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Vlasov-Poisson simulation of current-carrying ion acoustic instability: nonlinear saturation and ion kinetics

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Current-carrying ion acoustic instability is one of the most fundamental phenomena in plasma physics. The electron stream relative to the ion stream undergoes an electrostatic instability, e.g. Buneman instability. In the presence of thermal effects, the ion Landau damping occurs, which sets a minimum threshold for the drift velocity for the instability to grow. In this talk, a grid-based direct kinetic (DK) simulation is used to investigate the long-time nonlinear saturation and particularly the ion kinetics of this streaming instability. The phenomenon is characterized by the electron Mach number, namely, the ratio between the electron drift velocity and the electron thermal velocity. First, the numerical results are verified against the theory which is valid for small electron Mach numbers. Second, transition to a large-amplitude waves that propagate in both directions (along and opposite direction of the original electron stream) is observed at electron Mach number larger than 1.3, which was previously reported. Finally, the potential amplitude and high-energy ions formed by the large-amplitude plasma waves are characterized. Using a simple sputtering rate model, the numerical results show that such high-energy ions may be a potential cause of enhanced erosion in hollow cathodes.

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