Department of Chemistry and Biochemistry & Materials Science Graduate Program Colloquium Presentation

Nematic order and topological defects in cell layers

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Some cell types have a naturally elongated shape and spontaneously develop nematic order. There is increasing evidence that topological defects in cell alignment affect cell dynamics, cell organization and even morphogenesis.
We use micro-patterned ridges to induce topological defects and distortions in monolayers of 3T3 fibroblasts. This simple tool constitutes a useful platform to characterize various properties of the cell monolayers. For example, we characterize the cell organization and dynamics around topological defects. We show how cells tend to migrate towards the center of +1 defects with a behavior that depends on cell-substrate adhesion. Once the cells have reached high surface density, we then detach the cell layer from the substrate to form a thin free-floating sheet. We verify that as cells detach, the nematic order parameter decreases and the cells' contraction is higher along the nematic director. We use this concept to program Gaussian curvature in the detached fibroblast layers, thus demonstrating the possibility to control the final shape of the cell layers through 2-D alignment.

Francesca Serra is an Associate Professor in the Department of Physics, Chemistry and Pharmacy at the University of Southern Denmark. She received her Ph.D. in Physics from the University of Cambridge in 2010, following a BS and MS in Physics from the University of Parma. After postdoctoral research positions at the University of Milan and the University of Pennsylvania, she joined Johns Hopkins University as an Assistant Professor in 2016. She has been at the University of Southern Denmark since 2021.

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