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Dispersive Alfven Waves and It's Nonlinear Evolution with Background Magnetic Islands in the Solar Wind

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Since a long time, it is alleged that the linear and nonlinear dynamics of Alfvén waves are responsible for some of the key qualitative features of plasma turbulence that distinguish it from hydrodynamic turbulence, including the cascade of energy and the development of coherent structures or current sheets at small scales (1). In addition, the occurrence of magnetic reconnection in turbulent plasmas and its interplay with a fully-developed turbulent state and vice-versa is another matter of great debate. Studying the relation between turbulent dissipation and reconnection is very important for completely understanding the space plasma dynamics. Perri et al. (2012) have reported the formation of current sheets or coherent structures in the dissipation region of the solar wind turbulence. They provided direct evidence of the existence of current sheets (and possible coherent structures) of sub-ion scales where turbulent dissipation through magnetic reconnection may take place. Therefore, further investigation is needed to determine whether the turbulent dissipation arises as a consequence of magnetic reconnection or other processes, like instabilities which causes the formation of coherent/localized structures or/and both. Recently, Voros et al (2014) have demonstrated using Wind data that reconnection outflow may generate turbulence in solar wind plasmas. They indicated that for the fluctuations driven by the outflow, the observed scaling exponents in the inertial and dispersive regime resembles those in the solar wind. Further, the dynamical processes of turbulence and magnetic reconnection may give rise to the formation of magnetic islands of various forms from round to elongated ones. We propose that dispersive Alfven waves (DAW) may interact nonlinearly with these magnetic islands at the reconnection sites leading to the development of coherent structures and current sheets. The scale size of these current sheets ranges from sub-ion scales to ion scales. A two-fluid model is used to formulate the dynamical equations of the concerned wave. Numerical simulation is performed to study the evolution of coherent structures or current sheets in the spatial domain. We see that both the mechanisms i.e., reconnection and instabilities support the formation of coherent or localized structures. Also, current sheets of size of the order of few ion inertial scales are formed. Using a semi-analytical model, the dependence of the scale size on the field strength of DAW is also studied. Power spectral density is obtained to study the fluctuations at small scales. The consistency of these results with the observational (2,3) findings is also discussed. Thus, we can say that the spectral break around the ion inertial length scales could be associated with the formation of current sheets, or the coherent structures or Hall effect, that may eventually account for the heating via magnetic reconnection

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