Orientational texture of lipid membrane domains

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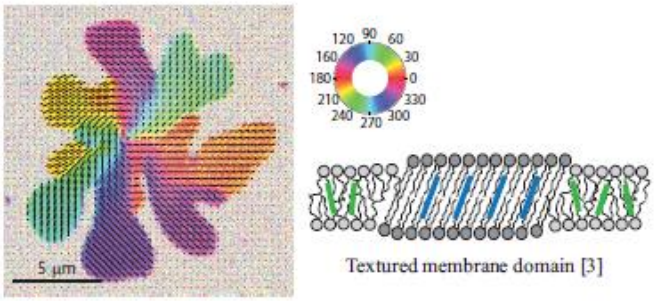
The principles underlying the in-plane organization of biomembranes remain incompletely understood more than 20 years after the proposition of the raft hypothesis[1]. Artificial model membranes with well-defined compositions have become some of the most useful systems for understanding domain formation in a controlled setting. Using advances in sample preparation and microscopy, new insights into the formation and structure of membrane domains are continuously being revealed.

We have focused attention on the gel phase, which can display a rich set of domain shapes and sizes as regulated by the growth kinetics and the spatial arrangement of nucleation points. Using polarized fluorescence imaging it was shown that gel domains in phospholipid membranes may contain long-ranged orientational texture patterns originating from the projection (the director) of the tilted acyl chains on the bilayer plane[2]. We visualize the texture using polarized 2-photon fluorescence microscopy and the Laurdan probe that aligns with the lipid acyl chains. An analysis of the signal variations with respect to polarization angle enables the lipid orientation to be resolved in single pixels. We have found that the texture of gel domains can exhibit topological defects including a vortex, pairs of half-integer vortices, and line defects[3]. The texture type is closely linked to the lipid composition as demonstrated by the occurrence of uniformly textured domains in some systems[4]. The texture patterns found in bilayer domains bear resemblance to smectic liquid crystal textures and textures in Langmuir monolayer domains and have also been associated with hexatic positional order of the lipids[5]. Texture represents a previously hidden level of complexity in the organization of bilayers, with potential unknown implications for the structuring of biomembranes. We provide an overview of orientational texture in a range of membrane systems and describe our efforts to understand and systematize defect types.



Textured membrane domain [3]

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