Minicourse

Nematic Liquid Crystals: A Playground for Mathematics and Applications

Prof. Dr. Apala Majumdar, University of Strathclyde, UK

Place: Emil-Fischer-Str. 40, 40.03.003

Time:
Wednesday 14 June 2023, 10.00-11.00
Thursday 15 June 2023, 10.00-11.00
Wednesday 21 June 2023, 10.00-11.00
Thursday 22 June 2023, 10.00-11.00

This minicourse will be the introductory part to a **Master's Seminar Mathematics in the Sciences** (M=SMNW-1S, 08050750) by Prof. Dr. Anja Schlömerkemper. Students and scientists who are interested in studying the Mathematics of Liquid Crystals in more depth are in invited to join a reading course that will follow this minicourse. (Time and place on mutual agreement. Please contact Prof. Schlömerkemper if interested.) The minicourse by Prof. Majumdar can be attended independently of this.

Prof. Majumdar will stay at the Institute of Mathematics for several months in 2023 and 2024 as part of the **Friedrich Wilhelm Bessel award** by the Alexander von Humboldt foundation that she was awarded. Future mutual exchange of students and scientists from Würzburg and Strathclyde will be appreciated.

Abstract: Nematic liquid crystals are paradigm examples of soft materials and complex fluids. Nematics combine the fluidity of liquids with the orientational order of conventional solids i.e. they have distinguished special directions, referred to as "directors". Consequently, they have a direction-dependent response to external fields and light, making them the working material of choice for the multi-billion liquid crystal display industry, along with new applications in biosciences, artificial intelligence and nanotechnologies etc. The mathematics of nematic liquid crystals is broad and rich, spanning multiple branches of mathematics such as the calculus of variations, nonlinear partial differential equations, numerical analysis, topology, stochastic analysis and scientific computation.

In the first lecture, we will survey the continuum Oseen-Frank and Nobel-Prize winning Landau-de Gennes theory for nematic liquid crystals, the governing systems of nonlinear coupled partial differential equations and the theory of isotropic-nematic phase transitions. In the second lecture, we will focus on two case studies - the canonical radial-hedgehog defect in the Landau-de Gennes theory for nematic liquid crystals and the reduced Landau-de Gennes approach for planar or two-dimensional bistable liquid crystal devices. All collaborations will be acknowledged during the lectures. Some references are given below.

References:

[1] A. Majumdar, Equilibrium order parameters of liquid crystals in the Landau-de Gennes theory, European Journal of Applied Mathematics, 21 (2010), 181.

[2] A. Majumdar and A. Zarnescu, The Landau-de Gennes theory of nematic liquid crystals: the Oseen-Frank limit and beyond, Archive of Rational Mechanics and Analysis, 196 (2010), 227.

[3] A. Majumdar, The radial-hedgehog solution in Landau – de Gennes' theory for nematic liquid crystals, European Journal of Applied Mathematics, 23 (2012), 61.

[4] C. Luo, A. Majumdar and R. Erban, Multistability in planar liquid crystal wells, Physical Review E, 85 (2012), 061702.

[5] Y. Han, A. Majumdar and L. Zhang, A Reduced Study for Nematic Equilibria on Two-Dimensional Polygons, SIAM Journal of Applied Mathematics, 80 (2020), 1678 - 1703.

Brief Bio: Apala Majumdar is an internationally acclaimed expert in the mathematics and modelling of liquid crystals and their applications. She is Full Professor of Applied Mathematics at the University of Strathclyde. She received her PhD in applied mathematics from the University of Bristol in 2006, where she was also a CASE student with Hewlett Packard laboratories. She worked in Oxford as a research fellow, was appointed as a faculty member at the University of Bath in 2012 and moved to Strathclyde in 2019. Apala's research programme is strongly interdisciplinary and international in character; she has worked with physicists, chemists, researchers from industry from all around the world e.g. Europe, China, India, USA, Chile, Mexico etc. Her scientific achievements and service to the community have been recognised by several national prizes - a London Mathematical Society Anne Bennett Prize in 2015, prizes from the British Liquid Crystal Society and a Suffrage Science Award for inspirational women in STEM in 2020. In light of her global research programme, Apala is also the Associate Dean for International Research for the Faculty of Science at the University of Strathclyde. In 2022, Apala was awarded a Bessel Research Award from the Humboldt Foundation to work with Professor Anja Schlömerkemper at the University of Würzburg. More details about Apala's research and activities can be found at https://www.strath.ac.uk/staff/majumdarapalaprofessor/