Secondary instabilities in the collisionless Rayleigh-Taylor instability: Full kinetic simulation

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The Rayleigh-Taylor instability (RTI) is a well-known hydrodynamic instability in neutral fluid as well as in magnetized plasma, which grows at an interface between two fluids when a light fluid supports a heavy fluid against an external force such as gravity. In previous studies, various numerical simulations for the RTI have been performed by using the MHD code, the Hall MHD code, the Finite-Larmor-Radius MHD code and the hybrid particle-in-cell code. In this study, the nonlinear evolution of the RTI at a density shear layer transverse to magnetic field in 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. Small-scale secondary instabilities are generated due to secondary density/velocity shear layers formed at the nonlinear stage of the primary RTI. The secondary instabilities take place asymmetrically in the coordinate axis parallel to gravity. It is suggested that these secondary instabilities correspond to the electron Kelvin-Helmholtz instability generated by the electron velocity shear, whose evolution depends on the sign of the inner product between the magnetic field and the vorticity of the velocity shear layer.