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COMPUTATIONAL BRAIN MULTIPHYSICS

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ABSTRACT

Our brains are composed of soft, intertangled tissue consisting of neurons, glial cells, and extracellular space filled with interstitial fluid, penetrated by blood vessels and surrounded by cerebrospinal fluid. As such, the brain features an intriguing but complex interplay between electrical, chemical and mechanical forces interacting across a wide range of spatial and temporal scales. Our understanding of the underlying mechanisms is incomplete, leaving a striking potential for in-silico approaches to give new insights into brain function and brain health. At the same time, modelling and simulation of brain multiphysics poses characteristic mathematical and computational challenges and a need for the development of new concepts, methods and technology. This minisymposium aims to bring together scientists from the multifaceted field of computational brain multiphysics to share recent findings, exchange ideas and to foster discussion.

Topics covered will include, but are not limited to: linear and non-linear brain mechanics, cerebrospinal fluid flow, molecular transport and clearance, glymphatics, data-driven techniques, network dynamical systems, reduced order modelling and geometrical model reduction, structure-preservation and robustness in numerical discretizations, efficient solution algorithms, as well as applications in neurological and neurodegenerative clinical contexts.

REFERENCES

[1] R. Masri, M. Zeinhofer, M. Kuchta, M. E. Rognes. The modelling error in multi-dimensional time-dependent solute transport models. *ESAIM: Mathematical Modelling and Numerical Analysis*, *58*(5), 1681-1724 (2024)

[2] I. Fumagalli, M. Corti, N. Parolini, P. F. Antonietti, Polytopal discontinuous Galerkin discretization of brain multiphysics flow dynamics, Journal of Computational Physics, 513:113115 (2024)