Abstract Submitted
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A semi-implicit finite element method for viscous lipid membranes[1] DIEGO RODRIGUES, Universidade de São Paulo, Brazil, ROBERTO AUSAS, Universidade de São Paulo, Brazil / IBM Research, Brazil, FERNANDO MUT, GUSTAVO BUSCAGLIA, Universidade de São Paulo, Brazil — We propose a robust simulation method for phospholipid membranes. It is based on a mixed three-field formulation that accounts for tangential fluidity (Boussinesq-Scriven law), bending elasticity (Canham-Helfrich model) and inextensibility. The unknowns are the velocity, vector curvature and surface pressure fields, all of which are interpolated with linear continuous finite elements. The method is semi-implicit, it requires the solution of a single linear system per time step. Conditional time stability is observed, with a time step restriction that scales as the square of the mesh size. Mesh quality and refinement are maintained by adaptively remeshing. Another ingredient is a numerical force that emulates the action of an optical tweezer, allowing for virtual interaction with the membrane. Extensive relaxation experiments are reported. Comparisons to exact shapes reveal the orders of convergence for position (5/3), vector curvature (3/2), surface pressure (1) and bending energy (2). Tweezing experiments are also presented. Convergence to the exact dynamics of a cylindrical tether is confirmed. Further tests illustrate the robustness of the method (six tweezers acting simultaneously) and the significance of viscous effects on membrane's deformation under external forces.

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