Experimental observation of Homoclinic bifurcations in Chua’s Circuit

Syamal Kumar Dana,1,* Satyabrata Chakraborty,1,† and Garani Ananthakrishna2,‡

1 Instrument Division, Indian Institute of Chemical Biology, Jadavpur, Kolkata 700032, India
2 Material Research Centre and Centre for Condensed Matter Physics, Indian Institute of Science, Bangalore, India

We report our experimental observations on homoclinic bifurcations in Chua’s circuit, namely, homoclinic chaos near bifurcation point, and gluing bifurcation in asymmetric system. We observed homoclinicity to a saddle focus in a Chua’s oscillator when a second Chua’s oscillator in stable equilibrium is coupled in the weaker limit. Homoclinic chaos may also be observed with lower dimension of the coupled system a stable node. When the first oscillator is near the periodic adding regime of alternate period-doubling and saddle node bifurcation with a single parameter variation, the first Chua’s circuit shows homoclinic chaos of Shil’nikov type as induced by the stable node of the second oscillator for a selected coupling strength of weaker limit. The coupling strength acts as the bifurcation parameter. A countably infinite number of unstable periodic orbits are found near the bifurcation point, which reveals the stretching and folding of global dynamics near saddle focus. For coupling strength a little away from the homoclinic point, bursting are observed, which has strong relevance to the studies on the mechanism of bursting neurons. Moreover, gluing bifurcation near homoclinicity to a saddle focus of a modified Chua’s oscillator, where some additional asymmetry is introduced in the circuit. Two asymmetric homoclinic orbits glued to a single symmetric orbit for two-parameter bifurcation of codimension two. Several alternate periodic and chaotic states are observed for parameter variation. More complicated situations are also discussed.

*Electronic address: skdana@iicb.res.in
†Electronic address: satya_iicb@yahoo.com
‡Electronic address: garani@mrc.iisc.ernet.in