§2. Orbit Calculation of High Energy Particles in LHD

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A computer code calculating the orbit of high energy charged particles is developed. The code traces the ion orbit in the magnetic field by solving the Newtonian equations of motion; the magnetic field is obtained by interpolating from the 3D table of the LHD (LHD90).

When the piecewise Lagrange interpolation formula is applied, and the Hamming method of fourth order with automatic step size control is used, the step size is reduced more than 10 times, and the procedure is aborted. The discontinuity at the boundary of the interpolating region is thought as the origin of this phenomenon. This is solved by replacing the integrator by the Adams method with the automatic order control as well as the step size control. The interpolation formula is also replaced by the piecewise Hermitian interpolation formula, in which the continuity up to the the first derivative is guaranteed.

The first wall of the LHD device is implemented and when the particle crossed the wall, the calculation is stopped.

When the magnetic field is lowered to 1 Tesla or less, the high energy particle may hit the wall below the helical coil. In order to evaluate the possibility, the orbit is calculated by changing the field strength. The initial position and pitch angle $\theta = \tan^{-1}(v_{//} / v)$ are chosen as follows

A1) R=4.54, Z=0.0, ϕ =0.0, $\theta \leq 40.0°$
A2) R=4.54, Z=0.0, ϕ =0.0, $\theta \geq 140.0°$
B1) R=2.96, Z=0.0, ϕ =0.0, $\theta \leq 40.0°$
B2) R=2.96, Z=0.0, ϕ =0.0, $\theta \geq 140.0°$

The ion energy is chosen as 180keV. The point A1) and A2) corresponds to the outer edge of the plasma surface, and the point B1) and B2) to the inner side of the plasma surface; at the angle ϕ=0 helical coils are up- and down.

When the magnetic field strength is 3T, no particles hit the wall during the time T. If the field B is lowered to 1T or 0.5T, the particles A2) reached the wall in the diverter region, and the some particles in B1) hit the wall in the coil groove.

In this study the Newtonian equation of motion is solved. The comparison with the result obtained by solving the drift equation of motion is remained to the future task. The use of the more realistic initial condition is necessary to reach the definite conclusion.