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Performance investigation of stochastic resonance in bistable systems with time-delayed feedback and three types of asymmetries

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Abstract

The simultaneous influence of potential asymmetries and time-delayed feedback on stochastic resonance (SR) subject to both periodic force and additive Gaussian white noise is investigated by using two-state theory and small-delay approximation, where three types of asymmetries include well-depth, well-width, and both well-depth and well-width asymmetries, respectively. The asymmetric types and time-delayed feedback determine the behaviors of SR, especially output signal-to-noise ratio (SNR) peaks, optimal additive noise intensity and feedback intensity. Moreover, the largest SNR in asymmetric SR is found to be relatively larger than symmetric one in some cases, whereas in other cases the symmetric SR is superior to asymmetric one, which is of dependence on time delay and feedback intensity. In addition, the SR with well-width asymmetry can suppress stronger noise than that with well-depth asymmetry under the action of same time delay, which is beneficial to weak signal detection.

Keywords: stochastic resonance, time-delayed feedback, potential asymmetries, weak signal detection

1. Introdution

The employment of noise in enhancing weak signal detection has attracted sustaining attention [1, 2, 3, 4] in various fields such as biology [5, 6], medicine [7], optics [8], communications [9, 10] and mechanics [11, 12, 13]. Traditionally, the methods based on noise cancellation attempt to suppress or cancel the noise and further highlight weak signals masked in noise. Since they inevitably endamage weak signals more or less in the de-noising process, the performance on weak signal detection is unsatisfactory under strong background

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