Simulation Studies of Plasma Heating and Nonlinear Evolutions of Electrostatic and Electromagnetic Instabilities in a Field-Aligned Multi-Beam Plasma

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Abstract

Nonlinear evolutions of electrostatic (ES) and electromagnetic (EM) instabilities in a field-aligned multi-beam plasma are studied by means of a full particle code simulation. Our simulation results show that a plasma system with field-aligned two ion beams and two electron beams can lead to fast growing electrostatic two-stream instability to heat electrons along the background magnetic field directions. If the background magnetic field is not strong enough, the field-aligned heating and the two ion beams can easily make the system unstable to the electromagnetic kinetic fire-hose instability and/or the ion-beam instability. The nonlinear kinetic Alfven waves generated by the kinetic fire-hose instability or ion-beam instability can isotropize the electron pressure and heat ions by both ion-cyclotron instability and non-adiabatic ion gyro-reflections. The gyro-reflecting events can form a new localized ion beam. The region occupied by the localized ion beam corresponds to an ion density hole structure. The localized ion beam can also lead to further electrostatic heating of the plasma. Results of this study provide a possible explanation of the observed ion density holes in the space plasma .