When Macro Mimics Micro:
Investigating Liquid-Crystal-Like Phenomena in Macroscopic Systems

B.Sc or M.Sc. Thesis Project

Goal: Using a combination of discrete particle method (DPM) simulations and experimental work conducted using both optical techniques and the University of Birmingham's world-leading Positron Emission Particle Tracking facility, we will gain new insight into the observed tendencies of *macroscopic particulate systems* to exhibit behaviours which draw remarkable parallels with those demonstrated by *microscopic, molecular systems*.

Motivation: Multi-body systems comprising macroscopic, athermal components are omnipresent in our everyday lives, in science and in industry. Indeed, other than water, these granular media represent the most widely-handled substance on Earth, playing vital rôles in numerous multi-billion-dollar industries and highly consequential natural phenomena. However, our understanding of these materials – and our ability to theoretically explain and predict their behaviours – remains startlingly deficient as compared to our knowledge of molecular systems.

Recent research has shown that strongly excited systems, despite their inelastic, frictional and athermal nature, demonstrate properties strikingly similar to those of liquid crystal systems. These similarities hint at the possibility that theoretical models developed for liquid crystal systems may potentially be adapted for granular media, leading to a deeper understanding of these materials that may prove revolutionary both in academia and industry.

In this project, you will get the chance to be involved in cutting-edge contemporary research investigating the possibility of applying statistical-mechanics-based concepts to macroscopic particulate systems. Due to the multi-faceted nature of this project, students can choose to engage in theory-based, simulation based or experimental work, with the possibility of travelling to the UK to perform Positron Emission Particle Tracking at one of only two PEPT facilities in the world.

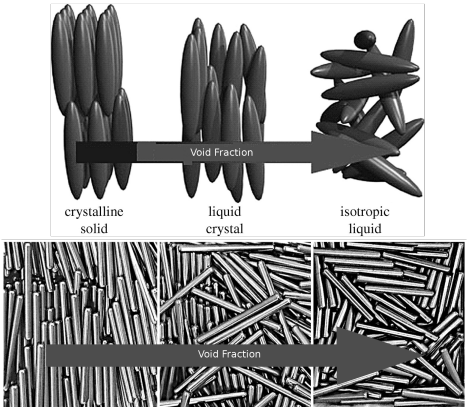

Figure 1: Comparison of phase changes observed in liquid crystal systems and macroscopic systems of steel particles.

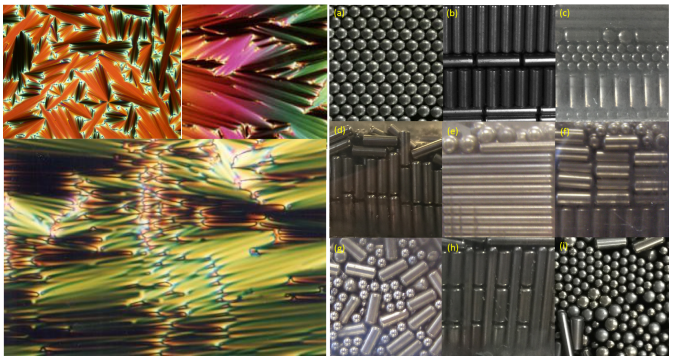

Figure 2: A selection of the many diverse and complex phase states exhibited by liquid crystal (left) and granular (right) systems.

Agenda:

- Literature review.
- Introduction to and training in the use of MercuryDPM.
- Introduction to and training in PEPT analysis.
- Introduction to liquid crystal theory.
- Discussions, presentations and the production of a Master's Thesis.

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