Slow-fast dynamics in bursting neurons: (ICMNS 2019, M. Desroches, Inria, France)

1. Planar neuron models (one slow and one fast variables)

- **The main objects and their role:** slow subsystem, fast subsystem, critical manifold.
- **Excitability:** type I/II neurons, threshold and the role of *canards*.
- **Examples:** Morris-Lecar, reduced Hodgkin-Huxley, FitzHugh-Nagumo, theta model.

2. Bursting models with one slow variable

- **Ingredients for bursting:** Dynamic bifurcations, hysteresis loop.
- **Slow-fast dissection (due to Rinzel):** a key geometrical insight.
- **Rinzel's classification of bursting profiles:** square-wave and elliptic classes.
- **Izhikevich's classification:** (almost) any pair of fast subsystem bifurcations will do.
- **Spike-adding via canards:** the Hindmarsh-Rose square-wave burster example.

3. Bursting in systems with two slow variables

- **Parabolic bursting (Rinzel's 3rd class):** fast subsystem SNIC bifurcations; spike-adding via folded-saddle canards; various examples.
- **Pseudo-plateau bursting:** canard-induced mixed-mode oscillations (MMOs) and folded-node singularities; pseudo-plateau bursting as an MMO system in disguise.
- **Mixed-mode bursting oscillations (MMBOs):** combining MMO and bursting; the extended Hindmarsh-Rose example.

References

- M Desroches, TJ Kaper and M Krupa, *Mixed-mode bursting oscillations (...)*, Chaos **23**(4): 046106, 2013. PDF
- M Desroches, M Krupa and S Rodrigues, *Spike-adding in parabolic bursters: The role of folded-saddle canards*, Phys D **331**: 58-70, 2016. PDF
- EM Izhikevich, *Neural excitability, spiking and bursting*, Int J Bifurcations and Chaos **10**(6): 1171-1266, 2000. PDF
- J Rinzel, *A Formal Classification of Bursting Mechanisms in Excitable Systems*, Proc ICM, Berkeley, California, USA, Vol. 2 (1986), pp. 1578--1593. PDF
- T Vo, R Bertram, J Tabak and M Wechselberger, *Mixed mode oscillations as a mechanism for pseudo-plateau bursting*, J Comp Neurosci **28**(3): 443-458, 2010. PDF