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Long Time Scale Nonlinear Dyamics of Beam-Plasma Interaction

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The generation of Langmuir turbulence by beam-plasma interaction is a well-known problem. The process of bump-on-tail instability in the linear regime followed by quasilinear saturation by plateau formation in the beam distribution function is a textbook problem. Nonlinear wave-wave and nonlinear wave-particle interaction processes which take place in the time scale much longer than quasilinear plateau time scale is also well described by weak turbulence theory involving decay and scattering processes. However, to go even beyond the nonlinear mode coupling regime requires the consideration of dynamic ions, which is not so straightforward owing to large ion-to-electron mass ratio. Specifically, it is difficult to fully resolve both the ion and electron velocity scales in a numerical scheme. We have devised a formalism which overcomes such a difficulty. In this talk, we present the results of our scheme in which the ion dynamics are incorporated by means of the moment method. That is, instead of directly solving for the ion kinetic equation, we resort to taking the various moments of ion particle kinetic equation by assuming a self-similar form of the ion distribution. The resulting formalism allows one to solve the theoretical equations in the full temporal range of dynamic ions.