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Transport properties in the discontinuous dissipative standard mapping

Juliano A. de Oliveira[1] Rodrigo M. Perre[2]
UNESP, São João da Boa Vista, SP
J. A. Méndez-Bermúdez[3]
Benemérita Universidad Autônoma de Puebla, Mexico
Edson D. Leonel[4]
UNESP, Rio Claro, SP

The dissipative two-dimensional nonlinear mapping that describes a kicked rotator given by a rigid bar of length L with one end attached by a pivot and the other end subjected to a vertical and periodic impulsive discontinuous force has the following form [1]

$$T : \begin{cases} I_{n+1} = (1-\gamma)I_n + kf(\theta_n)\sin(\theta_n), \\ \theta_{n+1} = [\theta_n + I_{n+1}] \mod (2\pi) \end{cases} \tag{1}$$

where I and θ are the action and angle variables, k and γ are control parameters responsible for controlling the intensity of nonlinearity and dissipation respectively. Figure 1 shows the phase space using control parameters $k = 10^2$ and $\gamma = 10^{-3}$ which we observe chaotic attractors. The I^* is an approximation of the maximum value of the chaotic attractors.

Now we discuss about transport properties [1, 2]. We consider a set of particles with initial conditions for $I_0 = 10^{-5}$ and θ_0 uniformly spaced along of the range $\theta \in [0, 2\pi]$. During the time evolution one of them has $I \geq h$, in which as h is a typical position in the phase space, we assume that the particle reached a hole in $h = c_p I^*$ in which c_p is chosen to be 20% of the higher of I^* and then occur the escape. After escaping this particle is removed from simulation and the number of iterations performed until the escape is stored in a vector and a another initial condition is started with a different phase and same value of I_0. This procedure is repeated until complete the ensemble of initial conditions. An histogram for the number of particles that escaped for n iterations may be built using the control parameters $k = 1$, $\gamma = 4 \times 10^{-4}$. The histogram initially grows with a short n, reaching a maximum value characterized by n_p and after reaching the peak begins to decrease asymptotically to zero. One can see that an exponential decay of $Histogram$ as a function n is observed. We show an exponential fit of the type $Histogram = A\ e^{Bn}$ gives $A = 1.570(1)$ and $B = -0.0009196(3)$.

To summarise we have considered the dissipative standard mapping and studied the transport properties in the phase space along of the chaotic attractors. Our results showed an histogram that grows reaching a maximum value and after it decrease asymptotically to zero. The behaviour of the decreasing of the histogram was exponential. Using different control parameters and considering an specific transformations in the axes a collapse of all histograms may be shown in a single one and universal plot characterizing an invariance scaling. The procedure considered is general and may be applied in different systems known in the literature.

[1]juliano.antonio@unesp.br
[2]rodrigoperre@yahoo.com.br
[3]autor3@email
[4]edson-denis.leonel@unesp.br

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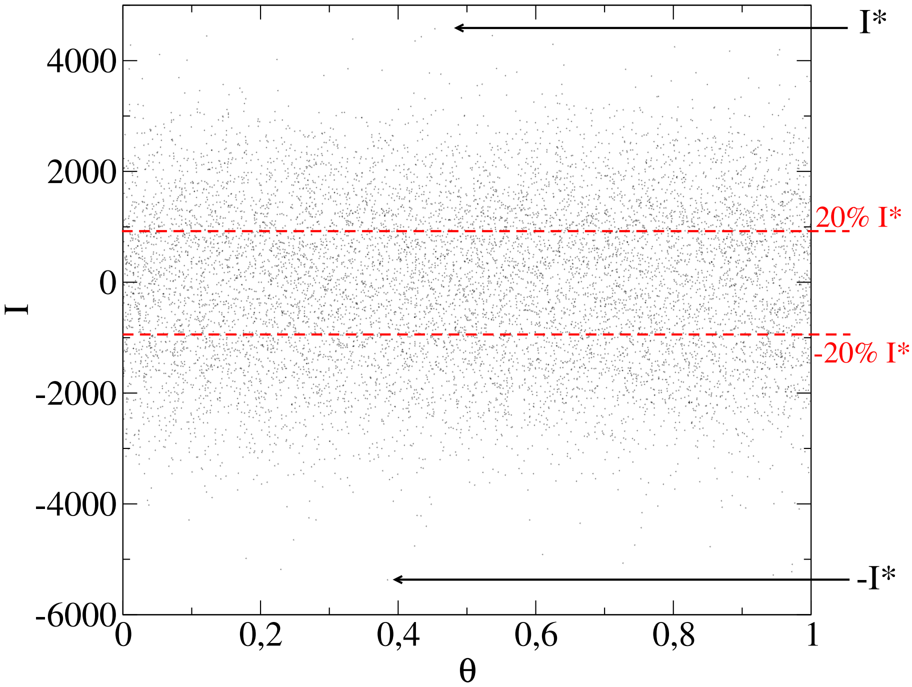

Figura 1: Phase space for the Eq. (1) using ϵ=10^2 and δ=10^{-3}.

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