Leap-frog patterns in motifs of two coupled FitzHugh-Nagumo units

Igor Franović,
Associate Professor
Center for the Study of Complex Systems
Institute of Physics Belgrade,
e-mail: franovic@ipb.ac.rs

Within this talk, it will be shown that simple circuits comprised of two Fitzhugh-Nagumo units with repulsive linear couplings and local dynamics close to a canard transition can exhibit complex activity patterns beyond the classical synchronization paradigm. While attractive interactions in the fast variables always lead to synchronized behavior with a constant phase shift between the successive spikes of two units, the repulsive couplings can give rise to dynamical regimes with alternating spiking order, called leap-frogging or leader-switching patterns [1]. The individual dynamics of units engaged in leap-frog dynamics resembles the mixed-mode oscillations in multiple timescale systems, where the large-amplitude relaxation oscillations are interspersed with small-amplitude subthreshold oscillations. We unveil various types of periodic and chaotic leap-frogging regimes, using numerical path-following techniques to investigate their onset and stability domains [2]. In particular, for the simplest periodic leap-frogging pattern with the space-time symmetry, we identify a complex bifurcation scenario that organizes its appearance in phase space, demonstrating that the associated stability domain has the shape of a locking cone pointing to the canard transition of the uncoupled system. We explain the role of timescale separation in the emergence of leap-frog patterns, showing how the sensitivity to perturbations of relaxation oscillations in vicinity of the fold singularity of the slow manifold [3] induces rapid transitions between relaxation and subthreshold oscillations.

REFERENCES

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