A nonlinear model of the Farley-Buneman plasma instability growth in the auroral ionosphere

Y.N. Kulikov *(Polar Geophysical Institute, Murmansk, Russia)*

An approximate nonlinear model of the growth of unstable ion-acoustic waves generated by the auroral electrojet in the E region of the polar ionosphere is presented. In the framework of the fluid dynamics theory analytical solution of the nonlinear plasma equations, having the form of the supersonic "running waves" propagating in the direction of the electron drift velocity, has been derived. Using this approach the profiles of the basic plasma wave parameters in the wave front have been obtained, including plasma density, electron and ion velocity, and longitudinal electric field. The stability of the derived solutions has been analysed.

It is found that the condition for the instability of the supersonic nonlinear running wave of the finite amplitude exactly coincides with the instability condition for the weak ion-acoustic waves that follows from the linear Farley-Buneman theory. However, contrary to the linear theory that does not stop the unlimited growth of the plasma density irregularities, according to this nonlinear theory, the amplitude of plasma density in a supersonic wave and the time of wave saturation have limited values that depend on the wave Mach number and the electromagnetic drift velocity.