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EQUIVALENT SLAB MODEL (ESM) FOR DRIFT BALLOONING MODE IN QUADRUPOLE FIELD GEOMETRY

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ABSTRACT

A prescription is given for the construction of a one-dimensional "equivalent slab model" which is shown to reproduce the dispersion curve in good agreement with experiment. The phase velocity calculated from ESM model is found half that of intrinsic drift mode. This result is also in good agreement with experiment.

INTRODUCTION

Drift waves have been studied both theoretically and experimentally in the UMIST GOLUX [1] and [2]; the theory was based on the general theory of Quadrupole [3]. Most of this work was concerned with the ordinary drift mode which has its maximum at the points of minimum field strength and is anti-symmetric between the two sides of the machine, though [1] searched experimentally for the drift-ballooning mode of the opposite symmetry which has its maxima at the field maxima and is anti-symmetric between the top and bottom of the machine. No trace of this mode was found; this was unexpected because previous studies of drift waves in quadrupole [4,5] had concluded that this was the mode expected to be unstable. Later, it became possible to launch waves in the quadrupole [6] and a damped propagating mode of the drift-ballooning character was successfully launched. Accordingly, a theoretical study of the drift-ballooning mode was undertaken and is described in this paper.

The Plasma in the UMIST quadruple [7] has typically $T_e \sim 0.5$ev, $n \sim 10^{15}$ m^{-3} where the drift waves are strongly excited. The plasma is only weakly collisional, and the plasma properties are guaranteed to be constant along field lines.

The important features of quadrupole geometry are closed lines of force [Fig.1] giving a well defined parallel wavelength and no problems with boundary conditions; and strong variation of field strength along the field lines, implying a preponderance of trapped over passing particles.

THEORY OF THE DISPERSION CURVE

The derivation is based on the model developed by Hastie and Taylor [3] for multi pole field geometry, referred to below as HT, whom we follow with some obvious changes in notation. We consider electrostatic mode propagating parallel to the quadrupole axis and quasi-neutrality is assumed. Due to the symmetry of the mode the trapped particles integrals vanish identically. The eigenvalue equation is obtained by equating the ion and electron response to an assumed perturbation of the electrostatic potential ϕ. The ion and electron responses are based on equation 13 and 8 of HT [3]