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Turbulence formation via the Kelvin-Helmholtz vortex in an asymmetric velocity shear layer: 2D PIC simulations

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We have investigated the turbulence formation process in collisionless plasmas via the Kelvin-Helmholtz (KH) vortex using two-dimensional full kinetic simulations. In viscous fluid, it is well-known that eddy turbulence can easily appear for large Reynolds numbers. In collisionless plasmas, on the other hand, the generation mechanism of turbulence is still under debate even though turbulence features have frequently been observed in various regions such as the solar wind and the Earth's magnetospheric boundary layer. An important candidate for the turbulence formation is the KH vortex which grows in a velocity shear layer. Past numerical studies showed that density jump across the velocity shear layer can induce secondary smaller scale KH waves which can disturb the parent vortex structure and cause turbulence within the vortex. Unfortunately, however, past studies also suggested that these secondary waves tend to be strongly stabilized by only a weak magnetic field parallel to the shearing flow, since such a parallel field tends to be strengthened at the edge of the vortex where the secondary waves are induced. Nevertheless, this study revealed that the secondary waves can easily appear via the vortex-induced reconnection (VIR) which is induced within the vortex and release the strengthened parallel magnetic field. This study further revealed that the turbulence via the secondary waves causes efficient perpendicular heating of ions and electrons within the vortex. In our presentation, we will show detailed results of our full kinetic simulations and discuss how important the eddy turbulence via the KH vortex is in space plasmas.