PHYSICAL MATH SEMINAR

From Classical to Contemporary Models of Collective Motion

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ABSTRACT:

From cereal poured into the breakfast bowl, through traffic joined on the way to work, to a flock of birds spotted flying across the evening sky, we are surrounded by moving collectives. They may be formed by inanimate objects driven by external forces or by living beings propelled by their internal objectives. Some of them, like air molecules, are very fast and very small, and some of them, like migrating sand dunes, are too slow and too large to be fully appreciated by a casual observer. Mutual interactions between individuals often lead to surprising collective phenomena, such as self-organization.

In this talk, I will discuss different modeling approaches to collective motion based on high-dimensional ODEs (individual-based models), and PDEs (field theories), using two very different examples: dune fields, and human crowds. In the first part of the talk, I will focus on the hydrodynamic coupling between two migrating sand dunes, which is believed to control the long-term evolution of desert landscapes. In the second part, I will discuss spontaneous lane formation in freely moving crowds. In both examples, I will emphasize the role of experimental data in inspiring and validating the models, and I will show how some aspects of the modeling process an be automated using statistical learning.

TUESDAY, FEBRUARY 10, 2026
2:30 PM – 3:30 PM
Building 2, Room 449