



SEMINAR

APPLIED MATHEMATICS AND MECHANICS

FS1010

5 May 2025

A DCAMM seminar No. 786 will be presented by

Associate Professor Morten Gram Pedersen
Department of Information Engineering
University of Padova, Italy

The title of the lecture is

**Non-standard geometrical singular perturbation analysis of bursting in
next-generation neural mass models with spike-frequency adaptation**

Abstract:

We analyze a four-dimensional model of electrical activity in a neural population with synaptic coupling and spike-frequency adaptation (SFA), which was derived as a mean-field model of a population of quadratic integrate-and-fire neurons. We show that traditional slow-fast analysis, with the SFA term as the slow variable, is insufficient for explaining the bursting behavior seen in simulations, and propose that nonstandard geometric singular perturbation theory (GSPT) must be applied to explain the full model dynamics. In particular, a small additive parameter in the population firing frequency equation suggests an alternative, non-standard, singular limit. To understand the dynamics during the silent phase of bursting, we find the critical manifold and investigate its stability in this alternative singular limit. We show that the end of the active phase can be understood as the passage through a contact point. For the active phase, we again go to the singular limit and show that the system is near-conservative, in the sense that under an additional slow-fast assumption, the fast subsystem has a conserved quantity, which we interpret as a “potential” for electrical activity. This quantity explains why the system performs ellipse-like oscillations during the active phase. After a time-rescaling, we find an explicit solution of the fast subsystem, which allows us to apply slow-fast averaging and understand the overall dynamics during the active phase. In summary, we apply – to the best of our knowledge – for the first time GSPT to a neuronal model in non-standard form, which leads to non-trivial analysis, in particular for the active phase.

DATE:	Monday, 19 May 2025
TIME:	13:00 – 13:45
PLACE:	Building 303B, Room 134, Matematicum DTU, Technical University of Denmark

Danish pastry, coffee and tea will be served 15 minutes before the seminar starts.

All interested persons are invited.

Jan Becker Høgsberg

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