Kinetic Studies of Crossfield Plasma Instabilities in Weakly Collisional Plasmas

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Ionospheric plasma instabilities are frequently studied phenomena which can affect ionospheric electrodynamics [1]. In the lower layers of ionosphere, two-stream like instabilities are common, due to a high collision frequency between ions and neutrals and in the analysis, ions are often assumed as stationary, as in for example the Farley-Buneman instability [2].

In the upper layers of the ionospheric E-layer one can find conditions where for both plasma species the collision frequency is lower than the relevant cyclotron frequency, thus both species will drift in the **E**×**B** direction. On the basis of the previous numerical results [3], we have simulated these weakly collisional plasmas using a Particle-In-Cell code, and observed highly nonlinear, unstable regimes. In our study, we have considered two types of collisions for ions: charge exchange and elastic scattering, and found different instability characteristics such as electrostatic potential fluctuations or electrostatic wave spectra for each type of collision. In addition to numerical simulations, we focus on analytical studies based on kinetic theory. We derive the dispersion relation and follow the linear analysis for addressing such problems as finding the stability conditions and parameters for the maximal growth rate of the instability. Our numerical and analytical studies can improve the understanding of ionospheric phenomena and relevant processes in laboratory experiments.

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