Abstract

Solar eruptions, encompassing phenomena like flares and coronal mass ejections (CMEs), are primary drivers of space weather. Understanding the underlying mechanisms of energy release, plasma heating, particle acceleration, and subsequent transport in the magnetized coronal environment remains a central challenge. Radio emissions, generated by energetic electrons produced during these events, serve as powerful remote sensing tools. This talk highlights our recent advancements in utilizing radio observations, particularly the technique of radio imaging spectroscopy, which combines spatial resolution with spectral information across a wide frequency range. We will demonstrate how this technique provides unprecedented diagnostics, allowing us to pinpoint the precise locations, timing, and evolution of electron acceleration sites within the complex eruptive structures. By analyzing spectro-spatial characteristics (e.g., burst positions, frequency drift rates, source sizes), we can infer properties of the accelerated electron populations and the ambient plasma conditions, thereby distinguishing between potential acceleration mechanisms such as magnetic reconnection in current sheets, stochastic acceleration in turbulent regions, or shock acceleration associated with CMEs. These detailed observational constraints are crucial for validating and refining the foundational physics within early-stage numerical and theoretical models of solar eruptions, ultimately improving our understanding of energy partition and particle energization in these dynamic events.