The Complexity Cluster Event Organisers Professor Gui-Qiang G. Chen, Professor Helen Byrne, and Professor Mohit Dalwadi, cordially invite you to attend a Complexity Cluster Research Workshop on Tuesday, 20th May 2025, in the Glen Callater Room, H B Allen Centre, Keble College.
The details of the event are given below.

Complexity Cluster Research Workshop

Venue: Glen Callater Room, H B Allen Centre, Keble College
Date: Tuesday, 20th May 2025
Organisers: Professor Helen Byrne
Professor Gui-Qiang G. Chen
Professor Mohit Dalwadi

Programme:

4.00pm – 4.15pm: **Coffee, Drinks & Refreshments**

4:15pm – 4:40pm: Professor Didier Bresch
CNRS and Universite Savoie Mont-Blanc, France
Title: Mathematical Topics around Granular Media
Abstract: In this presentation, I will discuss how the study of complex flow phenomena encourages further research in mathematics, both theoretically and numerically. I will focus on specific properties of phenomena related to granular materials and present recent results and open problems.

4:45pm – 5:10pm: Dr. Keith Chambers, Mathematical Institute, University of Oxford
Title: Structured Population Models to Explore Lipid-Driven Macrophage Heterogeneity in Early Atherosclerotic Plaques
Abstract: Atherosclerosis is a chronic inflammatory disease of the artery wall and a leading cause of death worldwide. A particular danger is the clinically silent development of its early stages. These early stages are characterised by the accumulation of fatty compounds (lipids) within immune cells called monocyte-derived macrophages (MDMs). MDMs ingest extracellular lipids, sourced primarily by low-density lipoprotein (LDL) particles, and offload them onto high-density lipoprotein (HDL) particles for clearance. The relative frequency of these and other microenvironmental interactions generates considerable cell-cell variation amongst lesion MDMs with respect to lipid content, phenotype and spatial position. Understanding this heterogeneity is key to predicting which lesions will resolve and which will persist to become life-threatening. In this talk, I will present a series of structured population models we used to explore how MDM heterogeneity arises and evolves in early atherosclerotic lesions. The model analyses, which include numerical and asymptotic solutions, implicate the bloodstream concentrations of LDL and HDL as key parameters in shaping cell-cell variation.

5:15pm – 5:40pm: Coffee, Drinks & Refreshments

5:40pm – 6:05pm: Dr. Tara Trauthwein, Department of Statistics, University of Oxford
Title: Approximation Results for Large Networks
Abstract: Networks are all around us - be it the omnipresent internet, street networks or more abstract structures like similarities in patient genes. In this talk, we will look at various mathematical models of spatial networks (or graphs), and how to show large limit results by introducing small local disturbances. The methods developed to show these (central) limit theorems are astoundingly general and apply to many problems even outside of stochastic geometry. Time permitting, we will briefly see how geometry can have an impact on the behaviour of graphs.
What is the expected composition of the audience going to be like? Mostly mathematicians and maths students? Or students from social sciences and other subjects?

6:05pm-6:30pm: Isaac Newell, OxPDE, Mathematical Institute, University of Oxford
Title: The Gauss Equation for Isometric Embeddings of Regularity in $W^{1+2/3,3} \cap C^1$
Abstract: Let u : $(\Sigma, g) \to \mathbb{R}^3$ be isometric embedding of a smooth Riemannian surface in the three-dimensional Euclidean space. When u is smooth, the image surface is locally the graph of a function f satisfying the Gauss equation $det(D^2) f = K_g (1+|Df|$^2)^2$. We prove that this equation still holds in the sense of distributions when u has regularity $W^{1+2/3,3} \cap C^1$, via an approach based on the Cartan formalism. We also prove regularity and convexity results in the case of positive Gaussian curvature, extending earlier work by De Lellis, Conti, and Székelyhidi (Abel Symposium, 2010), Giron (DPhil thesis, 2021) and Pakzad (J. Funct. Anal., 2024). This is joint work with Luc Nguyen.

6:35pm-7:00pm: Discussion