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A statistical study of gyro-averaging effects in a reduced model of drift-wave transport

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ABSTRACT

A statistical study of finite Larmor radius (FLR) effects on transport driven by electrostatic drift-waves is presented. The study is based on a reduced discrete Hamiltonian dynamical system known as the gyro-averaged standard map (GSM). In this system, FLR effects are incorporated through the gyro-averaging of a simplified weak-turbulence model of electrostatic fluctuations. Formally, the GSM is a modified version of the standard map in which the perturbation amplitude, K_0, becomes $K_0 J_0(\hat{\rho})$, where J_0 is the zeroth-order Bessel function and $\hat{\rho}$ is the Larmor radius. Assuming a Maxwellian probability density function (pdf) for $\hat{\rho}$, we compute analytically and numerically the pdf and the cumulative distribution function of the effective drift-wave perturbation amplitude $K_0 J_0(\hat{\rho})$. Using these results, we compute the probability of loss of confinement (i.e., global chaos), P_c, and the probability of trapping in the main drift-wave resonance, P_t. It is shown that P_c provides an upper bound for the escape rate, and that P_t provides a good estimate of the particle trapping rate. The analytical results are compared with direct numerical Monte-Carlo simulations of particle transport.

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