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Membrane diffraction under controlled humidity: a tool to probe phase diagrams, distances and molecular forces in synthetic and natural lamellar systems

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There are many examples of synthetic and biomimetic lamellar organisations in surfactant and lipid systems, but there are only a few examples of such membrane multilayers in nature: the myelin sheet in vertebrates, stacked thylakoid membranes in photosynthetic organisms and the lamellar domains of the stratum corneum. Whether synthetic or natural, these examples have in common highly ordered lamellar structures or domains, an organization that requires a subtil balance between attractive and repulsive interactions, and between stiffness and flexibility to prevent collapse or unbinding.

As Thomas taught me, whether lamellar or non-lamellar, these structures can be probed by small-angle scattering techniques on bulk samples under controlled osmotic pressure and/or using samples oriented on a solid substrate by membrane diffraction under controlled relative humidity. In both techniques the osmotic pressure of the sample is controlled along dilution lines to investigate the phase diagram, the structure of the phases (distances, order) and the forces at play by determining the pressure-distance curves. By means of polymer solutions or under controlled relative humidity these forces can be identified and quantified analytically or using MD simulation at known osmotic pressure or water chemical potential.

In this short talk, I will present 3 examples of increasing complexity: a charged synthetic lipid system (DOPS), a complex quaternary lipid model of thylakoid membranes, and myelin from the central and peripheral nervous systems of mouse and rat nerves.

Abstract Title

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