Electron Acoustic Waves (EAW)

EAW’s are novel kinetic waves that exist only because nonlinear trapping turns off Landau damping. We recently provided the first experimental characterization of EAW’s, showing that they are easily excited by low amplitude drive applied at the theoretically predicted frequency. The driver automatically creates the required trapped particle distribution. Surprisingly, large amplitude drives excite the modes off resonance over a broad range of frequencies. The driver modifies the particle distribution until a kinetic wave can exist at the driver frequency.

The results are summarized in the figure on the right. The blue crosses and squares are linear Langmuir waves (called Trivelpiece-Gould waves for a magnetized plasma column), and the red dots and crosses are the EAW’s. Both sets of points lie close to the theoretically predicted dispersion curve. The broad purple bar shows the frequency range over which EAW-like waves (KEEN waves ?) are excited by a large amplitude drive.
EAW’s continued.

To measure the trapped particle velocity distribution we developed a post-hoc coherent detection technique for our laser induced fluorescent measurements, in which the arrival time of every photon is recorded and later binned according to wave phase. The figure on the left shows a schematic of the pure ion plasma device and associated LIF system, and the figure on the right shows the measured phase space velocity distribution for an EAW. A trapped particle region is clearly visible at the wave phase 180 degrees. (Note that electron acoustic wave is a misnomer; the wave dynamics involves only a single species, so the wave exists in a pure ion plasma.)