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Yet Another Chaotic Attractor

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Abstract

This Express Letter reports the finding of a new chaotic attractor in a simple three-dimensional autonomous system, which resembles some familiar features from both the Lorenz and Rössler attractors.

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1 The New Attractor

In the pursuit of anticontrol of chaos (also called chaotification), which means making a nonchaotic system chaotic [Chen, 1997; Chen & Lai, 1998; Wang & Chen, 1999], we have recently found a new chaotic attractor from the following system:

$$\begin{cases} \dot{x} = & a\,(y - x) \\ \dot{y} = & (c-a)\,x - x\,z + c\,y \\ \dot{z} = & x\,y - b\,z\,, \end{cases} \tag{1}$$

which has the attractor shown in Fig. 1 when

$$a = 35, \qquad b = 3, \qquad c = 28.$$

To compare, we recall the Lorenz system

$$\begin{cases} \dot{x} = & a\,(y - x) \\ \dot{y} = & c\,x - x\,z - y \\ \dot{z} = & x\,y - b\,z\,, \end{cases} \tag{2}$$

which is chaotic when

$$a = 10, \qquad b = 8/3, \qquad c = 28;$$

and the Rössler system

$$\begin{cases} \dot{x} = & -y - z \\ \dot{y} = & x + a\,y \\ \dot{z} = & x\,z - b\,z + c\,, \end{cases} \tag{3}$$

which is chaotic when

$$a = 0.2, \qquad b = 5.7, \qquad c = 0.2.$$

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It is easy to verify that systems (1) and (3) are not topologically equivalent since the former has three equilibria but the latter has only two. Although systems (1) and (2) look alike, it is straightforward (but somewhat tedious) to verify that there is no nonsingular (linear or nonlinear) coordinate transforms that can convert system (1) to (2) or vice versa. Therefore, systems (1) and (2) are not topologically equivalent either. More detailed analysis will be provided in a forthcoming paper.

References

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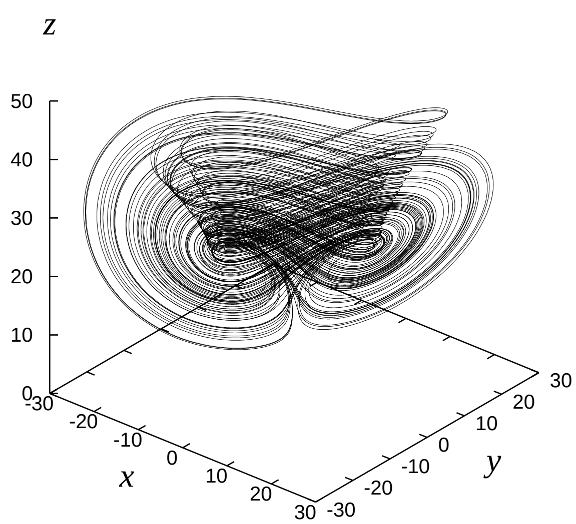

Figure 1: The new chaotic attractor. $a = 35$, $b = 3$, $c = 28$, $x(0) = -10$, $y(0) = 0$, $z(0) = 37$.