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A theoretical model of nonlinear Alfven waves including kinetic compressional modes

NARIYUKI, Yasuhiro[1*]

[1]Faculty of Human Development, University of Toyama

It is well known that magnetohydrodynamic (MHD) turbulence in solar wind plasmas often has clear correlations between magnetic field and velocity field (Alfvenic correlations). Although it is widely believed that Alfvenic fluctuations play important role in making developed MHD turbulence and scattering charged particles, damping processes of the fluctuations have not been clarified yet. Over the nearly four decades, nonlinear evolution equation of Alfven waves has been discussed by many authors. Mio etal(1976) and Mjolhus(1976) derived a nonlinear evolution equation of envelope-modulated Alfven waves. Rogister(1971), Mjolhus and Wyller(1988), and Spangler(1989,1990) derived a kinetic-fluid model including nonlinear Landau damping of compressional fluctuations. Hada (1993) derived a nonlinear evolution equation set including compressional propagating mode by using a novel expansion. In the present study, we discuss a nonlinear evolution equation of Alfven waves including both kinetic effects and compressional modes. Such a model was phenomenologically discussed by Nariyuki and Hada(2007). We here systematically derive and discuss the expansion of Hada (1993) in the resultant kinetic-fluid model. We also discuss effects of mean fields and thermal noises.

Keywords: Alfven waves, kinetic theory, solar wind