Geophysical Research Abstracts
Vol. 12, EGU2010-285-2, 2010
EGU General Assembly 2010

Effect of the thermal pressure on upward plasma fluxes due to ponderomotive force of Alfvén ion cyclotron waves

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In a number of papers devoted to the effect of the ponderomotive force of Alfvén ion cyclotron waves on plasma fluxes in the Earth's magnetosphere, it was shown that the plasma density increases in the vicinity of the equator (e.g. Guglielmi et al. 1993). The increase of density takes place as a result of plasma fluxes flowing upward along the magnetic field lines under the action of the ponderomotive force. This force emerges due to inhomogeneity of the background number density and magnetic field (Guglielmi et al. 1993, Nekrasov and Feygin 2005). However, the experimental data by Olsen (1992) show that the plasma density accumulation at the equator is not observed. On the contrary, the density at the equator is lower than outside of it. In the present paper, we show that the quasi-stationary density evolution always tends to decrease under the action of the ponderomotive force. This decrease is proportional to the local wave amplitude, i.e. it is deeper in regions, where the wave amplitude is larger. As a result, the thermal pressure prevents the flux from flowing upward and the stationary state is settled. A typical time of this process is the ratio of the wave amplitude inhomogeneity length to the sound speed. In the stationary state, the flux is equal to zero. As it is known, a part of the ponderomotive force is proportional to the nonlinear magnetic moment of the medium and gradient of the background magnetic field. We show that the well-known Pitayevsky's formula for the magnetic moment in the cold plasma (Pitayevsky 1960) is not complete. This formula does not take into account the part of the magnetic moment induced by the nonlinear current connected with the quasi-stationary velocities of charged species.

References

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