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Langmuir Eigenmodes of Density Wells in the Solar Wind and Planetary Foreshocks

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Localized Langmuir waves are commonly observed in type III solar radio bursts and planetary foreshocks and are a potential source of some of the radio waves observed at the local electron plasma frequency and its harmonics. Recent analytic work shows that localized Langmuir eigenmodes of density wells can produce radio waves via an antenna mechanism. By measuring the electric field waveforms and density perturbations using STEREO spacecraft data, it is shown that these localized Langmuir waves are eigenmodes of density wells. An analytic model is developed for the eigenmode frequencies. The depths and widths of the observed density wells typically only allow the lowest order Langmuir eigenmode to form, explaining the preponderance of single-peaked waveforms. More complicated waveforms are shown to be consistent with single eigenmode solutions of more complicated density profiles. The depth of the density well increases with the intensity of Langmuir waves, providing evidence for the ponderomotive force but not wave packet collapse. The relationships found here between eigenmode electric fields and density depletions will in the future significantly constrain the role of eigenmodes in producing radio waves in type III solar radio bursts and planetary foreshocks.