High resolution parameter spaces for an experimental chaotic circuit

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The interest in codimension-two bifurcations in flows, when we vary simultaneously two of the system parameters, have grown substantially in last years. This is due to the observation of complex periodic structures, immersed in chaotic regions, until recently just observed in discrete time maps. More recently, some works reported the existence of those periodic structures inside the chaotic phases in some systems described by continuous-time models. Regarding experimental data, few works reported those structures in two-dimensional parameter spaces with low-resolution. Therefore, the aim of this work is to report two high-resolution experimental parameter spaces for a chaotic circuit, in this case, a Chua´s Circuit.

The Chua´s Circuit is forced by a voltage source d.c., in series with the Chua´s Diode. Such resolution in the parameter spaces was propitiated by the use of a 0.5 mV step d.c. voltage source as the new control parameter. The voltage Vdc change the equilibrium points, defined by the intersection of the "line charge" and the Chua´s I(V) curve. So we have different intersections points for different control parameters.

The two high-resolution codimension-two parameter-spaces presented in this work, one for the periodicity and one for the largest Lyapunov exponent, show abundance of complex periodic structures. Those complex periodic structures organize themselves in a period-adding bifurcation cascade, as (period-2)-(chaos)-(period-3)-(chaos- and so on ... , that accumulates in the chaotic region, for Vdc = 0.0000 V. Numerical investigations on the dynamical model of this forced circuit were also carried out to corroborate several new features observed in those experimental high-resolution parameter-space.

This forced circuit consists in a platform for the study of this intricate periodic networks formed by periodic self-similar structures surrounded by chaotic phases. Regarding chaos based communication systems, the knowledge of what exactly is embedded in the regions of chaos, in dynamical systems, is an important question since clean and extended domains of chaos are important for applications in secure communications.