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Noise and Multistability in the Square Root Map

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Abstract

In this paper we describe the complex structure of the basins of attraction of stable periodic orbits of the one-dimensional square root map and how this produces sensitivity to the addition of small amplitude noise. In particular we focus on how noise of varying amplitudes affects the system in parameter regions of attractor coexistence and also how trajectories jump between different periodic behaviours. We show that there is a non-monotonic relationship between the noise amplitude and the proportion of time spent in each periodic behaviour. These relationships are explained by examining approximations of steady-state distributions of trajectory deviations due to noise and the complicated deterministic structures of the map. We also show how the effect of noise scales on consecutive intervals of multistability.

Keywords: square root map, basins of attraction, noise, nonsmooth dynamical system, period-adding bifurcation, border-collision bifurcation, multistability

1. Introduction

A dynamical system is made up of a set of states X, known as the state space, and a dynamical rule that specifies the immediate future of all state variables,

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