

The Phase Behavior of Mixed Lipid Membranes in Presence of the Rippled Phase

N. Shimokawa and S. Komura

Department of Chemistry, Faculty of Science, Tokyo Metropolitan University
Minami-Osawa 1-1, Hachioji, Tokyo 192-0397, Japan

D. Andelman

School of Physics and Astronomy, Raymond and Beverly Sackler Faculty of Exact Sciences, Tel Aviv University
Ramat Aviv 69978, Tel Aviv, Israel
simokawa-naohumi@ed.tmu.ac.jp

We propose a model describing liquid-solid phase coexistence in mixed lipid membranes by including explicitly the occurrence of a rippled phase [1]. For a single component membrane, we employ a previous model in which the membrane thickness is used as an order parameter. As function of temperature, this model properly accounts for the phase behavior of the three possible membrane phases: solid, liquid and the rippled phase, as shown in Fig. 1. Our primary aim is to explore extensions of this model to binary lipid mixtures by considering the composition dependence of important model parameters. The obtained phase diagrams show various liquid, solid and rippled phase coexistence regions, and are in quantitative agreement with the experimental ones for some specific lipid mixtures as shown in Fig. 2.

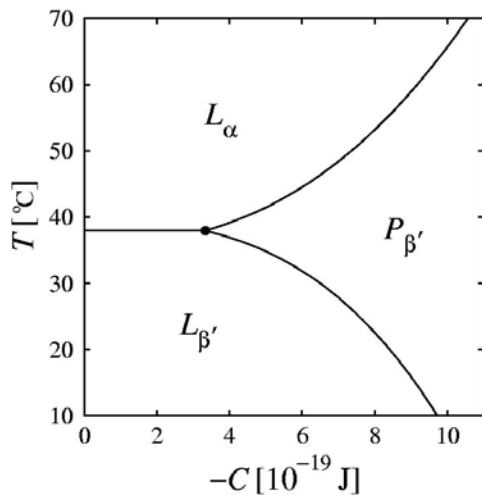


Fig. 1. Mean-field phase diagram of a single-component lipid membrane as a function of (negative) elastic constant C and temperature T (in degrees Celsius). The liquid (L_α), solid ($L_{\beta'}$) and rippled ($P_{\beta'}$) phases are separated from one another by first-order phase transition lines which meet at a triple point (marked by a full circle): $C_{tr} = -3.33 \times 10^{-19} \text{ J}$, $T_{tr} = 38^\circ \text{C}$.

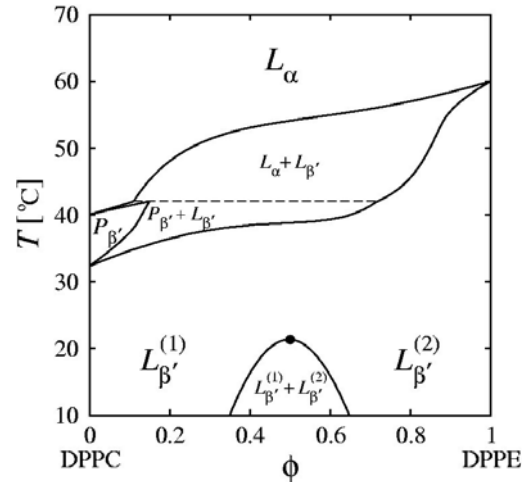


Fig. 2. Calculated mean-field phase diagram of a binary lipid mixture as a function of their relative composition ϕ and temperature T . The parameter values are chosen to fit DPPC/DPPE mixtures. The critical point is indicated by a full circle and occurs at $T_c = 21.3^\circ \text{C}$. The horizontal dashed line indicates the three-phase coexistence at triple point, $T_{tr} = 42.0^\circ \text{C}$.

References

[1] Shimokawa, N., Komura, S., and Andelman, D., The Phase Behavior of Mixed Lipid Membranes in Presence of the Rippled Phase, To be published in Eur. Phys. J. E