Wave Mode Identification and Implications of Plasma Waves Near the Electron Cyclotron Frequency in the Near Sun Solar Wind

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Recent studies of the solar wind sunward of 0.25 AU using the Parker Solar Probe spacecraft have revealed that that solar wind can be bimodal, alternating between regions of (i) nearly quiescent wind with low fluctuation amplitudes and Parker-like magnetic fields and (ii) highly turbulent plasma and magnetic field fluctuations associated with 'switchbacks' of the radial magnetic field.

The quiescent wind regions are highly unstable to the formation of plasma waves near the electron cyclotron frequency (fce), possibly driven by strahl electrons, which carry the solar wind heat flux, and may provide one of the most direct particle diagnostics of the solar corona at the source of the solar wind. These waves are most intense near ~0.7 fce and ~fce (Malaspina et al. ApJ, 2020). The near-fce waves are found to become more intense and more frequent closer to the Sun, and statistical evidence indicates that their occurrence rate is related to the sunward drift of the core electron population. The near-fce waves have not yet been observed in switchback regions.

In this study, we examine high time resolution burst captures of these waves, demonstrating that each wave burst contains several distinct wave types, including broader band harmonics and extremely narrow band waves highly sensitive to the magnetic field configuration. Using properties of these waves, including the Doppler shift of the narrow band mode, we provide evidence to support the identification of their likely plasma wave modes and the instabilities responsible for generating these waves. By understanding the driving instabilities responsible for these waves, we infer properties of the quiescent near-Sun solar wind.