Nonlinear Vesicles Dynamic

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Vesicles consisting of a two-layer membrane of amphiphilic lipid molecules are surprisingly flexible and at the same time slightly compressible surfaces. We study the evolution of vesicle shapes over time under various conditions. Our analysis of bilayer dynamics is based on a hydrodynamic approach, which treats a bilayer as an infinitely thin fluid layer on which shape-dependent forces applied to the surrounding viscous liquid are concentrated. The starting point of such consideration is the Helfrich energy[W.Helfrich, Z.Naturforsch (1973)]. Although we consider flows with low Reynolds numbers, which are governed by a linear hydrodynamic equation (Stokes' equation), the shape of the vesicle undergoes significant changes over time. This results in a highly nonlinear system of equations, necessitating the use of numerical simulation techniques to model the process.
At first, we investigated the relaxation dynamics of vesicles. Specifically, normal modes were found for three branches of axially symmetric stationary shapes, including the vicinity of critical points where the metastability of the branch disappears.The bilayer is a "soft" object due to its small surface tension, and its shape can be easily deformed by external influences. In particular, we simulate the process in which a part of the membrane detaches from the main structure forming a vesicle triggered by various factors such as jet flow or optical tweezers. This kind of process is important from a biological point of view. [Funakoshi K, Suzuki H, Takeuchi S (2007)]