STEREO/WAVES Science Nugget
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Eigenmode Structure in Solar-Wind Langmuir Waves

Type III solar radio bursts generate the strongest radio emission in the solar system. They are produced when solar flare generated electron beams propagate away from the Sun and through the solar wind. These beamed electrons drive plasma instabilities that lead to the growth of electron plasma oscillations, also called Langmuir waves. The mechanism by which Langmuir waves are converted into the observed type III radio emission is a sixty-year-old puzzle without observations that definitively distinguish among the theoretical possibilities.

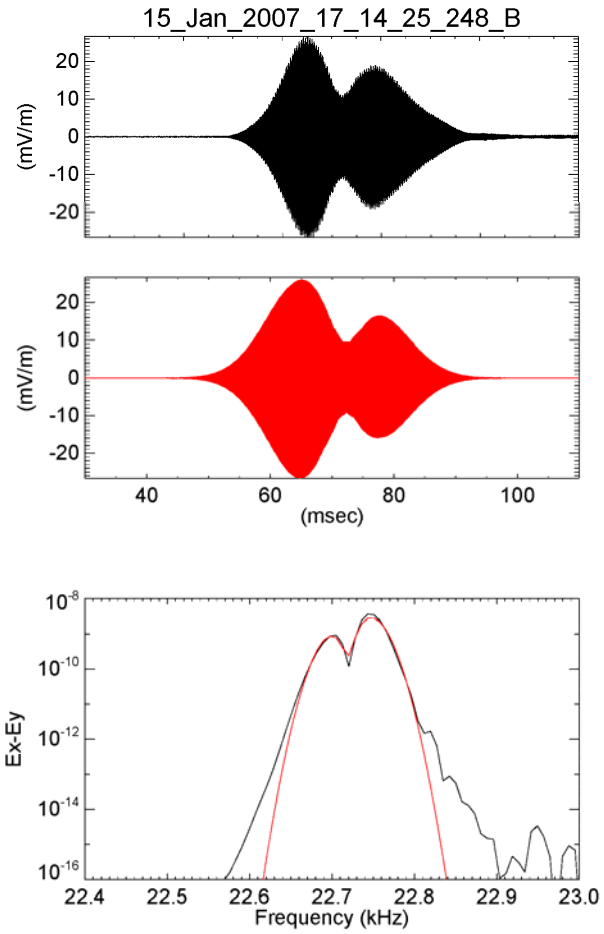
Using the unique measurement capabilities of the STEREO/WAVES electric field experiment, it was discovered that a large fraction of type III Langmuir waves share similar waveform envelope morphology. Further, the observed spatial- and frequency-domain signatures of these waves are well described as Hermite-Gauss eigenmodes of Langmuir waves trapped in parabolic density wells.

The mathematical formalism for Hermite-Gauss eigenmodes was developed in the context of quantum physics to describe waveforms trapped in a parabolic potential well. Yet STEREO/WAVES observations show that essentially the same equations describe electron plasma waves trapped in solar wind density wells.

This observational confirmation of Langmuir eigenmodes in the solar wind invites consideration of new mechanisms for the generation of type III radio emission, including the possibility of antenna radiation from intense, localized Langmuir wave eigenmodes.

Ergun, R. E.; Malaspina, D. M.; Cairns, I. H.; Goldman, M. V.;Newman, D. L.; Robinson, P. A.; Eriksson, S.;Bougeret, J. L.; Briand, C.; Bale, S. D.; Cattell, C. A.; Kellogg, P. J.; and Kaiser, M. L.: 2008, Physical Review Letters, 101, 051101. *Eigenmode Structure in Solar-Wind Langmuir Waves*.

Malaspina, D. M., Cairns, I. H., & Ergun, R. E. : 2010, Journal of Geophysical Research (Space Physics), 115, 1101, *The $2f_p$ radiation from localized Langmuir waves.*



(a) The electric field waveform of Langmuir waves in the solar wind. The waveform has near linear polarization along the local magnetic field direction. (b) The waveform reproduced from an eigenmode fit to the power spectrum (c) The observed spectrum (black) and the fit to a sum of eigenmodes (red).