Solitary ion-acoustic wave in a collisionless nonisothermal plasma

Kuznetsov S V

Joint Institute for High Temperatures of the Russian Academy of Sciences, Izhorskaya 13 Bldg 2, Moscow 125412, Russia

shenau@rambler.ru

The process of propagation of an ion-acoustic soliton in a collisionless non-isothermal plasma is studied analytically in one-dimensional geometry. To describe the electronic component of the plasma, a kinetic approach was used without any additional simplifications. The movement of ions is described by the equations of hydrodynamics. It is shown that in this model, the Vlasov kinetic equation for electrons and the hydrodynamic equations for ions admit solutions in the form of a solitary ion-acoustic wave if trapped electrons are present in the soliton potential well.

It was found that the main parameter determining the amplitude of the ion-acoustic soliton is the value of its propagation speed in the plasma. A soliton is possible only at transonic and supersonic propagation speeds, and the higher the speed of the soliton, the greater its amplitude reaches. The limit to the increase in soliton amplitude is determined by the phenomenon of breaking the ion component of the plasma.

It was found that, along with the movement of ions and the flow of trapped electrons in the direction of propagation of the ion-acoustic soliton in the plasma, there also exists a current of transit electrons, which is opposite in sign to the current of trapped electrons. Integrated over the time of passage of the soliton through any cross section in the plasma, the total current of all charges is equal to zero. Consequently, the quasineutrality of the plasma is preserved after the passage of an ion-acoustic soliton through it.