A THEORY OF FARLEY-BUNEMAN WAVE STABILIZATION: DECOHERENCE

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We propose a new mechanism for the stabilization of primary Farley-Buneman waves. Wave stabilization occurs due to spatial decoherence of the primary wave with the EXB drifting electron fluid parcels driving the instability.

Many of the previous studies invoking mode coupling arguments of wave stabilization assumed a uniform background flow and calculated separately the effect of nonlinear drifts on the evolution of the waves. Our description of the wave-background interaction is one where the nonlinear mode coupling processes disrupt the electron flow through fluctuating EXB drifts making it nonuniform in space and time. Such fluctuations are attributed to the secondary ion acoustic structures generated through mode-coupling. A plane Farley-Buneman wave on such nonuniform background will be observing and interacting with a mixture of background flow patches convecting at different velocities. When this happens, the wave loses resonance with the background flow. We term this picture as wave decoherence.

A modified fluid equation for electrons is introduced that takes into account a model nonuniform and fluctuating background electric field representing the above picture. A single parameter directly enters into the system of equations describing this interaction: the spread or the mean square value of the turbulent electron flow after the mean flow velocity is subtracted. The new theory predicts a modified anisotropy factor, albeit through a collisionless process in contrast to previous works invoking anomalous electron collisions. The predicted anomalous anisotropy factor is complex and does not have a simple analytical solution. Numerical solutions of the new dispersion relation predict a reduced wave phase velocity and growth rate as the turbulent spread increases.

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