

## Dynamical Systems with Complex Hysteretic Nonlinearity

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Complex hysteretic behavior is observed in so diverse systems such as shape memory alloys, porous materials, or economic systems [1]. It is characterized by a non-local memory resulting in sub-loops, sub-sub-loops, etc. within the main hysteretic loop. This ubiquitous behavior is well described by the so-called Preisach operator [2]. We investigate the behavior of simple deterministic and stochastic dynamical systems coupled to this operator. We present results for the case where the Preisach operator acts simply as a transducer on chaotic or fractal time-series generated by the logistic map, and on stochastic input time-series generated by an Ornstein-Uhlenbeck process. We show that the return maps of the output and its spectrum, respectively, exhibit a non-trivial behavior with hitherto unknown scenarios. The latter is explained by a fluctuating and input dependent internal memory of the Preisach model. We also consider the case where the output of the Preisach transducer is repeatedly fed back to itself under the intermediate action of a nonlinear map. For this case we can show the existence of infinitely many attractors and we provide numerical evidence for a fractal dependence of the system behavior on the initial conditions [3].

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  - [3] G. Radons et. al., *Phys. Rev. E*, submitted, 2006.