Non-MHD effects in the nonlinear development of the MHD-scale Rayleigh-Taylor instability

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The nonlinear evolution of the Rayleigh-Taylor instability (RTI) at a density shear layer transverse to magnetic field in a collisionless plasma is investigated by means of a fully kinetic Vlasov simulation with two spatial and two velocity dimensions. The primary RTI in the MHD regime develops symmetrically in a coordinate axis parallel to gravity as seen in the previous MHD simulations. The primary RTI in the Hall-MHD regime develops asymmetrically in a coordinate axis parallel to gravity. A compressible flow is formed at the secondary density shear layer by the Hall effect, which generates a strong scalar pressure gradient of ions. A Hall electric field due to the diamagnetic current results in the asymmetric flow at the tip of the finger structure. In the primary RTI with the ion gyro kinetic effect, secondary RTI with a wavelength shorter than the wavelength of the primary RTI is generated at the saturation stage of the primary RTI. A seed perturbation for the secondary RTI is excited by another secondary instability due to the coupling between the electron stress tensor and the Hall electric field. The heat flux term plays an important role in the time development of the total pressure. On the other hand, the contribution of the ion stress tensor is small in both the electric current and the total pressure.

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