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ORIGINAL ARTICLE

Stability criterion for the non-Maxwellian permeating plasma

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Abstract Employing Vlasov-Poisson model for nonthermal distributed permeating plasma consisting of electron-positron-ion plasma of our earth's magnetosphere and the solar wind plasma with some fixed streaming velocity, can drive ion-acoustic waves unstable. The growth rates are computed with respect to the variation in spectral index of the kappa or generalized Lorentzian distribution and streaming velocity of the solar wind. It is found that the growth rate increases with the decrease of spectral index and increases with the streaming velocity of the solar wind. The numerical results are also presented by choosing some suitable parameters.

Keywords Permeating plasma · Lorentzian plasma · Electron-positron-ion · Earth's magnetosphere

1 Introduction

There has been a great deal of interest to study linear and nonlinear waves in electron-positron (e-p) as well as electron-positron-ion (e-p-i) plasmas due to its importance in astrophysical and laboratory produced plasmas. The electron-positron plasma exists in active galactic nuclei (Mille and Witta 1987), at the center of our galaxy (Burns et al. 1983), Van Allen radiation belts, in the polar cap region of fast rotating neutron stars (Michel 1991), in the polar magnetosphere of pulsars (Michel 1982), in the early universe (Cho and Lee 2003; Misner et al. 1973; Shukla et al. 2003) and in the intense laser fields (Berezhiani et al. 1992; Lazar and Schlickeiser 2003). Recently, the existence of trapped anti-particles in the innermost magnetosphere of the Earth are shown to exist and during the geomagnetic unstable periods, they could leave the magnetosphere and go into the interplanetary medium (Gusev et al. 2000, 2001a, 2001b). The nuclear reactions between energetic trapped inner zone protons and heavier atoms (He and O), are assumed to be a natural source of magnetospheric energetic positrons as well as electrons in the uppermost Earth atmosphere (Gusev et al. 2000). Carlson et al. (2007) and Dwyer et al. (2008) presented the possibility of new source of high-energy electrons and positrons in the inner magnetosphere of the earth. The recent measurements from the Ramaty High Energy Solar Spectroscopic Imager (RHESSI) indicates the positron production from the sun under certain conditions (Share et al. 2003) and the collision of plasma due to solar flares near the surface provides enough energy to produce positron-electron pairs. The presence of electron-positron pairs is also discussed very comprehensively in the references (Spjeldvik et al. 2008; Atwood 2012).

It is well known that in space-plasma which is inhomogeneous, due to temperature, density and magnetic field gradients, various types of drift-waves and instabilities can exist. It is well established fact that in the space plasma, the particle distribution function is non-Maxwellian. The nonthermal

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