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Area-preserving maps models of gyroaveraged E×B chaotic transport

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J. D. da Fonseca^{1, a)}, D. del-Castillo-Negrete^{2, b)}, and I. L. Caldas^{1, c)}

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ABSTRACT

Discrete maps have been extensively used to model 2-dimensional chaotic transport in plasmas and fluids. Here we focus on area-preserving maps describing finite Larmor radius (FLR) effects on $E \times B$ chaotic transport in magnetized plasmas with zonal flows perturbed by electrostatic drift waves. FLR effects are included by gyro-averaging the Hamiltonians of the maps which, depending on the zonal flow profile, can have monotonic or non-monotonic frequencies. In the limit of zero Larmor radius, the monotonic frequency map reduces to the standard Chirikov-Taylor map, and in the case of non-monotonic frequency, the map reduces to the standard nontwist map. We show that in both cases FLR leads to chaos suppression, changes in the stability of fixed points, and robustness of transport barriers. FLR effects are also responsible for changes in the phase space topology and zonal flow bifurcations. Dynamical systems methods based on the counting of recurrences times are used to quantify the dependence on the Larmor radius of the threshold for the destruction of transport barriers.

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