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The Gross-Pitaevski map as a chaotic dynamical system

The Gross-Pitaevski map is a discrete time, split-operator version of the Gross-Pitaevski dynamics in a circle. It is a symplectic map in a infinite-dimensional phase. space and here it is analyzed as a fully classical dynamical system, by a systematic analysis of Lyapunov exponents. Whenever the "kicking period" is incommensurate to the free rotation period, evidence is found of strongly chaotic behavior, with all of the finite-dimensional approximations turning ergodic as nonlinearity is increased. Assuming ergodicity, and using Levy's lemma , the analytical dependence of the maximal Lyapunov exponent on the nonlinearity parameter is explicitly found, in excellent agreement with numerical data. In the commensurate case, the map has infinitely many independent constants of motion and on each invariant manifold it is found to undergo an integrable-to-chaotic transition,with a threshold that decreases as the incommensurate case is approached .