

Nonlinear Processes in Space Plasmas

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Many, if not all, physical processes in nature exhibit nonlinear behavior. Space plasma is no exception. In this talk some examples of nonlinear processes in space plasma will be discussed. The underlying theme in all the examples is the kinetic plasma turbulence theory. The first example is the problem of non-Maxwellian plasma velocity distribution function widely detected in space environment. A theory based on kinetic plasma turbulence formalism explains the origin of non-Maxwellian electron distribution function in terms of a concept where it is viewed as a dynamical steady-state between the electrons and plasma turbulence. Such a steady-state may be termed the turbulent quasi-equilibrium, and it may be described heuristically as the non-additive thermo-statistical state. A second example is taken from the Earth's auroral ionosphere where the precipitating energetic electrons excite upper-hybrid waves, which in turn, nonlinearly merge to produce the harmonic extraordinary mode. Such a process has recently been observed. A process that is similar but is a reverse counterpart takes place in the ionospheric modification experiment. In the ionospheric heating experiment, a powerful ordinary (O) mode pump wave is launched to the auroral ionosphere from the ground. When the O mode converts to the upper-hybrid mode, then the high-intensity upper-hybrid mode subsequently undergoes decay interaction with electron Bernstein and lower-hybrid waves. The nonlinear interaction involving the upper-hybrid, Bernstein, and the lower-hybrid mode is considered important for the ionospheric heating, and thus represents the third example. These are but a few examples that lend themselves to nonlinear kinetic plasma turbulence theory. The kinetic plasma turbulence theory is at an incomplete stage when compared with the more mature linear theory, and many scientists are unaware of its usefulness. It is the purpose of the present talk to disseminate the notion that nonlinear kinetic theory is important for studying natural plasma processes.