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TH/P3-12: A Flute Instability in an Open System and the Line Tying Effect on it

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A flute instability is the most dangerous instability to an open system such as GAMMA10. A line tying is a powerful tool for stabilizing a flute instability because the magnetic field lines terminate at the conducting ends in an open system. Firstly, a particle simulation was performed to investigate a flute instability and the line tying effect on it. Here the particle code takes into account the electron inertia along a magnetic field line precisely and the code (two and half dimension) adopts the implicit method so that it can calculate the problems with large space and time scales. The particle simulation has revealed the mechanism of an appearance of the line tying in a flute instability. That is, the acceleration of electrons due to a flute instability was found to be responsible for the line tying, but not the electron thermal speed. There is not, however, a stability boundary resulting from line tying in the linear phase of a flute instability. We have newly found the nonlinear (quasilinear) stability criterion to a flute instability with conducting ends. Secondly, a reduced MHD simulation was carried out in order to investigate the line tying effect of the limiters on a flute instability in GAMMA10. There are two limiters (named MLO) at z = 7m and -7m in GAMMA10, which are inserted into the plasma, where the radius of the limiter is 0.115m mapped at the central cell. The plasma radius is 0.18m at the central cell, so that the plasma escaping from the central cell touches MLO. MLO is expected to have an effect of line tying on a flute instability in GAMMA10 in the light of the nonlinear (quasilinear) stability criterion found by a particle simulation. The reduce MHD code solves the time evolution of vorticity, mass density, temperature and electrostatic potential in two-dimensional cross section perpendicular to the magnetic field lines. The centrifugal acceleration of ions resulting from a magnetic field line curvature is included in the radial dependence of magnetic field line specific volume. The line tying effect of MLO is taken into account by setting the fluctuating part of vorticity being zero in r > 0.115m, because the vorticity plays a role of charge density in the frame of MHD. The reduced MHD simulation has revealed that MLO has a stabilizing effect on the flute instability, which is consistent with the experimental observation.

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