STEREO/WAVES Science Nugget

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Evidence for wave-coupling associated to Type III radio bursts:

in-situ observations and kinetic simulations

The physical mechanism that triggers radio emissions associated to Type III bursts is a longstanding issue. Among different mechanisms, it has been considered that the radio emission observed at twice the plasma frequency (**T2fp**) could have its origin in a two step three-wave coupling, starting from the decay of large amplitude electron plasma waves (**L**) into ion acoustic waves (**S**) and a second daughter electron plasma wave (**L'**): **L –> L' + S**, followed by the scattering of both electron plasma waves into the radio wave emission **L + L' –> T2fp.**

An analysis of in-situ STEREO WAVES data has provided direct evidence for three-wave electrostatic coupling associated to Type III radio bursts [1]. We combined complementary spectral methods (Fourier, wavelet, bi-coherence) as well as a study of the frequency drifting to show the decay of electron plasma waves: **L –> L' + S**. The coherent density fluctuations of the ion sound waves (**S**) generated by this nonlinear coupling instability has been directly observed *in situ* for the first time.

In a complementary study, the threshold for the electron plasma waves decay instability **L –> L' + S** has been calculated using full kinetic Vlasov simulations [2], taking into account the finite spectral width of the waves. The instability threshold is confirmed by STEREO WAVES in-situ observations (Figure 2).

These two observational and theoretical complementary works give clear evidence for three-wave electrostatic coupling occurs during Type III radio bursts. It could be the first step toward the identification of the physical mechanism responsible for the radio emissions associated to Type III bursts.

[1] Henri, P.; Briand, C.; Mangeney, A.; Bale, S.D.; Califano, F.; Goetz, K.; Kaiser, M.: 2009, Journal of Geophysical Research (Space Physics), 114, A13, 3103. *Evidence for wave coupling in type III emissions*.

[2] Henri, P., Califano, F., Briand, C., & Mangeney, A.: 2010, Journal of Geophysical Research (Space Physics), 115, 6106. *Vlasov-Poisson simulations of electrostatic parametric instability for localized Langmuir wave packets in the solar wind.*

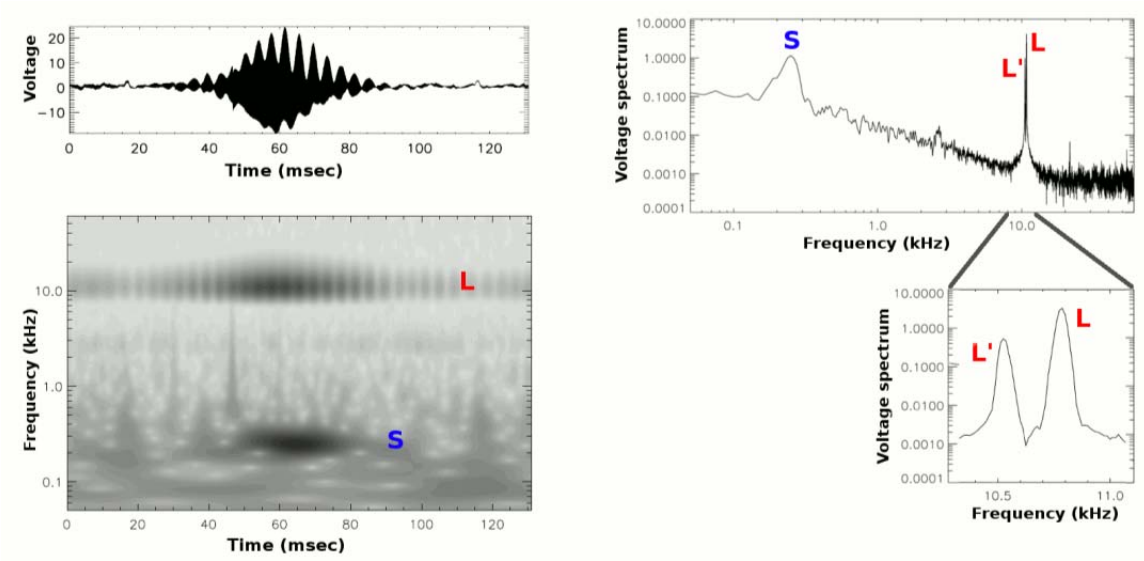

Figure 1: *Top left panel:* STEREO/WAVE electric antenna waveform showing a beating structure typical of wave coupling. *Bottom left panel:* Morlet wavelet transform of the waveform showing that the associated ion sound wave (**S**) is observed when the beating of electron plasma waves (**L**) is maximum. *Right panels:* Fourier spectrum showing both the ion acoustic wave (**S**) and the two electron plasma waves (**L** and **L'**) in a zoom view. [1]

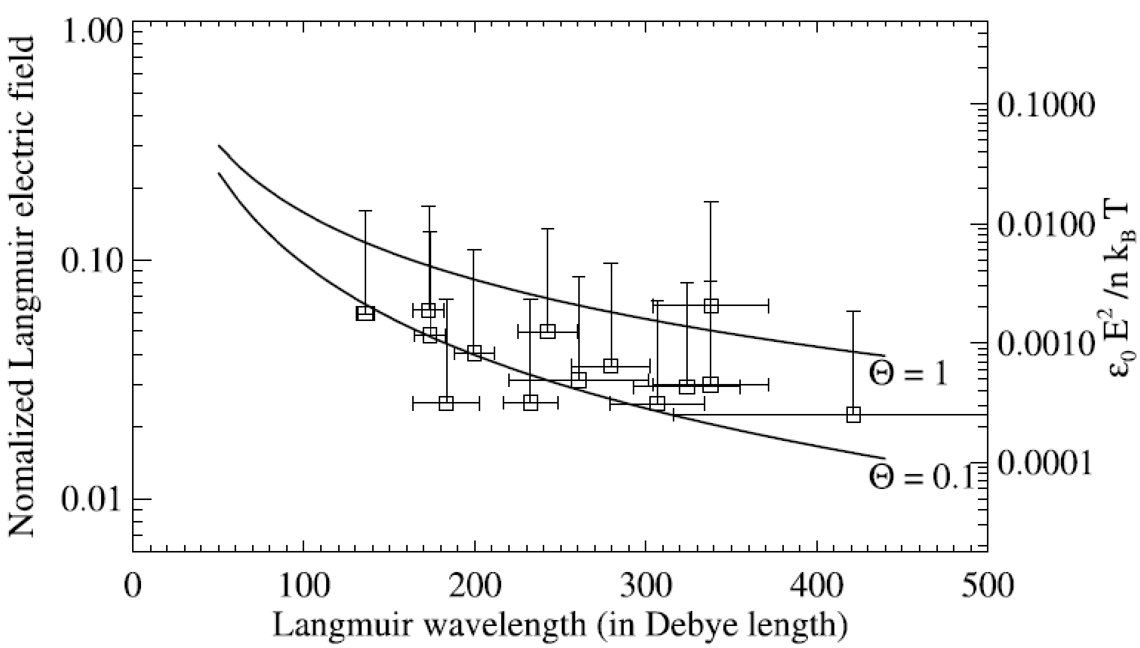

Figure 2: Theoretical threshold (black lines) for the electrostatic decay instability (three-wave coupling instability) of an electron plasma wave for two different ion-to-electron temperature ratios Θ=1 and 0.1, typical of solar wind conditions, shown in the wavelength-energy space. STEREO/WAVES in-situ observations are shown as squares with the associated error bars. [2]