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**Observations of nonlinear couplings between electron and ion dynamics  
using the STEREO spacecraft as a density probe**

In order to study the nonlinear coupling between electron and ion dynamics, one must observe both the electric field and density at high rates. Measuring electric field is not a problem; the issue is to measure plasma density at the same time.

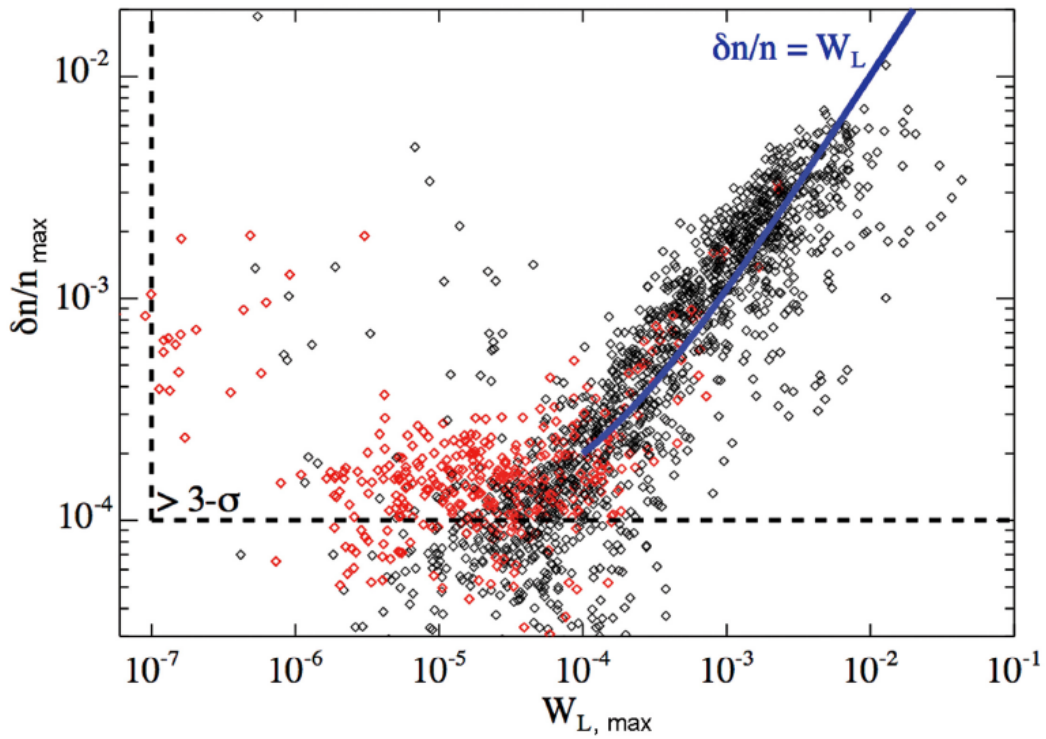
We developed a new technique to observe *in situ* plasma density fluctuations in a frequency range well above what is currently available in space instrumentation. The method is based on the dependence of the spacecraft floating potential on the surrounding plasma density and uses monopole antennas that act as a ground in the frequency range of interest.

This new technique has been applied to STEREO/WAVES antennas used in monopole configuration; the STEREO spacecraft itself is used as the density probe. It provides, for the first time, direct *in situ* observations of density fluctuations in the solar wind at high frequency (in the electrostatic frequency domain, above the electron cyclotron frequency).

By coupling *in situ* observations of the electric field associated with electron plasma waves to *in situ* observations of plasma density (using the newly developed technique), we observe the nonlinear coupling between electron plasma waves and density fluctuations. The coupling is an *electrostatic ponderomotive effect* and is characteristic of electrostatic turbulence. It is observed to be particularly efficient in the Earth electron foreshock. [1]

This work opens new opportunities to study nonlinear processes in the solar wind as well as extend turbulence studies to the electrostatic frequency domain.

- [1] Henri, P., Meyer-Vernet, N., Briand, C., & Donato, S. : 2011, *Physics of Plasmas*, 18, 082308. *Observations of Langmuir ponderomotive effects using the Solar TERrestrial RELations Observatory spacecraft as a density probe.*



**Figure:** Maximum observed density fluctuations  $\delta n/n_{\max}$  vs. the maximum electric energy of electron plasma waves  $W_{L, \max}$ , in the electron foreshock (*black diamonds*) and the free solar wind (*red diamonds*). The blue line represents the expected level of density fluctuations generated by Langmuir nonlinear ponderomotive effects. The black dotted lines show the 3-sigma detection levels. More than three years of STEREO/WAVES data are summarized in this plot.