Evidence of Langmuir/Z-mode Wave Decay into Z-mode Electromagnetic Radiation in the Solar Wind

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Résumé

The nonlinear decay of Langmuir/Z-mode waves into electromagnetic Z-mode wave radiation near the plasma frequency is studied in the framework of Particle-In-Cell simulations. Guided by the numerical study, a Langmuir wave snapshot recorded during the encounter of the Solar Orbiter satellite with an electron beam associated with a Type III radio burst is found to exhibit the generation of Z-mode waves through this process. The decay process is identified through multiple lines of evidence: satisfaction of frequency and wavevector resonance conditions, strong phase coherence and temporal coincidence between the interacting waves, exclusion of competing mechanisms, and full agreement with theoretical predictions. Two-dimensional Particle-in-cell simulations, conducted under close beam-plasma conditions, successfully reproduce the key features of the observations. Notably, they suggest that the wave packet observed by Solar Orbiter may be trapped within an extended, nearly flat-bottomed density well, where the decay process is not overcome by wave scattering on random density fluctuations and subsequent mode conversion effects.

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