Coagulation–Fragmentation and Liquid Crystals:

A day of talks in honour of Professor Iain W. Stewart, FRSE

14:00–19:00, Thursday, May 4th, 2023, Livingstone Tower LT908

Funded by the Department of Mathematics & Statistics at the University of Strathclyde and the School of Mathematics & Statistics at the University of Glasgow

Speakers:

Prof. J. Banasiak (U. Pretoria)
Prof. P. Laurençot (U. Savoie Mont-Blanc)
Prof. S. McKee (U. Strathclyde)
Prof. A. Majumdar (U. Strathclyde)
Prof. M. Osipov (U. Strathclyde)

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Programme

2:00-2:10 John Mackenzie: Opening Address

2:15-2:55 Jacek Banasiak: Transport–fragmentation–coagulation equations: modelling and analysis

3:00-3:40 Philippe Laurençot: The collision-induced fragmentation equation

3:45-4:15 Tea Break

4:15-4:45 Apala Majumdar: Mathematics and applications of liquid crystals: the Strathclyde legacy and beyond

4:50-5:20 Sean McKee: Boundary layers in pressure-driven flow in Smectic A liquid crystals and other topics

5:25-5:55 Mikhail Osipov: Continuum theory of Smectic C liquid crystals and a collaboration between Iain Stewart and Frank Leslie

6:00-6:10 Iain Stewart: Closing Words

6:15-6:45 Wine Reception

Abstracts

Jacek Banasiak (University of Pretoria & Technical University of Łódź): **Transport–fragmentation–coagulation equations: modelling and analysis**

Fragmentation and coagulation processes are often accompanied by other phenomena, such as the growth/decay of clusters due to chemical reactions or vital processes, or transport in the physical space. The latter are modelled by first-order differential operators, which having no smoothing properties, significantly complicate the analysis of the combined equations. In the talk, we will

survey the theory of such problems based on the observation that the pure fragmentation operator, considered in spaces with finite higher moments, is sectorial. The related smoothing property extends to a broader class of problems which allows for proving well-posedness results also for nonlinear problems with unbounded nonlinearities.

Philippe Laurençot (Université de Savoie Mont-Blanc): **The collision-induced fragmentation equation**

The collision-induced fragmentation equation describes the dynamics of particles which break apart upon colliding. The well-posedness is studied when the collision kernel is given by the classical sum/product kernel with exponents $\alpha \le \beta \le 1$ and homogeneity $\lambda = \alpha + \beta$. When $\lambda \in [1, 2]$, the existence of a global mass-conserving weak solution is shown, while finite time blowup takes place when $\lambda \in [0, 1]$ and $\alpha \ge 0$. Finally, non-existence is established for $\alpha < 0$ (joint work with Ankik Kumar Giri, Roorkee, India).

Sean McKee (University of Strathclyde): **Boundary layers in pressure-driven flow in Smectic A liquid crystals and other topics**

This talk will start with a brief discussion of our most recent collaboration (with David Wheatley and others) on modelling the Wheatley heart valve and the result of it opening and closing under a pressure difference. With regard to Smectic A liquid crystals when $\boldsymbol{n}$ (the director) and $\boldsymbol{a}$ (layer normal) are constrained to coincide, de Gennes sketched a flow field and argued that a boundary layer exists related to the interlayer distance. Stewart (Dynamic Theory of Smectic A Liquid Crystals, 2007) developed a theory for the case when $\boldsymbol{n}$ and $\boldsymbol{a}$ do not coincide. Using this theory, Stewart *et al.* (2015) showed that there exist two boundary layers, the first being the one discovered by de Gennes, and the second being concerned with the director and the layer normal which turns out to be an order of magnitude smaller than the interlayer thickness. We shall conclude with a discussion of joint numerical work on the Ericksen-Leslie equations for nematic liquid crystals, in particular on free surface flows.

Apala Majumdar (University of Strathclyde): **Mathematics and applications of liquid Crystals: the Strathclyde legacy and beyond**

We review the history of liquid crystal research at Strathclyde, from the pioneering work of Frank Leslie to the contributions of Iain Stewart and others, including a snapshot of contemporary liquid crystal research at Strathclyde. Current research topics include solution landscapes of confined liquid crystalline systems, nematodynamics, active liquid crystals, computational methods for liquid crystal and soft matter systems and modelling of novel liquid crystal applications. We conclude with future perspectives and our vision for liquid crystal research at Strathclyde.

Mikhail Osipov (University of Strathclyde): **Continuum theory of Smectic C liquid crystals and a collaboration between Ian Stewart and Frank Leslie.**

The contribution of Iain Stewart to the theory of Smectic A and Smectic C liquid crystals is briefly reviewed. In particular, we focus on his theory of dynamical and static properties of the Smectic C phase which had been developed together with Frank Leslie.