Poster: Ivan Fumagalli[1]

Modeling cerebrospinal fluid dynamics in neurodegenerative diseases

Other non-presenting authors: P. F. Antonietti[1], M. Corti[1], N. Parolini[1]

Abstract: The impairment of waste clearance mechanisms in the brain is strongly linked to the onset and progression of neurodegenerative diseases, such as Alzheimer's. The cerebrospinal fluid (CSF) primarily plays a role in this clearance function, removing misfolded proteins through filtration in cerebral tissue and flow within the brain's ventricles. The generation of CSF and its pulsatile flow are connected to blood perfusion in the brain. This talk presents a coupled computational model integrating multiple-network poroelasticity (MPE) equations for CSF filtration and blood perfusion with Stokes equations for CSF flow. Our approach utilizes an advanced discretization scheme on polytopal meshes, enabling efficient and accurate simulations in complex geometries. We demonstrate the practical performance of the computational framework for patient-specific geometries reconstructed from MRI data of Alzheimer's patients. This work contributes to the understanding of waste clearance and the transport of misfolded proteins in the brain, a subject of active debate in the clinical and bioengineering communities, leveraging high-performance computing tools.

This research is supported by ICSC-Centro Nazionale di Ricerca in High-Performance Computing, Big Data, and Quantum Computing, funded by the European Union-NextGenerationEU.

1. MOX, Dipartimento di Matematica, Politecnico di Milano