Multistability in the Lorenz system

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Abstract:

The Lorenz system is one of the most widely studied of the many chaotic systems now known, and it is the prototypical example of sensitive dependence on initial conditions (the butterfly effect). For the standard parameters used by Lorenz, there is a single symmetric double-wing chaotic attractor that resembles a butterfly. In this paper, the dynamical behavior of the Lorenz system is examined in a previously unexplored region of parameter space, in particular where r is zero and b is negative. For certain values of the parameters, the classic butterfly attractor is broken into a symmetric pair of strange attractors, or it shrinks into a small attractor basin intermingled with the basins of a symmetric pair of limit cycles, which means that the system is bistable or tristable under certain conditions. This multistability may have not obvious physics meaning of fluid convection, however it may be associated with some other physical systems as well as their application since the Lorenz equations have been used to model other systems, such as lasers, dynamos, thermosyphons, waterwheels, and chemical reactions.

Keywords: Lorenz system; coexisting attractor; multistability.