Cross-Field Particle Transport due to Electromagnetic Fluctuation in a Field-Reversed Configuration

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The cross-field particle transport in a Field-Reversed Configuration (FRC) due to the electromagnetically fluctuating fields is investigated. The fluctuation is described by the toroidal and poloidal mode numbers. We trace orbits of many ions numerically and observe the temporal change of the canonical angular momentum for the ions in the fluctuating field; this quantity is a constant of motion in axisymmetric and non-fluctuating FRC and is a good measure for the location of the guiding center. In order to estimate the cross-field transport coefficients, the first and second cumulants of the canonical angular momentum are calculated. From the evolutions of the first cumulant of the canonical angular momentum, it is found that the cross-field drift of plasma ion can be neglected safely. The fluctuation, however, causes the diffusive flow near the separatrix, where the density gradient is large. The dependences of the diffusion coefficients on the various parameters are studied. We examine the fluctuation effects in the lower frequency range than ion cyclotron frequency. It is found that the fluctuation with higher toroidal mode and lower frequency affect the cross-field particle diffusion deleteriously. The scaling of the particle confinement time is estimated with respect to the stability parameter $S \equiv (r_s - R)/\rho_i$, where r_s, R and ρ_i are the separatrix radius, the radius of magnetic axis, and the Larmor radius, respectively. It is found that the particle confinement time is proportional to $S^{3.156}$. It appears that about two times stronger dependence on S is obtained compared with the experimental results.