# §36. Distribution Function Analysis of High Energy Particle in Heliotron J

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It is one of the important issues to evaluate the heating efficiency by NBI in Heliotron J. There exists the large region, in which the closed magnetic surface is not formed, outside the last closed magnetic surface (LCMS). Thus, a number of high energy particles are likely to become re-entering particles which are repeatedly go out and into the LCMS. The distribution function of high energy particles including the behavior of re-entering particles has not been analyzed in Heliotron J. In the present study, we investigate the heating efficiency of NBI and the high energy particle behavior in Heliotoron J by means of the calculation of the distribution function of high energy particles including the behavior of re-entering particles.

It is required that the position of the LCMS is precisely determined in order to investigate the behavior of re-entering particles in Heliotron J. We develop the new determination method of the LCMS position in Heliotron J. In this method, the position of the LCMS is determined as follows:

i) With changing the starting points of the field line trace, pass points of field lines on the specific poloidal surface. The obtained pass points are processed to *quasi magnetic surface* by the aid of the radial basis function technic.

ii) Variances of pass points from the quasi magnetic surface are calculated and plotted against starting points. The inflection point on this graph is determined as the position of the LCMS.

The LCMS obtained by use of the above procedure is shown in Fig. 1.

The collisionless orbits of particles are traced from the outside region of the obtained LCMS. We investigate whether particles going into the core plasma region inside the LCMS. The initial condition of particles passing into the core plasma region is shown in Fig. 2. It is seen from Fig. 2 that p traced from the region near the LCMS can pass into the LCMS. In addition, initial pitch angles of such particles are nearly equal to π. Figure 3 shows Poincaré plots of particles passing into the LCMS. Even particles passing into the LCMS do not deeply go into the region near the magnetic axis. This result seems good for the plasma confinement in Heliotron J.

We develop the new method to determine the LCMS and apply this method to the vacuum magnetic field of Heliotron J. Particles are traced from the region outside the determined LCMS. It is found that only particles traced from the region near the LCMS pass into the LCMS and that even such particles do not deeply go into the core region. We will study the behavior of NB particles by the Monte Carlo code which has been developed.

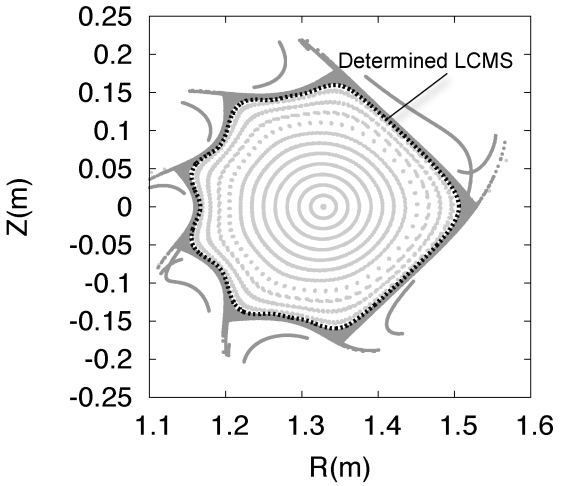


Fig. 1. Determined LCMS in Heliotron J.

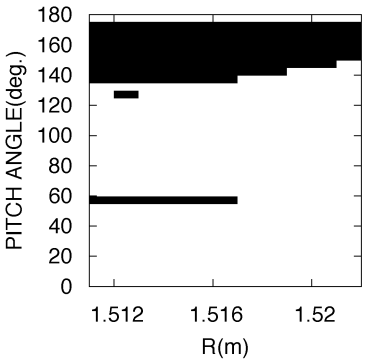


Fig. 2. Initial conditions of particles passing into the LCMS.

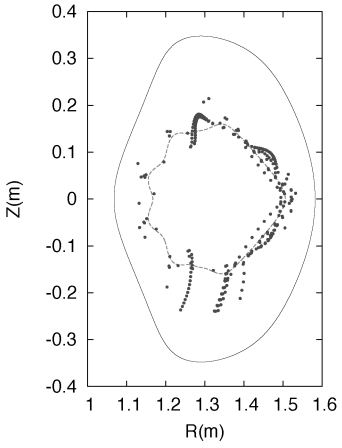


Fig. 3. Poincaré plots of particles passing into the LCMS.