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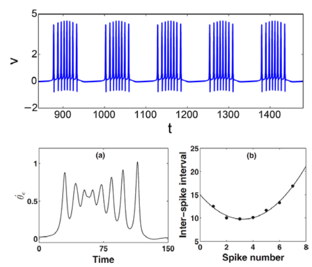
Similarities in the oscillations of neurons and Josephson junctions paves the way for superconducting nanowires and research into future artificial brain networks.



The electrical signals of spiking and bursting dynamics have been recorded in many living cells and neurons. The spiking and bursting dynamics seen in neurons are commonly recorded in the superconducting Josephson junction, which consists of two superconductors separated by a thin insulating barrier, in both self-triggered and externally triggered conditions.

Mishra et al. explore the similarity in the spiking and bursting patterns and explain the physical and nonlinear process involved in the origin of bursting behaviors from the dynamical system perspective.

Spiking and bursting in neurons and other biological cells are common dynamical features that control the functional behaviors of the systems. Experimental and phenomenological biological models have been developed to explain the origin of these special kind of oscillations.

The specific feature of neuron-like bursting in Josephson junctions, however, has generally been overlooked and accepted simply as relaxation oscillations.

As the researchers related the superconducting junction with biological oscillations, two possible classes of bursting were identified: fold/homoclinic and circle/circle. Furthermore, they discovered three important classes of transient bursting, showing striking similarities in pattern and spiking behavior with the dynamical property of neurons.

The simulations and electronic analogue of Josephson junctions confirmed the bursting behaviors like neurons.

"In particular, recent progress in the experimental fabrication of superconducting nanowires with evidence of parabolic bursting is really inspiring," said author Chittaranjan Hens. "Most encouraging is the invention of superconducting nanowires that also reveals the origin of both the fold-homoclinic and parabolic bursting. This discovery may lead to research in the future design of an artificial brain network."

Source: "Neuron-like spiking and bursting in Josephson junctions: A review," by Arindam Mishra, Subrata Ghosh, Syamal Kumar Dana, Tomasz Kapitaniak, and Chittaranjan Hens, *Chaos* (2021). The article can be accessed at https://doi.org/10.1063/5.0050526.