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運動量保存および非線形衝突を考慮にいれたGNETコードの開発
Development of momentum conserving and nonlinear collision operator for GNET code

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A good confinement of energetic particles is required to sustain the high temperature plasma and to avoid first wall damage by lost energetic particles. Thus the confinement of energetic ions is one of key issues in the fusion reactor design. We have developed GNET(Global NEoclassical Transport) code[1, 2, 3] solving a drift kinetic equation in 5D phase-space. Using GNET code we have evaluated the radial transport of the energetic particle including the finite orbit size effect with particle collisions (energy slow down and pitch angle scattering) in the helical plasmas.

If we consider the plasma distribution, $f = f_{bg} + f_{eng}$ (f_{bg} and f_{eng} are the background plasma and energetic particle distributions.) the collision term including the energetic particles can be expressed as

$$C^{\rm coll}(f) = C(f_{eng}, f_{\rm bg}) + C(f_{\rm bg}, f_{eng}) + C(f_{eng}, f_{eng}), \quad (1)$$

where the first term is the linear collision operator by background plasma and the second one is the change of the background plasma due to the collisions with the energetic particles. The last term is the self collision between the energetic particles.

In the present GNET code we have used only the linear collision operator, which includes the collisional effect between test particle and background particle only as the pitch angle scatter and energy scattering. The change of the background particle distribution and the momentum transferred from the test particle to the background are ignored in this operator. Also the collisions between energetic particles would have some effect on pitch angle scattering, although the density of high-energy particles is much less than that of thermal other ions. The nonlinear collision effect may lead to deteriorate the energetic particle confinement, because of the increase of pitch angle scatterings.

In this paper, we develop a collision operator for GNET, in which the parallel momentum is conserved and the nonlinear collision is included. In the calculation we obtain the solution solving the GNET code iteratively.

References

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