Curvature-driven effective attraction in multicomponent membranes

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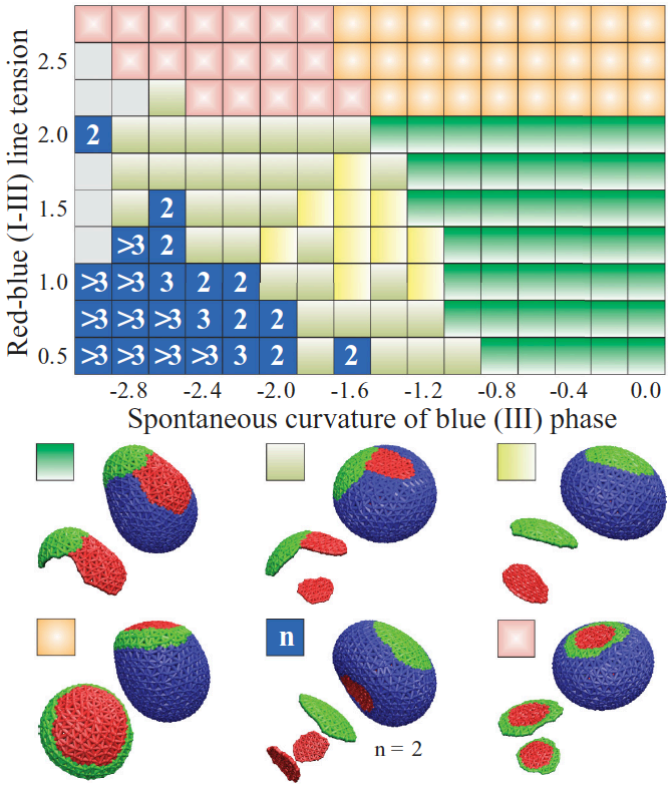
We study closed liquid membranes that segregate into three phases due to differences in the chemical and physical properties of its components. The shape and in-plane membrane arrangement of the phases are coupled through phase-specific bending energies and line tensions. We use simulated annealing Monte Carlo simulations to find low-energy structures, allowing both phase arrangement and membrane shape to relax. The threephase system is the simplest one in which there are multiple interface pairs, allowing us to analyze interfacial preferences and pairwise distinct line tensions. Our findings suggest that an intricate interplay between the geometry and composition can lead to a rich phase behavior of complex fluid membranes.

- The mutual response to geometry acts as an effective attraction between phases of most disparate spontaneous curvature in a three-phase liquid membrane.
- This effect arises indirectly through the coupling of deformation and compositional arrangement rather than through a direct component-component interaction. Nonetheless, it is robust enough to compete with a countervailing line tension.
- In some cases it results in predominance of interfaces between phases least miscible by pure line tension considerations.



Phase diagram for the composition ratio I:II:III = 1/10:1/10:8/10, varying spontaneous curvature C_{III} and line tension $\lambda_{I,III}$. All other parameters are fixed, with $C_I = 0.0$, $C_{II} = -1.0$, and $\lambda_{I,II} = \lambda_{II,III} = 1.0$.

Phases I, II, and III are shown in red, green, and blue, respectively.

Each example vesicle is shown twice: On the top right, all phases are visible; on the bottom left, one phase has been removed so that the pattern can be more clearly seen. Bright gray squares in the leftmost column denote assorted structures with multiple green and red domains.

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