Contribution ID: **667** Type: **Poster**

Study of evolution of trapped particle undamped coherent structures: An important agent in intermittent plasma turbulence and anomalous transport

Thursday 25 October 2018 14:00 (20 minutes)

The physics of particle and energy transport in collision-less plasmas presents substantial challenge because of largely linear threshold based plasma turbulence are replaced by their nonlinear counterparts capable of operating at smaller amplitudes. An outstanding property for collision-less plasmas is the essential nonlinear character of coherent structures supported by them at small amplitude. A supplementary mode spectrum of stable coherent structure plays an important role in intermittent plasma turbulence and anomalous transport. In the present work, these additional undamped structures are considered, in a 1D, collision-less plasma as a paradigm of intermittent plasma turbulence and anomalous transport and are investigated based on the result of a kinetic simulation of the plasma. The computational analysis explores initial phase-space perturbation in a current-driven plasma within the linear threshold limit for accessing the regime uncovered under the linear approximation. These coherent structures are described by a continuum of electron and ion hole modes governed by a multi-parametric nonlinear dispersion relation (NDR)[1]. On the basis of both the simulation results and the three level comprehensive description, namely fluid, linear Vlasov and nonlinear Vlasov descriptions, the importance of trapped particle nonlinearity and the invalidity of the linear threshold limit for v_{phase}« v_{th} are presented. The formulation describing the evolution merges the discrete and continuum limits by resolving the inevitable resonant region and shows that coherent electrostatic equilibria are generally controlled by kinetic particle trapping and are hence fundamentally nonlinear. The analytical results are characterized with respect to the evolution observed in the kinetic simulations and quantitative analysis of the associated coherent structure parameters.

[1] H. Schamel, D. Mandal, D. Sharma, Phys. Plasmas, 24, 032109 (2017)

Country or International Organization

India

Paper Number

TH/P6-28

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Session Classification: P6 Posters