

Interactions from lipid membrane deformations Azadbakht, A.

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Propositions

accompanying the thesis

Interactions from Lipid Membrane Deformations

I

The use of simple anisotropic colloids, such as dumbbells, provides valuable insight into understanding the role of particle shape in endocytosis. *Chapter 2 of this thesis*

II

The deformation-mediated interaction in lipid membranes is non-additive, which means that the presence of an additional particle weakens the interaction between the other two particles.

Chapter 3 and 5 of this thesis

III

Holographic optical tweezers are a precise tool for manipulating and quantifying indirect forces between colloids.

 $Chapter \ 4 \ and \ 5 \ of \ this \ thesis$

\mathbf{IV}

By using the attachment-free method, the experimental system for measuring the deformation-mediated interaction on lipid membranes was greatly simplified which allowed studying the interaction between more than three spheres and anisotropic objects.

Chapter 5 and 6 of this thesis

v

The presence of different polymers outside and inside a membrane induces a spontaneous curvature of the membrane, which should be taken into account when wrapping a particle by a membrane.

Spanke HT, et al. "Wrapping of Microparticles by Floppy Lipid Vesicles". Phys Rev Lett. 2020;125(19):1-9.

 \mathbf{VI}

The aggregation of colloidal particles on a vesicle observed by Ramos et al. was driven exclusively by charged surfactants and colloidal particles, and deformation-mediated interactions were hardly involved in the aggregation.

Ramos L, et al. Surfactant-mediated two-dimensional crystallization of colloidal crystals. Science. 1999;286(5448):2325-2328.

\mathbf{VII}

The difference in interaction energy between two membrane-deforming particles measured by van der Wel et al. and Sarfati et al. was due to the wrapping fraction of the particles.

Sarfati R, et al. Long-range attraction of particles adhered to lipid vesicles. Phys Rev E. 2016;94(1):2-7. and van der Wel C, et al. Lipid membrane-mediated attraction between curvature inducing objects. Sci Rep. 2016;6:1-10.

VIII

In contrast to the findings reported by Ewins et al., we could not reproduce 50% penetration depth of negatively charged colloids into the lipid membrane with 5% positively charged lipid. This significant penetration depth was achieved only when the lipid membrane was doped with 40% positively charged lipids alongside similar lipids and colloids.

Ewins EJ, et al. "Controlled adhesion, membrane pinning and vesicle transport by Janus particles". Chem. Commun. 2022;58(18):3055-3058.

\mathbf{IX}

To better understand the effect of artificial activity on membrane fluctuation, Vutukuri et al. should have measure membrane tension directly and without significant disturbance by pulling on a membrane tube from their vesicles. Vutukuri HR, et al. Active particles induce large shape deformations in giant lipid vesicles. Nature. 2020;586(7827):52-56.

\mathbf{X}

Artificial intelligence (AI) is becoming more and more helpful in academic projects, but scientists should find a way to put an end to p-hacking by AI.

\mathbf{XI}

Scientists should communicate to the public that scientific findings are not always absolute truths and emphasize the importance of considering the context and dynamic nature of scientific findings.

> Ali Azadbakht Leiden, 11-1-2024