NONLINEAR LOCALIZATION AND TURBULENCE IN MAGNETIZED PLASMAS

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by

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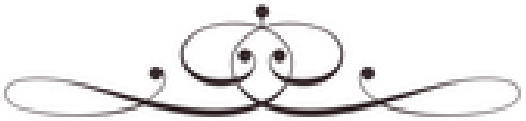

Dedicated to

my

Beloved Parents,

Brother

and

God

Certificate

This is to certify that the thesis entitled **"Nonlinear Localization and Turbulence in Magnetized Plasmas"** being submitted by **Ms. Swati Sharma** to the Indian Institute of Technology Delhi, for the award of the degree of ***Doctor of Philosophy***, is a record of bonafide research work carried out by her. The thesis has reached the standards fulfilling the requirement of the regulations relating to the degree. The results contained in this thesis have not been submitted in part or full to any other university or institute for the award of any degree or diploma. I approve the thesis for the award of the aforesaid degree.

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(***Swati Sharma)***

Abstract

The space environment consists of fully (Sun, solar wind, magnetosphere) or partially ionized plasmas (ionosphere etc) and neutral particles. The space plasma is extremely turbulent in nature and has been studied for decades using satellite observations and models. Despite these studies, the exact mechanism leading to the acceleration and heating of the solar wind is not well understood. In order to improve the understanding of physical mechanisms that are involved in these processes present study is carried out. The thesis aims towards the role played by dispersive Alfvén wave (DAW) in explaining several features observed in solar wind such as particle heating, formation of localized structures, spectral transfer of energy between different length scales etc. The dispersion in Alfvén wave is considered on account of the finite frequency correction of the wave. In finite frequency correction, we assume that the frequency of pump wave is not negligible compared with the ion cyclotron frequency. The two modes of circularly polarized DAW, left (L) and right-handed (R) fluctuations are found to behave very differently at small scales. The properties of these modes and diverse aspects of spectral transfer of wave energy over different wavenumbers is analyzed. DAW is prone to parametric instabilities such as filamentation or transverse collapse. The nonlinear interaction of DAW with other wave modes such as ion acoustic wave and magnetosonic wave is treated with ponderomotive nonlinearity using two fluid approaches. The nonlinear coupling of L and R modes; and its effect on the localized structures and resulting power spectrum is also studied in present thesis. The present research is devoted to study the nonlinear evolution of DAW in space and time using numerical techniques and semi-analytical

tools to develop basic understanding of the physics involved in DAW localization. Numerical simulation is performed to analyze the dependence of localization upon the initial wave frequency and turbulence evolution for different set of frequencies. To analyze the influence of initial condition, numerical simulation is performed by varying the initial profile of perturbation superimposed on DAW. The compressibility associated with waves such as IAW, kinetic Alfvén wave (KAW) may contribute in explaining the spectral transfer of energy at small scales. The power spectrum is studied for field and density fluctuations. The results obtained are discussed with relevance to the observations including their implication in solar wind regime.

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