FORMATION OF SPATIAL STRUCTURE OF PRECIPITATING ELECTRONS FOR PULSATING AURORA

D. L. Pasmanik [(1)], V. Yu. Trakhtengerts [(2)]

[(1)] Institute of Applied Physics of the RAS, 46 Ulyanov st., 603950 Nizhny Novgorod, Russia.
E-mail: pdl@aurora.appl.sci-nnov.ru

[(2)] As (1) above, but E-mail: vyt@appl.sci-nnov.ru

INTRODUCTION

The theory of formation of pulsating aurora is generalized with more strict analysis of whistler waves propagation in the magnetosphere. It is suggested that pulsating aurora are connected with cyclotron instability developing due to interactions between whistler mode waves and energetic electrons in a duct of enhanced background plasma density, which serves as a waveguide for whistler waves. In previous papers [1, 2] a model of a flow cyclotron maser was suggested to explain the formation mechanism of pulsating auroras, but simplified consideration of whistler wave propagation in the duct does not allow to use this model to explain the spatial structure of precipitating electrons. In this paper we develop a more rigorous model of the cyclotron interaction of whistler waves and energetic electrons in magnetospheric duct suggested in [3].

MODEL

As a model for a magnetospheric duct a cylindrically symmetric column filled with cold plasma having an inhomogeneous radial distribution in an external homogeneous magnetic field parallel to the duct axis. Cold plasma distribution, for which analytical solution for the eigenmodes of the duct exists, suggested and spatial structure and propagation properties of this eigenmodes are analysed. Results obtained are used to construct the set of self-consistent equations of quasi-liner plasma theory of cyclotron interactions, including the equations for distribution function of energetic electrons and spectral density of whistler waves, that are generalised with eigenmodes structure and energetic electrons spatial distribution taken into account.

RESULTS AND CONCLUSIONS

Based on equation set obtained in the paper, we can obtain the following qualitative picture of cyclotron instability development in a duct. Since the excitation efficiency of different modes depends on the spatial distribution of energetic particles in the duct, a certain mode is excited most efficiently at any time. However, the cyclotron interactions lead to the redistribution of energetic particles and their precipitation from the magnetic trap, which is more intense in the duct regions where the wave field is maximum. Therefore, if the particle source is not very strong, a gap in the transverse distribution of trapped energetic particles in a duct is formed, and the spatial structure of the precipitated electron flux is qualitatively similar to the transverse amplitude distribution of the excited waveguide mode. This, in turn, causes a decrease in excitation efficiency of this mode, and another mode is excited more efficiently. Therefore, one can expect a mode competition accompanied by variations in the wave spectrum and in spatial distributions of trapped and precipitated energetic particles.

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The work has been supported by Russian Foundation for Fundamental Researches (grant No 02-02-17109) and by INTAS (grant No 99-00502)