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Renormalization and destruction of tori in area preserving maps

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Abstract

Magnetic field lines and particle orbits in toroidal plasma devices are described by low dimensional Hamiltonian systems. The simplest cases of two degrees of freedom correspond to area preserving maps of a cylinder. In such a description, the invariant tori represent transport barriers. When studying nonmonotonic q-profiles, the corresponding maps are nontwist i.e. they violate the twist condition. We study the breakup of the invariant tori with various different winding numbers for both twist and nontwist maps. At the critical values for destruction of invariant tori, the phase space exhibits invariance under rescaling. This leads to the renormalization group framework developed by MacKay[1] for the case of the golden mean winding number. We extend this to other winding numbers by constructing the appropriate renormalization group operators. The simple (integrable) and critical fixed points of these operators are presented. We relate the fixed points for different winding numbers by coordinate changes in the space of maps and the operators for different winding numbers are shown to be related by transformations induced by these coordinate changes.

[1] R.S. MacKay, Ph.D. thesis, Princeton (1982); R.S. MacKay, Physica D, **7**, 283 (1983).