On the role of fluctuations in the scaling parameters of self-similar models for Hamiltonian transport

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Hamiltonian systems with mixed phase space typically present an algebraic decay of the survival probability $P(t) \sim t^{-\gamma}$. A fundamental question in Hamiltonian dynamics is how to relate the exponent γ to the structure of the phase space. The numerical determination of the exponent is made difficult by the presence of strong fluctuations around the computed curves and numerical experiments on different systems reported different estimates of the decay exponents. In particular it's still not clear if these fluctuations will eventually decay and a universal power-law exponent will emerge. Previous studies of two-dimensional twist maps have shown that the basic structure of the dynamics can be captured by a self-similar Markov tree model. While this model succeeds to reproduce a power-law behavior, there remain important questions concerning the approximation in scaling parameters. Using a suitable modification of the model we show how irregularity of scaling parameters can be accounted for and demonstrated that the their inclusion is essential. In particular we show that in a more realistic tree model with approximate self-similarity the fluctuations around algebraic decay will asymptotically die out and that the power-law decay exponent will not depend on the specific realization of the randomness in scaling parameters. We compare the analytical results with numerical experiments for the modified model and for Hamiltonian maps.

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