A Study of Evolutions of Growth Rates and the Most Unstable Modes in the Events of Sub-magnetosonic Kelvin-Helmholtz Instabilities in an MHD plasma

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The growth rates of the sub-magnetosonic Kelvin-Helmholtz (K-H) instability in an unbounded magnetohydrodynamic (MHD) plasma are studied theoretically based on the new shooting method we proposed in Refs. [1] and [2]. Traditionally, the eigenfunction of the unstable mode in the K-H instability is obtained by integrating the governing equations from a given perturbation boundary. In the new shooting method, the eigenfunction of the unstable mode in the K-H instability is obtained by integrating the governing equations from the center of the velocity shear layer. We found that the location of the perturbation boundary varies with tangential wavelength, the growth rate, and the Mach numbers of the surface waves. To verify our theoretical results, we have carried out a higher-order MHD simulation. Our simulation results indicate that when the locations of the perturbation boundaries expand away from the center of the velocity shear layer, the growth rate decreases, and the tangential wavelength of the most unstable mode increases. Both the amplitude distributions and the phase distributions of the eigenfunctions obtained in our simulations are in good agreement with those obtained in our theoretical studies.

References

[1] Chang, Y. W., and L. H. Lyu (2015), A new analysis of the vortex-size dependent growth rate of Kelvin-Helmholtz instability. 2015 AGU Fall Meeting, San Francisco, California, U.S.A.

[2] Lyu, L. H., and Y. W. Chang (2016), Stability analysis of the sub-magnetosonic Kelvin-Helmholtz instability in an unbounded magnetohydrodynamic plasma. 2016 AGU Fall Meeting, San Francisco, California, U.S.A.

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