Department of Numerical Analysis and Scientific Computing

Simula Research Laboratory

Oslo, Norway

Optimization in Oslo
A Seminar Series on Continuous Optimization

Date:
Thursday November 2, 2023 at 14:00 (CEST)

Speaker:
Prof. Shawn W. Walker
Louisiana State University

Title:
Controlling defects in the Landau-de Gennes model of nematic liquid crystals

Abstract:
This talk presents an optimal control framework for the time-dependent, Landau-de Gennes (LdG) model of nematic liquid crystals. We develop parabolic, optimal control techniques for controlling the L^2 gradient flow of the LdG energy. The controls are through the boundary conditions (by weak anchoring) and a body force term. We seek to find optimal controls that drive the LdG Q-tensor variable toward a desired "texture" state, including defect positions. The objective functional we minimize is of tracking type with additional regularization terms for the controls. To the best of our knowledge, this is the first time PDE-based optimal control has been developed for the LdG model. Existence of a minimizer for the control problem is established. Moreover, with various regularity estimates, we prove first order Fréchet differentiability results for the control objective. This enables gradient based optimization methods through an adjoint PDE. In the talk, we highlight the analytical issues that arise, especially those due to the gradient flow being a parabolic *system*. We then describe a finite element discretization of the full control problem and present numerical simulations in two and three dimensions demonstrating that point and line defect positions can be controlled.

Brief Bio:

Prof. Walker joined the LSU Department of Mathematics in 2010 after completing his postdoctoral research with the Courant Institute of Mathematical Sciences at New York University. He received his Ph.D. and M.Sc. from the University of Maryland in 2007. His research interests include mathematical modeling, numerical analysis, finite element methods (FEM) for Geometric Partial Differential Equations (PDEs), liquid crystals, geometric evolution and free boundary problems, and optimal control of PDEs. Geometry plays an important role in almost all of Dr. Walker's work. He has been continuously funded by the NSF with four awards, one of which was the prestigious NSF CAREER award for his work on numerical methods for liquid crystals and their optimal design.