

Thursday February 6, 2025

Refreshments at 3:15PM outside PSF 101
Colloquium from 3:30PM – 4:30PM in PSF 101

Collective functionalities emerging in living active matter

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Abstract:

Organisms often cooperate to perform functions that they cannot do alone. However, this puzzle of how biological self-organization emerges from the collective dynamics of individual constituents remains unsolved. In this talk, I will discuss some of these collective functionalities, including communication, navigation, and cooperative nutrient transport. First, we will explore how bacteria can reorient against flows and swim upstream [1]. Second, we consider how cells generate their own flows to transport nutrients [2], and how “active carpets” like biofilms can lead to enhanced non-equilibrium diffusion [3]. Finally, we focus on ultra-fast communication through “hydrodynamic trigger waves”, signals between cells that propagate hundreds of times faster than their swimming speed [4]. Together, these ideas help us understand emergent self-organization in biological systems and the design space of active materials.

[1] Torres et al., “Enhancement of bacterial rheotaxis in non-Newtonian fluids”, Proc Nat Acad Sci. (2024)

[2] Jin et al. “Collective entrainment and confinement amplifies transport by schooling micro-swimmers”, Phys. Rev. Lett. 127: 088006 (2021)

[3] Guzman-Lastra et al. “Active carpets drive non-equilibrium diffusion and enhanced molecular fluxes,” Nat. Commun. 12: 1906 (2021)

[4] Mathijssen et al. “Collective intercellular communication through ultra-fast hydrodynamic trigger waves,” Nature 571, 560-564 (2019)

Biography:

Arnold Mathijssen was named ‘30 under 30’ by Scientific American and was awarded the Sir Sam Edwards PhD Thesis Prize for his work in group of Julia Yeomans FRS at the University Oxford (2016). Supported by an HFSP cross-disciplinary fellowship, he moved to the lab of Manu Prakash at Stanford University, where the American Physical Society presented him the Charles Kittel Award (2019). He is now Assistant Professor of Physics & Astronomy at UPenn, co-director of the Penn working group on Environmental and Biological Fluid Dynamics, and chair of the 2024 CUWiP Conference for Undergraduate Women in Physics.