Macroscopic quasilinear kinetic model for electrons and protons instabilities in homogeneous and in inhomogeneous solar wind plasmas

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Solar wind species like electrons, protons and alpha particles are detected to possess temperature anisotropies with respect to ambient magnetic field. Microinstabilities driven by these anisotropies are responsible for an upper check of higher values of temperatures at different radial distances of solar wind. For a homogeneous and non-collisional medium, we employed a macroscopic quasilinear kinetic model to display asymptotic variations and saturations of temperature anisotropies and wave energy densities for electromagnetic electron cyclotron (EMEC) and electron firehose (EFH) instabilities. A bi-Maxwellian form of particles distribution adopted all the time except that temperatures may vary in time t. We showed that, in ($\beta_{\parallel}$, $T_{\perp}/T_{\parallel}$) phase space, the saturations stages of anisotropies associated with core and halo electrons lined up on their marginal stability curves for EMEC instability. For case of EFH instability, the electrons and protons dynamics saturated at firehose and proton cyclotron marginal stability curves, respectively. Next, we interpreted the outstanding issue that most of observed proton data resides in nearly isotropic state in phase space. Here, in quasilinear frame-work of inhomogeneous solar wind system, we formulated a set of self-consistent quasilinear equations to show a dynamical variations of temperatures with spatial distributions. On choice of different initial parameters, we showed that, interplay of electron and proton instabilities provided an counter-balancing force to slow down the protons away from marginal stability states. Our present approach may eventually be incorporated in global-kinetic models of the solar wind electrons and ions.

Keywords: solar wind, instabilities

