A theoretical model of ripple resonance diffusion of alpha particles in tokamaks

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A theoretical model of ripple resonance diffusion of fusion-produced α particles in tokamaks is presented. In the previous work [1], we numerically found a M-shaped energy dependence of diffusion coefficients (Fig. 1) around ripple resonance conditions in which the toroidal precession motion of banana particles resonates to the field strength with ripples. The M-shaped dependence comes from both island structure and initial distribution of α particles in a $(N\phi, \psi)$ phase space, where N is the number of toroidal field coils, and (ϕ, ψ) is the coordinate of the reflection point of a banana particle in the toroidal angle and the poloidal flux. Although the particles have periodic motions and a hamiltonian $H(N\phi, \psi)$ is conserved without collisions, pitch angle scattering by collisions changes constant parameters in H and causes the diffusion. If particles are located near the ripple-induced island in the phase space, they resonate to the ripple and enhance the diffusion. In this work, we present a theoretical model of the ripple resonance diffusion based on banana tip map and give a formula of a α particle diffusion.

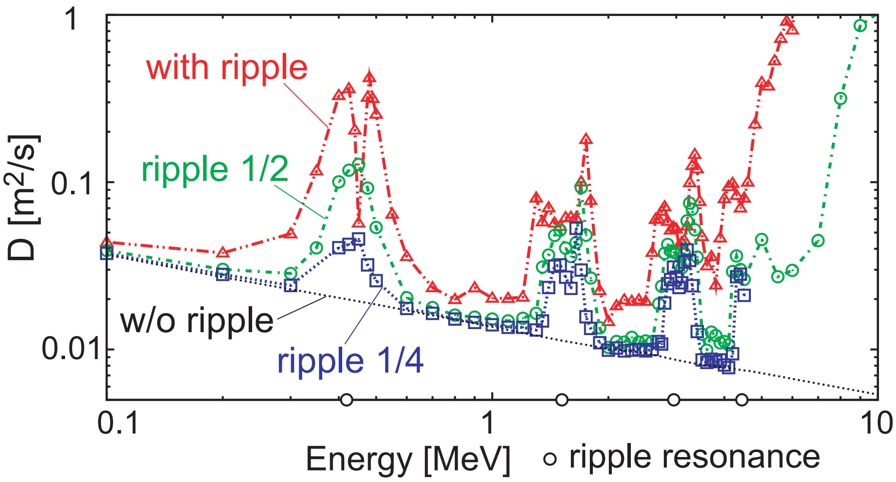

Figure 1: Energy dependence of the diffusion coefficients. The resonance energies are 0.14, 0.80 and 2.93 MeV in an axisymmetric field.

[1] H. Mimata, H. Tsutsui, S. Tsuji-Iio, R. Shimada, K. Tani, submitted to Plasma and Fusion Res.