§22. Confinement of Plasma Particles in an Axisymmetric FRC

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Studies of particle confinement in an axisymmetric FRC (Field Reversed Configuration) are presented. The confinement criteria have been considered for the cases where the accessible region is open or close for the particles with constant energy and canonical angular momentum P_q. Taking into account the dynamic motion, however, there are some possibilities for these particles to be confined due to adiabaticity in a magnetic mirror. In this report we considered the fusion protons with 15MeV from D-^{3}He fusion reaction and bulk ions with 100 keV in FRC of "ARTEMIS-L" [1].

For particles with relatively small pitch angle at the minimum field, the abrupt step-like change in their magnetic moment is observed in the vicinity of the minimum field (Fig.1(a)). This stochastic phenomina comes from the resonance between gyrating motion and the bounce one in a magnetic mirror. On the other hand the magnetic moment of particles with relatively large pitch angle is conserved during the bounce motion in the mirror (Fig.1(b)) because of lack of the resonance phenomena.

The investigation of the boundary between adiabaticity and stochasticity of paritcle motion is carried out by solving the exact equation of motion in an FRC with external mirror coils. Fig.2 shows the boundary of the pitch angle (a) for the fusion protons with 15 MeV form D-^{3}He fusion reaction with negative P_q/q, (b) for particles with energy of 100keV, which corresponds to the bulk ions of D-^{3}He fusion plasma. In this figure the boundary of the loss cone is shown by dashed line, which is obtained from the relation of

$\sin \Theta_0 \leq \sqrt{B_{\min} / B_{\max}}$: loss-cone from a mirror.

Here, particles with larger pitch angle play adiabatic behavior and confined in a magnetic mirror. The particle which play stochastic behavior diffuse toward the loss-cone region and are loss away from the system eventually. It is found that particles with lower energy (100keV bulk ions) have a wider adiabatic region.

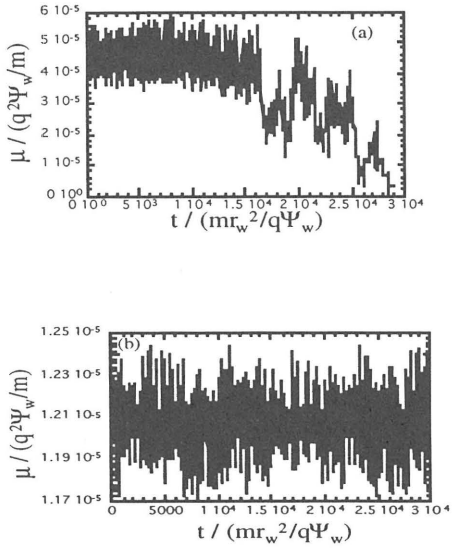

Fig.1 Time behavior of magnetic moment of particles with (a) relatively small pitch angle, and (b) relatively large pitch angle.

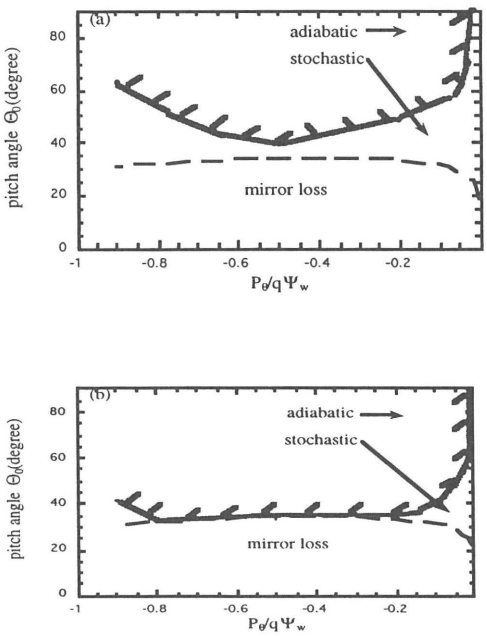

Fig.2 Boundary between adiabatic and stochastc motion (a) of fusion protons with 15MeV (b) of bulk ions with 100keV on pitch angle.

1)H.Momota et al., *Proc. 14th Int. Conf. Plasma Physics and Controlled Nucl. Fusion Research*, Wuerzburg, Germany, September 1992, Vol.3, p319, IAEA (1993)