Relaxation dynamics of a vesicle containing highly viscous fluid

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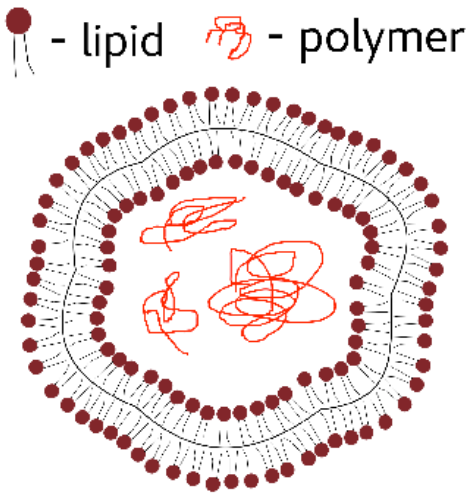
For biological membrane bound compartments, the internal environments could be vastly different from the external [1]. Assuming that these environments are made of simple fluids of different viscosities, we discuss the relaxation dynamics of a compressible bilayer vesicle. We analyse the stability of a free-energy model [2] which includes a coupling between the membrane curvature and the local density difference between the two monolayers. The linear stability analysis reveals two new types of instabilities (i) a large wavelength instability and (ii) a smaller wavelength instability depending on the coupling parameter. Considering two important dissipation sources, the inter-monolayer friction and the bulk fluid viscosity, we solve the coupled hydrodynamic equations both for the bilayer membrane and the surrounding bulk fluid in order to derive the dynamical equations for the vesicle. We find that the three relaxation modes are coupled to each other due to the bilayer architecture. The difference in bulk viscosity between the inner and outer fluid medium alters the coupled relaxation rates by shifting the mode crossing point. As the vesicle approach toward the unstable regions, the relaxation dynamics is dramatically slows down, and the mode structure changes significantly.



References
[1] R. J. Ellis and A. P. Minton, *Nature* **425**, 27 (2003).
[2] L. Miao, M. A. Lomholt, and J. Kleis, *Eur. Phys. J. E* **9**, 143 (2002).