

Dynamics and bifurcations in a conductance-based neuron model

Piotr Kowalczyk, Mathieu Desroches and Serafim Rodrigues

We present a computational study of a neuron model termed *Conductance-Based Adaptive Exponential (CAdEx) integrate-and-fire* model, which includes a biophysical aspect of conductance current. We show how the multiple timescale nature of the model, and the time scale separation, shape the dynamics by inducing the so-called *spiking* and *delayed bursting* behaviour. This dynamics is triggered by *discontinuity-induced bifurcations*, described analytically in our work in [1], which are mediated by so-called *canard* solutions. By means of numerical bifurcation analysis, using the software package COCO, we numerically unravel spike-increment transitions accompanied by a fold and a period-doubling bifurcations. These bifurcations are organised in parameter space along an *isola* periodic solutions with resets. Finally, we also unveil the presence of a homoclinic bifurcation terminating a canard explosion which, together with the presence of resets, organises the delayed bursting regime. The presentation is based on our recent research work [2].

References

- [1] M. Desroches P. Kowalczyk, and S. Rodrigues, *Spike-adding and reset-induced canard cycles in adaptive integrate and fire models*, *Nonlinear Dynamics*, Vol. 104, 2451–2470 (2021)
- [2] M. Desroches P. Kowalczyk, and S. Rodrigues, *Discontinuity induced dynamics in Conductance-Based Adaptive Exponential Integrate-and-Fire Model*, submitted for publication to *Bulletin of Mathematical Biology*, February (2024)

First Author: Piotr Kowalczyk

Affiliation: *Department of Mathematics, Wrocław University of Science and Technology
50-376 Wrocław, Poland*

e-mail: piotr.s.kowalczyk@pwr.edu.pl

Second Author: Mathieu Desroches

Affiliation: *MathNeuro Project-Team, Inria Branch of the University of Montpellier
34095 Montpellier, France*

e-mail: mathieu.desroches@inria.fr

Third Author: Serafim Rodrigues

Affiliation: *BCAM - Basque Center for Applied Mathematics
48009 Bilbao, Spain*

e-mail: srodrigues@bcamath.org