Constructing a Simple Chaotic System with an Arbitrary Number of Equilibrium Points or an Arbitrary Number of Scrolls

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Abstract. In a typical 3D smooth autonomous chaotic system, such as the Lorenz and the Rssler systems, the number of equilibria is three or less and the number of scrolls in their attractors is two or less. Today, we are able to construct a relatively simple smooth 3D autonomous chaotic system that can have any desired number of equilibria or any desired number of scrolls in its chaotic attractor. Nowadays it is known that a 3D quadratic autonomous chaotic system can have no equilibrium, one equilibrium, two equilibria, or three equilibria. Starting with a chaotic system with only one stable equilibrium, by adding symmetry to it via a suitable local diffeomorphism, we are able to transform it to a locally topologically equivalent chaotic system with an arbitrary number of equilibria. In so doing, the stability of the equilibria can also be easily adjusted by tuning a single parameter. Another interesting issue of constructing a 3D smooth autonomous chaotic system with an arbitrary number of scrolls is discussed next. To do so, we first establish a basic system that satisfies Shilnikovs inequalities. We then search for a heteroclinic orbit that connects the two equilibria of the basic system. Finally, we use a copy and lift technique and a switching control method to timely switch the dynamics between nearby sub-systems, thereby generating a chaotic attractor with multiple scrolls. Not only the number but also the positions of the scrolls in the chaotic attractor can be determined by our design method. This talk will briefly introduce the ideas and methodologies.

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