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Interactions of noise and non-smooth dynamics: transitions and qualitative changes

While there have been recent advances for analyzing the complex deterministic behavior of systems with discontinuous dynamics, there are many open questions about understanding and predicting noise-driven and noise-sensitive phenomena in the non-smooth context. Stochastic effects can often change the picture dramatically, particularly if multiple time scales are present. We demonstrate novel approaches for exploring and explaining surprising phenomena driven by the interplay of nonlinearities and randomness in specific applications with piecewise smooth dynamics - network excitability, relay control, impacting dynamics, and conceptual climate models. Effective techniques typically depend on the combination of mathematical techniques, multiple scales approximations, and phenomenological intuition from seemingly unrelated canonical models of biophysics, mechanics, and chemical dynamics. The appropriate strategy is not always immediately obvious from the area of application or model type. This gap may follow from the limited attention that stochastic models with discontinuous dynamics have received in the past, or it may be the reason for this limited attention. Combining the geometrical perspective with asymptotic approaches in physical and phase space appears to be a critical part of developing effective approaches.