The role of flute modes in the GAMMA10 tandem mirror

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The GAMMA10 tandem mirror contains two non-axisymmetric minimum B mirror cells in it for the stabilization of flute interchange modes. A high energy ion population is created by ion cyclotron resonance heating (ICRH) in the min.B mirror cells, by which the GAMMA10 achieves an average minimum B magnetic field.

Recently we have made a two-dimensional computer code on the assumption of an axisymmetric magnetic field by using reduced MHD equations which excluded the high frequency stable collective degrees of freedom corresponding to magnetosonic, Alfvén and longitudinal acoustic modes [1]. This code can simulate the flute interchange modes (similar to the Rayleigh-Taylor instability) and the instability associated with the presence of nonuniform plasma flow (similar to the Kelvin-Helmholtz instability).

In order to apply this code to the GAMMA10 for the investigation of flute mode fluctuations in the nonlinear state, the definition of the specific volume of magnetic field is changed as

$$U(\psi) = \int \frac{\widehat{p}_{\parallel} + \widehat{p}_{\perp}}{B} \mathrm{d}\zeta \ ,$$

which leads to the well known stability criterion $\partial U/\partial\psi = -2\int \Big([(\widehat{p}_{\parallel} + \widehat{p}_{\perp})\kappa_{\psi}]/B \Big) \mathrm{d}\zeta < 0$ of flute interchange modes. In this presentation, the pressure in the min.B region is fixed in time and the time evolutions of pressure et al. in the central cell of GAMMA10 are calculated, where the normalized pressure in the min.B region is assumed to be 4 and the pressure in the central cell is 1 at $\tau = 0$ in the simulation.

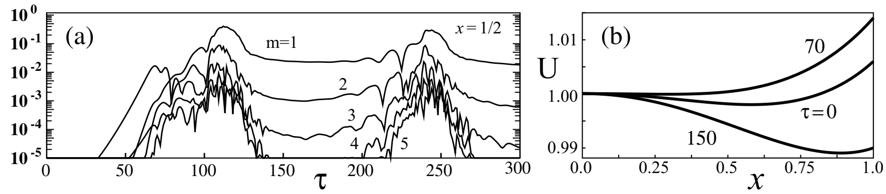

Figure 1: The simulation results. (a): time evolution of Fourier amplitudes of the electrostatic potential ϕ, and (b): radial profiles of specific volume. Here m is azimuthal mode number and x is normalized radial coordinate. That is, $x = 0$ is on axis and $x = 1$ is at the radial limiter position.

Figure 1(a) plots the simulation results that the flute mode grows at $\tau \simeq 50$, saturates at $\tau \simeq 100$, becomes stable at $\tau \simeq 150$, and this is repeated from $\tau \simeq 200$ again. This flute mode "grow and decay" process has a strong correlation to the specific volume U in Fig.1(b).

[1] I.katanuma, et al., J. Plasma Fusion Res. **84** (2008) 279.