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Direct evidence for three-wave coupling in the solar wind during a type III emission from STEREO/SWAVES data

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Abstract

The TDS (Time Domain Sampler) part of the WAVES experiment on board the two STEREO spacecraft allows the study of high resolution in-situ electric field waveforms in the solar wind.

From different TDS datasets, a complete set of direct evidence for three-wave coupling during a type III event have been recently reported [1], involving an electron beam-generated Langmuir wave (L), a second Langmuir wave (L') and ion acoustic density fluctuations (S). The mechanism is interpreted in term of the electrostatic Langmuir decay:

$$L \rightarrow L' + S$$

which is thought to be a first step toward the generation of type III radio emission at twice the plasma frequency ($EM_{2f_{pe}}$) from the coalescence of the two Langmuir waves: $L + L' \rightarrow EM_{2f_{pe}}$ [2].

First, the conservation of momentum and energy is checked through the resonant conditions on Doppler-shifted frequencies. Second, using information on the phase of the waves, a bicoherence analysis shows a good phase locking between the three waves, characteristic of a resonant interaction. Third, wavelet analysis allows to resolve for the first time the coupling regions, which spatial length is estimated to be 18 ± 5 km.

The Langmuir electrostatic decay dynamics is also investigated through Vlasov-Poisson simulations in order to confront the computed instability thresholds, growth rates and levels of saturation for density fluctuations with the STEREO/WAVES observations.

References

[1] Henri, P. et al. (2009), *JGR*, 114, A03103

[2] Ginzburg, V. L., and Zheleznyakov, V. V. (1958), *Soviet Astronomy*, 2, 653.