Generation of Phase Coherence in Foreshock MHD Turbulence

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Large amplitude MHD waves observed in the earth's foreshock are not completely phase random (as assumed in quasi-linear theories), but are almost always phase correlated to a certain degree. Furthermore, the larger the MHD wave amplitude is, the stronger is the phases correlation, implying that the detected phase coherence is a consequence of nonlinear interaction among the MHD waves. In order to understand physical processes leading to the generation of the phase coherence, we construct a simple model of weak turbulence consisting of multiple triplets, which are the minimum units of nonlinear interaction among eigenmodes. Long time statistical behavior of the multiple-triplet system critically depends on how the triplets are connected: if the connections are given in such a physical way that the frequency of each mode can be uniquely determined, the system approaches the self-organized critical state as time elapses; otherwise, the system does not evolve to any statistically interesting state. Adjacent modes often tend to phase synchronize as the modes exchange energy between them. Implications of the results to the phase coherence found in the foreshock MHD waves will be discussed.