Anisotropic Spectra of Weak Alfvén Wave Turbulence in High Latitude Ionosphere and Magnetosphere

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Recently, a k^{-3} energy spectrum has been obtained from a theory of weak anisotropic magnetohydrodynamic turbulence which involves a cascade of energy from large to small scales due to collisional interaction of oppositely propagating shear-Alfvén wave packets. It is suggested that this theory may help explain the observed k^{-3} spectrum in high-latitude ionospheric and magnetospheric turbulence for electric fields with $k > 1$ km^{-1}. Previously, such turbulence has been thought to be electrostatic in nature. However, recent rocket and satellite measurement combine with modeling efforts [D. J. Knudsen, M. C. Kelley, and J. F. Vickery, J. Geophys. Res., 97, 77, 1992] suggest that Alfvén waves do exist in such regions, and that the observed refractive index may be explained by interference effect from waves propagating in opposite directions. This suggests that electromagnetic modes are important. Based on three-wave interactions between two shear-Alfvén wave packets when they collide along a uniform magnetic field, a new relation is derived analytically and numerically between the spectral index of the three-wave coupling and that of the wave packets. A k^{-3} power spectrum can then be deduced, providing an alternative explanation of the spectra reported by Kintner [J. Geophys. Res., 81, 5114, 1976].