LMS Seminar

24 March 2022 at 11:00 am
Jean Mandel room

Mathematical modelling of human brain transport
From medical images to biophysical simulation

Marie E. Rognes

Simula Research Laboratory, Oslo, Norway

ABSTRACT

Your brain has its own waterscape: whether you are reading, thinking or sleeping, fluid flows through or around the brain tissue, clearing waste in the process. These biophysical processes are crucial for the well-being and function of the brain. In spite of their importance we understand them but little, and mathematical and computational modelling could play a crucial role in gaining new insight. In this talk, I will give an overview of mathematical, mechanical and numerical approaches to understand mechanisms underlying solute transport in the human brain. Topics include generalized poroelasticity [1], fluid-structure interactions [2], mixed finite element discretizations [3] and preconditioning [4], uncertainty quantification [5], and optimal control [6].

BIOGRAPHY

Marie E. Rognes is Chief Research Scientist and Research Professor in Scientific Computing and Numerical Analysis at Simula Research Laboratory, Oslo, Norway and Professor II at the Department of Mathematics, University of Bergen, Norway. She received her Ph.D from the University of Oslo in 2009 with an extended stay at the University of Minneapolis, Twin Cities, Minneapolis, US. She has been at Simula Research Laboratory since 2009, led its Department for Biomedical Computing from 2012-2016 and currently leads a number of research projects focusing on mathematical modelling and numerical methods for brain mechanics including an ERC Starting Grant in Mathematics (2017-2023). She won the 2015 Wilkinson Prize for Numerical Software, the 2018 Royal Norwegian Society of Sciences and Letters Prize for Young Researchers within the Natural Sciences, is a Founding Member of the Young Academy of Norway and is a core developer/member of the FEniCS Steering Council.

REFERENCES

[1] Qingguo Hong, Johannes Kraus, Miroslav Kuchta, Maria Lymbery, Kent-André Mardal, and Marie E Rognes. Robust approximation of generalized Biot-Brinkman problems. *arXiv preprint arXiv:2112.13618*, 2021.

[2] Cécile Daversin-Catty, Vegard Vinje, Kent-André Mardal, and Marie E Rognes. The mechanisms behind perivascular fluid flow. *Plos one*, 15(12):e0244442, 2020.

[3] Jeonghun J Lee, Eleonora Piersanti, K-A Mardal, and Marie E Rognes. A mixed finite element method for nearly incompressible multiple-network poroelasticity. *SIAM Journal on Scientific Computing*, 41(2):A722–A747, 2019.

[4] Eleonora Piersanti, Jeonghun J Lee, Travis Thompson, K-A Mardal, and Marie E Rognes. Parameter robust preconditioning by congruence for multiple-network poroelasticity. *SIAM Journal on Scientific Computing*, 43(4):B984–B1007, 2021.

[5] Matteo Croci, Vegard Vinje, and Marie E Rognes. Uncertainty quantification of parenchymal tracer distribution using random diffusion and convective velocity fields. *Fluids and Barriers of the CNS*, 16(1):1–21, 2019.

[6] Nicolas Boullé, Patrick E Farrell, and Marie E Rognes. Optimal control of Hopf bifurcations. *arXiv preprint arXiv:2201.11684*, 2022.