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Surfactant dynamics in lung alveoli

During breathing, the mammalian lung exchanges oxygen and carbon dioxide in bubble-like structures called lung alveoli. Their interior is covered by a thin film of water on which lipids act as surfactant. The surfactant ensures that the inner surface of the alveoli remains wetted in spite of a continuing expansion and compression. Atomic force microscopy has revealed, that the lipid surfactant undergoes phase seperation into a high- and a low-density phase. In order to describe the spatial separation of the two lipid phases, we have constructed a phase field continuum model. Thereby, the free energy of the system seperates the two phases by a barrier depending on overall lipid density and volume fraction of the low-density phase. The equations for transition profiles and resulting interface speed can be reduced to a set of nonlinear degenerated ODEs, which we solve numerically. For further insights elucidating the microsopic scale, we additionally perform computer simulations of rod-like lipids on a rigid water surface. The lipid-water interaction arises from a varying submersion of hydrophilic head- and hydrophobic tail-parts of the model lipids. Together with explicit, polar interaction forces between pairs of lipid rods, we obtain phases seperation and spatial cluster aggregates.

References

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