Ultra-fast collective dynamics in biological membranes

Mikhail Zhernenkov, NSLS-II, Brookhaven National Laboratory

Email: zherne@bnl.gov

Biological membranes exhibit a great deal of compositional and phase heterogeneity due to hundreds of chemically distinct components that form them. Their phase behavior is enormously complex and, as a result, structural and dynamic processes in cell membranes are extremely difficult to study, especially at the molecular level. In the present work, we argue that high resolution inelastic X-ray scattering (IXS) can provide valuable insight into biophysics of lipid membranes. In the series of IXS experiments [1-3] on single, binary, and ternary lipid mixtures, we obtain experimental evidence of propagating in-plane transverse acoustic (TA) and optical (OP) phononic modes in lipid systems. These phonon modes exhibit low-Q/low-E phononic gaps (the absence of phonons within a particular Q- or E-range). The energy and the Q-cutoff of the phononic gaps depends on the temperature and compositional variation in those systems. We show that phononic gaps behavior is directly related to such processes as passive transport, lateral lipid diffusion, and formation of phase separated domains and allows for quantitative study of these fundamental properties of a cell membrane.

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