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Multiwindow fuzzy recurrence analysis of component specific dynamics in a Duffing circuit

Finite, noisy records of a system response can conceal changes in response organization when only one observable is measured and no complete model is available. We analyze experimental capacitor voltage signals from a Duffing type circuit using fuzzy and thresholded recurrence methods in multiple windows across

the sweep of the excitation amplitude. Quantifiers of fuzzy proximity, recurrence density, texture, diagonal organization, and trapping time are interpreted with local maxima diagrams and estimates of the largest Lyapunov exponent. Abrupt changes in the resulting recurrence quantifier profiles indicate reorganizations of the reconstructed response as the excitation amplitude varies. Under the same measurement protocol, we compare antiparallel 1N4148 switching and 1N4237A Zener configurations. The 1N4148 circuit exhibits two localized reentrant intervals, whereas the 1N4237A circuit shows a later, broader multistage interval. Added noise increases local variability for 1N4148 but preserves the main recurrence reorganizations. The recurrence profiles help locate response changes across the sweep but do not independently establish chaos.

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