of Type II Emission Around a CME with the Sun Radio Interferometer Space Experiment (SunRISE) and MHD Simulations

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The Earth's Ionosphere limits radio measurements on its surface, blocking out any radiation below 10 MHz. Valuable insight into many astrophysical processes could be gained by having a radio interferometer in space to image the low frequency window, which has never been achieved. One application for such a system is observing type II bursts that track solar energetic particle acceleration occurring at Coronal Mass Ejection (CME)-driven shocks. This is one of the primary science targets for SunRISE, a 6 CubeSat interferometer to circle the Earth in a GEO graveyard orbit. SunRISE is a NASA Heliophysics Mission of Opportunity that began Phase B (Formulation) in June 2020, and plans to launch for a 12-month mission in mid-2023. In this work we present an update to the data processing and science analysis pipeline for SunRISE and evaluate its performance in localizing type II bursts around a simulated CME.

To create realistic virtual type II input data, we employ a 2-temperature MHD simulation of the May 13th 2005 CME event, and superimpose realistic radio emission models on the CME-driven shock front, and propagate the signal through the simulated array. Data cuts based on different plasma parameter thresholds (e.g. de Hoffman-Teller velocity and angle between shock normal and the upstream magnetic field) are tested to get the best match to the true recorded emission. This model type II emission is then fed to the SunRISE data processing pipeline to ensure that the array can localize the emission. We include realistic thermal noise dominated by the galactic background at these low frequencies, as well as new sources of phase noise from positional uncertainty of each spacecraft. We test simulated trajectories of SunRISE and image what the array recovers, comparing it to the virtual input, finding that SunRISE can resolve the source of type II emission to within its prescribed goal of 1/3 the CME width. This shows that SunRISE will significantly advance the scientific community's understanding of type II burst generation, and consequently, acceleration of solar energetic particles at CMEs. This unique combination of SunRISE observations and MHD recreations of space weather events will allow an unprecedented look into the plasma parameters important for these processes.