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Radio diagnostics of electron shock acceleration in the corona at LOFAR frequencies

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Non-thermal electrons accelerated by solar eruptive events can excite Langmuir waves which can convert into radio radiation through the plasma emission mechanism. These radio emissions are directly related to the local plasma frequency, and thus used as a remote-sensing diagnostic of the local coronal conditions. Recent high-resolution LOFAR observations conducted at sub-second scales have allowed for unprecedented imaging of the sources of Type II solar radio bursts, emissions driven by shock waves in the corona. A Type II burst that transitions between a stationary state (where no frequency-drift is observed) to a drifting state was observed for the first time. The emissions were temporally and spatially related to an erupting jet and a streamer-puff CME. Unlike previous observations that relate stationary Type II bursts to termination shocks in solar flares, this observation has been related to the interaction between the streamer and the CME-driven shock that followed the jet eruption, accelerating electrons near the flanks of the CME where the shock is believed to be quasi-perpendicular to the local magnetic field. The location, however, of Type II radio sources with respect to the shock front has been debated. Turbulence in the solar corona affects the propagation of photons, distorting the true properties of radio sources and subsequently affecting the interpretation of the coronal properties. For example, scattering causes radio sources to appear farther from the Sun that their true emission location. Using a LOFAR observation of a Type II burst that experiences band splitting, it was shown that sources which appear to be spatially separated in images could in fact be co-spatial, once the frequency-dependent scattering shift was taken into account. These findings demonstrate the importance of considering radio-wave propagation effects when attempting to localise radio sources to characterise the origins of the emissions and hence the electron acceleration mechanism.

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