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Spatial Evolution of Kelvin-Helmholtz Vortices

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We have performed two-dimensional fluid simulations in order to investigate the spatial evolution oh the Kelvin-Helmholtz instability (KHI). Here we set the box size in the flow direction to be much larger than the wavelength of the instability and let the instability develop as its seed is conveyed with the flow from the upstream boundary. Free boundary conditions are taken in the flow direction. Two domains, low density region (plasma-sheet region) and high density region (magnetosheath region) separated by the velocity shear layer are situated. Comparing the results from this model with those obtained under the periodic boundary condition, we find (1) the K-H vortices to show a new behavior around the saturation time and (2) soon after the saturation the vortex size expands very rapidly. These results mean that allowing a room for the spatial development, which is not the case for periodic systems, has significant impact on the vortex coalescence process. We have also made the density contrast across the shear layer to be so high that the velocity jump is larger than twice the sound velocity of the higher density (lower temperature) side. Overcoming the stabilization effect by the increased compressibility of the system, the rapid expansion of the vortex size is seen equally vigorously even in this case. The results suggest that the plasma mixing across a shear layer may occur more efficiently than one would think on the basis of results from a periodic system.