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math@tubitak.gov.tr

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Dynamical System Topology Preserved in the Presence of Noise

Judy A. KENNEDY
Department of Mathematical Sciences,
University of Delaware Newark DE 19716
James A. YORKE
Institute for Physical Science and Technology
University of Maryland
College Park MD 20742

Abstract: We first give a precise definition of the terms ``topological horseshoe'' and ``generalized quadrilateral'' and then examine the behavior of a homeomorphism F on a locally compact, separable, locally connected metric space X (X is usually a manifold in applications) such that F restricted to some generalized quadrilateral Q in X is a topological horseshoe map. For a set Q \subset X we define and describe (1) the permanent set Z of Q to be \{x\in X:F^n(x)\in Q for all integers n\}, and (2) the entrainment set of Q to be E(Q)=\{x\in X: F^{-n} (x)\in Q for all sufficiently large n\}. We give conditions under which various closed sets of \overline{E(Q)} are associated, in a strong way, with indecomposable, closed, connected spaces invariant under F. (A connected set A is indecomposable if it is not the union of two proper connected sets, each of which is closed relative to A.) Next we show that even when small amounts of noise are added to the dynamical system, there are associated indecomposable sets. These sets are not, in general, invariant sets for our process with noise, but they are the physically observable sets, while invariant Cantor sets are not, and they are the sets that can be measured.

Key Words: topological horseshoes, generalized quadrilateral, indecomposable continua, connected indecomposable sets, shift dynamics, noisy dynamical systems, permanent set, entrainment set, destination set.

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