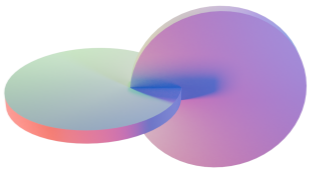

GIREP-EPEC
Transforming physics learning via Research & Practice
LEIDEN, 2025

Contribution ID: **68** Type: **Invited keynote**

The Physics of Flocking: Emergence of Collective Motion in Active Matter

Monday 30 June 2025 15:30 (1 hour)

From bacteria colonies, to insect swarms, to bird flocks, collective motion emerges within large groups of living creatures even in the absence of a leader. Physicists aim at uncovering the universal aspects shared by all these systems despite their differences in length scales, environments, or communication means - very much like in phase transitions, such as crystallisation, where some features are independent of the specific atoms or molecules. Characteristic of active matter is the ability of the individuals to self-propel by consuming energy, which keeps these systems out-of-thermodynamic equilibrium and underlies their rich spatio-temporal dynamics.
In this talk, I will present a model experimental system for studying the emergence of collective motion in the laboratory. In place of living creatures, we study plastic microspheres turned into self-propelled individuals via an electro-hydrodynamic instability. This setup allows us to investigate the collective dynamics emerging within large populations of up to millions of individuals, conveniently observed under the microscope. While the system remains isotropic at low density, with individuals moving in every direction, spontaneous symmetry breaking occurs at high density with all individuals moving on average in a common direction: the microspheres flock! I will rationalise this dynamical phase transition by discussing the electric and hydrodynamic interactions between individuals. Finally, I will discuss a few properties of these flocks, from wave propagation to their spontaneous demixing.

Education level

All ages

Physics topic

Contemporary and modern physics

Research focus

Other

Research method

Other

Organizing preference criteria

Physics topic

Author: MORIN, Alexandre

Presenter: MORIN, Alexandre

Session Classification: Keynote speaker

Track Classification: Contemporary and modern physics (CONT)