On the self-heating phenomenon in non-modal shear flow

J. W. Li(1,2), Y. Chen(2), Z. Y. Li(2)

(1) National Center for Space Weather Monitoring and Warning, China Meteorological Administration, (2) School of Earth and Space Science, University of Science and Technology of China

In this article the non-modal self-heating phenomenon of linear shear flow is investigated with an initially-excited Alfvénic perturbation focusing on the factors determining the efficiency of the heating process. It is found that to get an efficient self-heating process, the initial Alfvén wave must be at least partially transformed into the fast mode. This is because only the fast mode, among the three types of magnetohydrodynamic modes, can get amplified significantly by the shear flow. This requires the initial wave number along the shear to be positive so that the Spatial Fourier Harmonics can pass through the degeneration region, and also puts constraints on the plasma parameter β ($\beta = \frac{C_S^2}{V_A^2}$, where C_S (V_A) is the sound (Alfvénic) velocity). It is shown that the self-heating function, which represents the total energy dissipated at a certain time, decreases monotonically with increasing β. In addition, to get efficient heating the viscous coefficient should be located in an appropriate range. A smaller viscosity results in an insufficient thermalization of the perturbation energy, while a larger one corresponds to a suppressed non-modal amplification.

Since velocity inhomogeneities and Alfvénic perturbations permeate in the solar wind plasmas, this study may be relevant to the dissipation of Alfvén waves as well as the heating process in the solar wind.