Chaotic circuit exhibits unprecedented equilibrium properties

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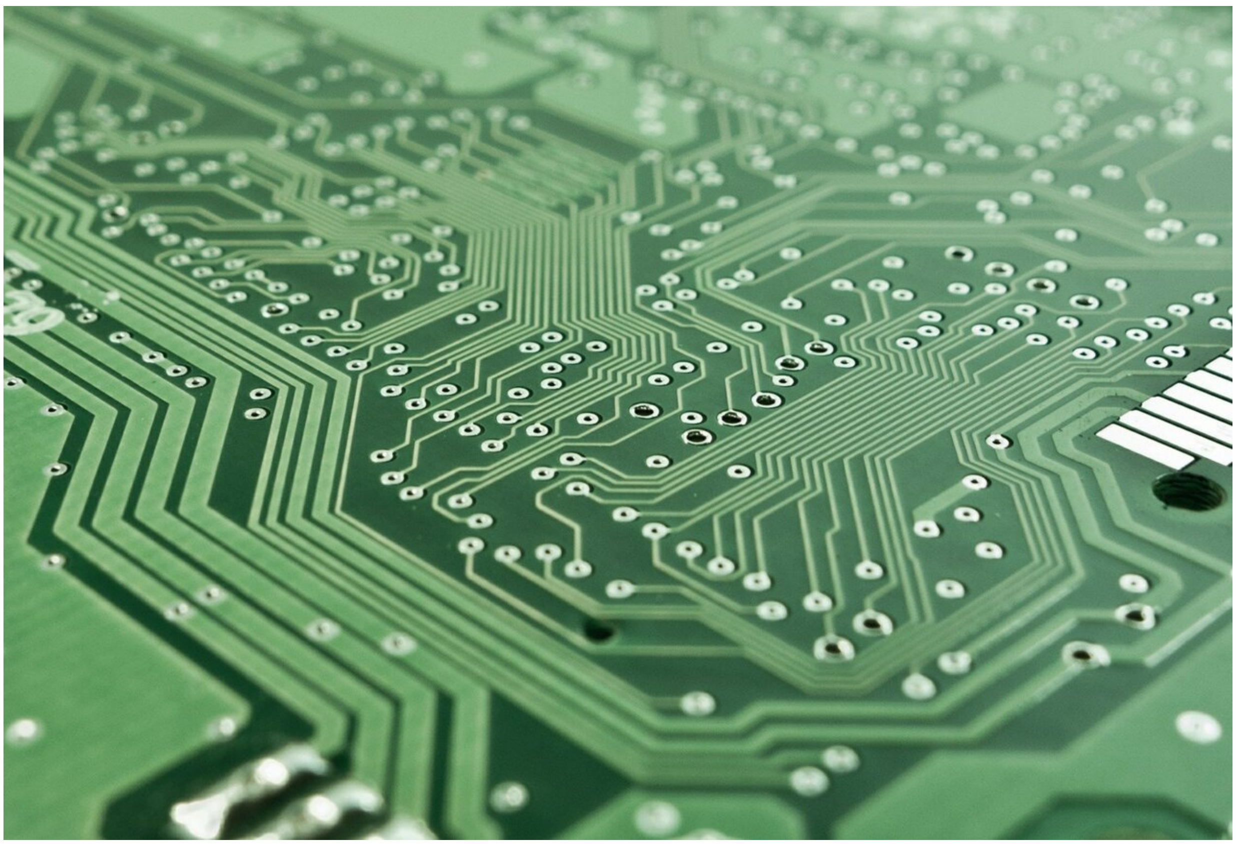

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Mathematical derivations have unveiled a chaotic, memristor-based circuit in which different oscillating phases can co-exist along six possible lines.

Unlike ordinary electronic circuits, chaotic circuits can produce oscillating electrical signals that never repeat over time—but nonetheless, display underlying mathematical patterns. To expand the potential applications of these circuits, previous studies have designed systems in which multiple oscillating phases can co-exist along mathematically-defined "lines of equilibrium." In new research published in *The European Physical Journal Special Topics*, a team led by Janarthanan Ramadoss at the Chennai Institute of Technology, India, designed a chaotic circuit with six distinct lines of equilibrium—more than have ever been demonstrated previously.

Chaotic systems are now widely studied across a broad range of fields: from biology and chemistry, to engineering and economics. If the team's circuit is realized experimentally, it could provide researchers with unprecedented opportunities to study these systems experimentally. More practically, their design could be used for applications including robotic motion control, secure password generation, and new developments in the Internet of Things—through which networks of everyday objects can gather and share data.

The building blocks of chaotic circuits are memristors: electrical components which limit the amount of current flowing through the circuit, while remembering the amount of charge that has flowed through them in the past. Recently, much interest has been shown in chaotic memristor circuits featuring multiple lines of equilibrium. These lines define the boundaries between different phases of oscillation, so that multiple phases can co-exist along them. So far, systems with as many as five lines of equilibrium have been proposed.

Through new derivations, Ramadoss' team discovered a system with six of these lines. By altering the parameters and starting conditions of their system, the researchers have observed a variety of complex dynamics: including the division of oscillating bubbles, and the coexistence of objects which would typically be attracted to each other, and merge into a single object. To establish the feasibility of their ideas, the team have now designed a memristor-based circuit, which they now hope to demonstrate practical in future experiments.

More information: Janarthanan Ramadoss et al, Chaos in a memristive oscillator with six lines of equilibria, *The European Physical Journal Special Topics* (2022). DOI: 10.1140/epjs/s11734-022-00555-0

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