Transport due to interchange mode turbulence in a mirror with divertor

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A magnetic divertor design of the GAMMA10 tandem mirror investigates a possibility of the fully axisymmetric tandem mirror with MHD stable configuration. The stability mechanism of interchange modes in a divertor is mainly plasma compressibility rather than ion finite Larmor radius effects, where the plasma pressure profile is controlled to be $pU^{\gamma} = const$ radially. Here p plasma pressure, U specific volume of a magnetic field line, and γ is a specific heat index. It is recognized that the interchange modes are marginally stable as long as the relation $pU^{\gamma} = const$ is satisfied in the radial direction. The ion orbit analysis near a magnetic null in a divertor reveals that the magnetic moment μ does not conserve so that some ions escape radially. These ions' loss near the magnetic null breaks the relation $pU^{\gamma} = const$ and the system becomes unstable to the interchange modes.

We investigate a transport process in the slightly unstable state of a divertor mirror cell. The basic equations used here are essentially the fluid equations which exclude the shear Alfvén modes and compressional modes from MHD equations. The divertor mirror cell adopted here is plotted in Fig.1.

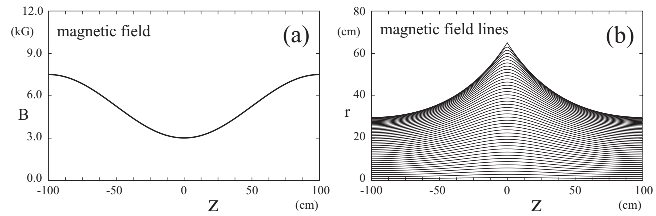

Fig.1 : A mirror cell with magnetic divertor.

The results of computer simulation are shown in Fig.2. Here temperature is defined as $T = S/\hat{\rho}$ with $\hat{\rho} = \rho U$, where ρ plasma mass density, $S \equiv pU^{\gamma}$ is entropy density. At $t = 0$, very small perturbation of T is added near periphery of plasma as an initial condition. At $t = 10.0$ the electrostatic potential is built up as shown in Fig.2(d) indicating that the instability is interchange modes and the core plasma begins to move upward in Fig.2(b). After $t \simeq 8.0$ the system enters a nonlinear phase with enhanced transport shown in Fig.2(c).

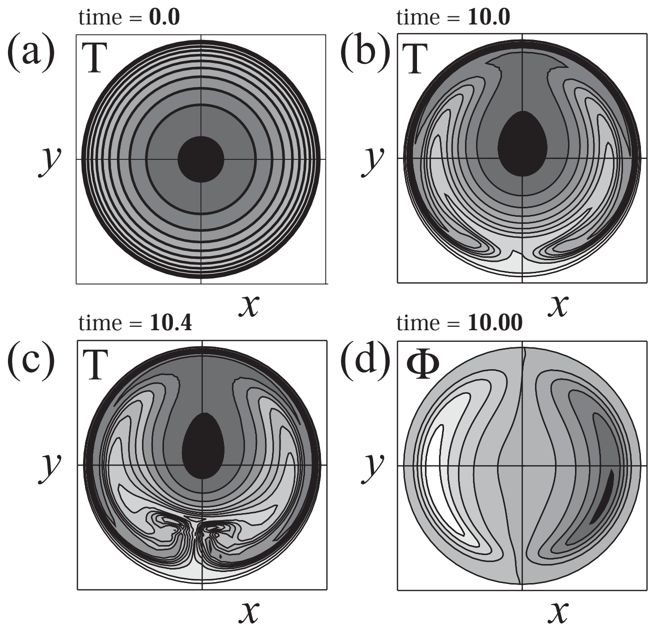

Fig.2 : Temperature T and potential Φ

The magnetic null plays a role of electrically short circuit of the system, so that the electrostatic potential has the same magnitude along the magnetic null line. Therefore plasma moves along the magnetic null azimuthally with $\boldsymbol{E} \times \boldsymbol{B}$ drifts and forms the structure of Fig.2. The resultant plasma transport process will be presented at the Meeting.