径方向に開いた太陽風中の非線形アルヴェン波の理論モデル

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A theoretical model of nonlinear Alfven waves in the radially expanding solar wind plasmas

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It is well known that the magnetohydrodynamic (MHD) turbulence in the vicinity of the sun (inner heliosphere) often has the clear correlation between the magnetic field and the bulk velocity. This correlation is known as the Walen relation, which indicates the MHD turbulence is mainly composed of the nonlinear Alfven waves. In the inner heliosphere, the inhomogeneity of the background magnetic field and plasmas may affect the wave dynamics. To discuss effects of the inhomogeneity of the inner heliosphere on the wave dynamics and instabilities in detail, the expanding box model (EBM) has received attention in recent years. However, few studies have applied the EBM to the nonlinear evolution of low-frequency Alfven waves. In this study, we revisit the EBM to discuss the nonlinear Alfven waves in the radially expanding solar wind plasmas. We derive multi-dimensional nonlinear evolution equations of Alfven waves in the radially expanding plasmas by using the reductive perturbation method. The theoretical models are compared with the numerical results of the hybrid EMB.