STEREO Science Nugget
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Langmuir wave polarization depends on electron beam speed in type III solar radio bursts

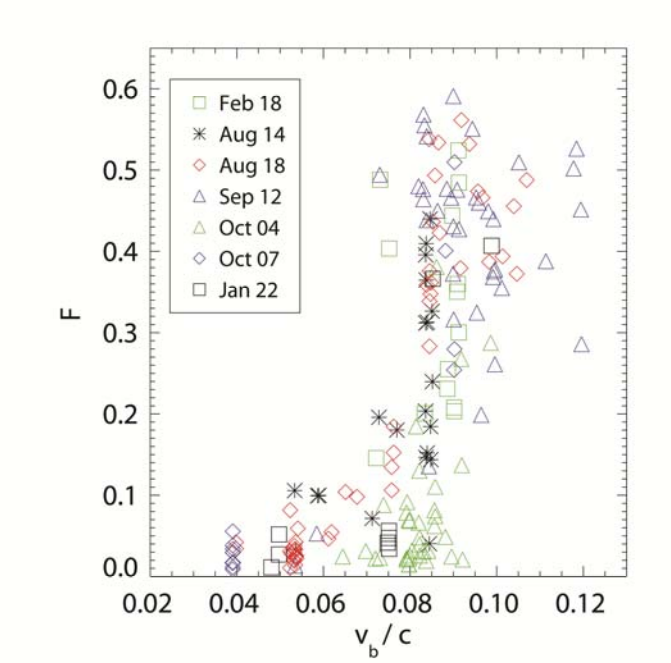
Electrostatic Langmuir waves are generated when electron beams, accelerated by solar flares, travel through the interplanetary medium at close to the speed of light. The Langmuir waves grown along the beam path generate electromagnetic radiation that is observed as type III radio bursts. When the electron beam passes over the STEREO spacecraft, local Langmuir waves are observed in-situ.

STEREO/WAVES is the first in-situ electric field instrument able to observe solar wind Langmuir waves in three-dimensions with waveform captures longer than 100 ms. Using this unique capability, it was found that the Langmuir waves associated with type III radio bursts show complex three-dimensional polarization when the driving electron beam is fast (> 0.08 c) and they show simple one dimensional polarization along the local magnetic field direction when the driving electron beam is slow (< 0.08c).

Analysis of the STEREO data strongly suggest that the complex polarization during fast beams is due to the conversion of normal Langmuir waves into Langmuir/z-mode waves through interactions with solar wind density turbulence. The evidence for Langmuir/z-mode waves supports the theory that Langmuir wave radiation is due to wave mode conversion at density gradients. This is an important clue in solving the sixty-year old problem of observationally determining the mechanism that generates electromagnetic radiation from electrostatic Langmuir waves.

Further, because Langmuir wave polarization contains information about driving electron beam speeds, it may be possible to use these waves to measure the speed of electron beams too tenuous or time variable for measurement by particle detectors.

"Dependence of Langmuir wave polarization on electron beam speed in type III solar radio bursts" Malaspina, David M.; Cairns, Iver H.; Ergun, Robert E. Geophysical Research Letters, Volume 38, Issue 13, CiteID L13101 (07/2011)



Fraction of total wave energy density (F) contained in electric field fluctuations perpendicular to the local magnetic field, for all TDS events from seven type III radio burst periods as a function of the estimated beam speed associated with each TDS event.