§23. Study of Energetic Ion Transport in the CHS Plasma

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The drift kinetic equation in 5D phase-space was solved using GNET code [1] in the CHS plasma ($R_{ax} = 0.921$m) to study the ripple induced transport of energetic ions. The NBI heating source term was calculated by HFREYA code, assuming beam energy of 40keV. We assumed the density, n, and temperature for ions, T_i, and electrons, T_i, as $n(r) = n_0\{1-(r/a)^2\}$ with $n_0 = 2.0\times10^{19}m^{-3}$, and $T_e(r) = T_i(r) = T_{e0}\{1-(r/a)^2\}$ with $T_{e0} = 0.4$keV. The magnetic field strength is set to 1.8T.

The beam ions deposit at the high velocity region ($v \sim 11v_{th0}$) and slow down to the thermal velocity. When the beam ion reaches to the critical velocity (about 4 times of thermal velocity) the pitch angle scattering takes place by the collisions with background ions, and the beam ion distribution spreads toward the higher pitch angle region. Then the ripple induced transport plays important role.

Figure 1 shows the radial density profile of the ions whose energy is greater than 2keV. The pitch angle is changed from the deeply trapped partcile to the passing particle region. We can see the rapid decrease of the density as pitch angle increases. This result show the significant radial transport of helically trapped particle.

Finally we compare our simulation results with the experimental results of FNA measurements[2]. The FNA was set to measure the distribution of the trapped ions changing the the measurement angle in the CHS. We simulated the FNA signal using the obtained distribution by GNET code. In the simulation we assume the monotonic beam energy of 40keV for simplicity, but there are two other components (20keV, 13.3 keV) of beam source in the actual CHS plasma. So we compare the energy distribution less than 6keV. Figure 2 shows the comparison of the ion distribution as a function of particle energy. We can see the similar tendency of the energy distribution depending on the measured line angle. This suggests an important role of neoclassical transport in energetic ions in the CHS plasma.

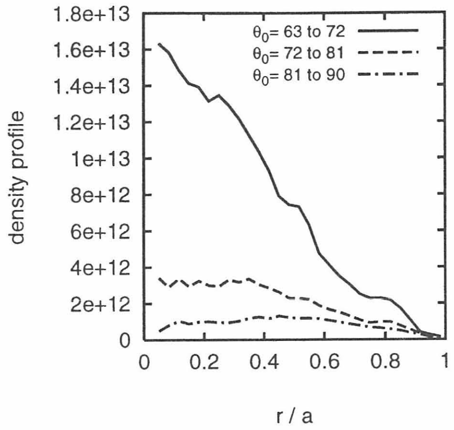

Fig. 1. Plots of the radial profile changing the pitch angle from passing through deeply trapped particle region.

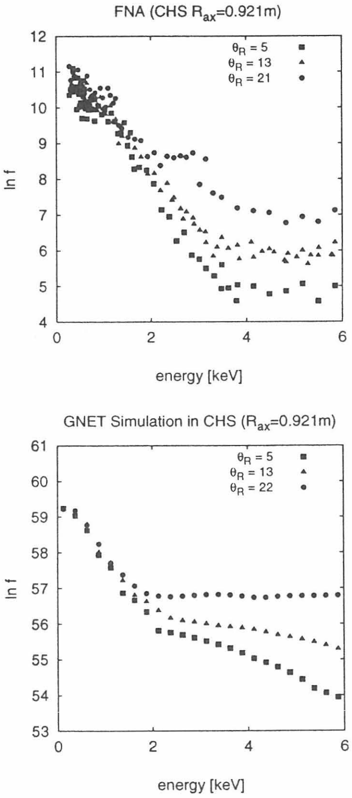

Fig. 2. Comparisons of the fast particle distribution obtained by FNA measurements (upper) and simulation (lower) for three different measurement angles.

References

1) Murakami, S., et al., Nuclear Fusion **40** (2000) 693.

2) Ida, K., et al., Proc. 17th IAEA Fusion Energy Conf. Yokohama, 1998, IAEA-CN-69/EX2/2.