

Do Langmuir wave packets in the solar wind collapse?

In type III solar radio bursts and planetary foreshocks Langmuir waves are generated by electron beams and are subsequently converted to radio waves. One proposed mechanism for generating localized wave packets and propagating radio waves is wave packet collapse, in which localized Langmuir waves shrink in spatial scale and increase in field strength. This process occurs when nonlinear self-focusing exceeds linear dispersion. For wave packet collapse to occur the peak electric field must exceed a threshold field strength. There is still ongoing debate over whether wave packet collapse is a viable process in the solar wind.

STEREO/WAVES records electric field waveforms in three orthogonal directions and records high resolution data over time intervals sufficient to capture the entire waveform of localized Langmuir waves. This makes STEREO/WAVES ideal for determining (a) whether the observed Langmuir waveforms are consistent with the waveforms of collapsing wave packets in three-dimensional simulations and (b) whether the maximum field strengths exceed the threshold for collapse.

A survey of 167 Langmuir waveforms observed by STEREO/WAVES from eight different type III source regions show that none of the observed waveforms have fields consistent with wave packet collapse (Figure 1). Detailed fitting to localized Langmuir waveforms reveals that approximately 30% have structure consistent with the known structure of collapsing wave packets but have fields too small for collapse to proceed.

These results show no evidence for wave packet collapse in type III radio bursts. Thus wave packet collapse cannot account for type III bursts. The localized Langmuir waves observed in type III source regions are more likely Langmuir eigenmodes of pre-existing density wells.

Graham, D. B.; Cairns, Iver H.; Prabhakar, D. R.; Ergun, R. E.; Malaspina, D. M.; Bale, S. D.; Goetz, K.; and Kellogg, P. J.: 2012, *Journal of Geophysical Research*, 117, A09107. *Do Langmuir wave packets in the solar wind collapse?*

Graham, D. B.; Cairns, Iver H.; Malaspina, D. M.; and Ergun, R. E.: 2012, *Astrophysical Journal*, 753, L18. *Evidence against the Oscillating Two-stream Instability and Spatial Collapse of Langmuir Waves in Solar Type III Radio Bursts*

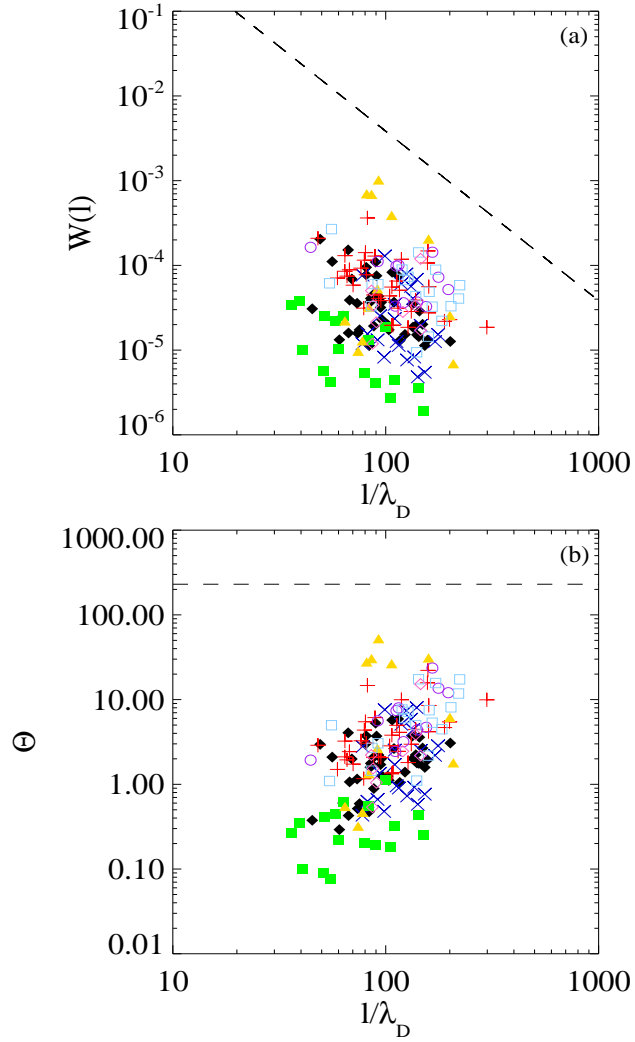


Figure 1: (a) Energy density $W(l)$ at l versus l/λ_D and (b) the collapse threshold Θ versus l/λ_D . Collapse is allowed above the dashed lines, corresponding to $\Theta_C = 230$, in (a) and (b). Data points are from 8 different events on: 2008 April 26 (red pluses), 2010 February 18 (pink diamonds), 2010 August 18 (purple circles), 2010 September 12 (light blue squares), 2011 February 26 (black diamonds), 2011 June 04 (yellow triangles), 2011 August 16 (green squares), 2011 September 30 (dark blue crosses).