APPLIED AND NUMERICAL ANALYSIS SEMINAR

Thursday April 7 Period 9

Speaker: Ingeborg Gjerde | Simula Research Laboratory

Title: Reduced-dimensional modelling of CSF flow in the brain

Abstract: Our brain uses approximately 20% of the body's energy in resting state. Yet the brain lacks a traditional lymphatic system for metabolic clearance. This raises the question of how the brain clears waste. This question is of key importance as several neurological diseases, such as Alzheimer's and Parkinson's disease, are characterised by the accumulation of toxic proteins in the brain.

According to the glymphatic theory, cerebrospinal fluid (CSF) flows in a network of perivascular spaces surrounding the arteries of the brain. This allows for a bulk flow of CSF through the brain that can remove metabolic waste. There are, however, several unanswered questions regarding the physical processes that are at work. For example it is unclear what the driving force of this flow is. In order to assess these questions we need to develop models for glymphatic fluid flow. One of the challenges of such a model is that the glymphatic network is highly complex, making it intractable to resolve as a 3D geometry.

In this talk, we consider 3D Stokes flow in the annular spaces surrounding blood vessels. The domain is allowed to move in order to take into account arterial pulsations. Assuming the flow behaves like annular Poiseuille flow, we then reduce this to a 1D network equation. We show that the reduced model captures the key features of the full 3D model at a fraction of the runtime and computational cost.