Topological defects in the buckling of elastic membranes

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We investigate the effects of topological defects on the low-energy shapes of single-component two-dimensional elastic vesicles with spherical topology. The membrane is described as a closed, triangulated two-dimensional manifold embedded in three-dimensional space using a dynamic triangulation model, thus allowing the creation of topological defects. Low-energy structures and connectivities are explored using a Monte Carlo simulated annealing method while also constraining the internal volume of the membrane to simulate incompressible contents within the membrane, such as in colloidosomes and viruses. We find that since the volume constraint partially suppresses the buckling transition such that the buckled icosahedral shape has a reduced asphericity, defect scars are favorable over a larger range of elastic parameters of the membrane compared with systems having no constraint on volume.

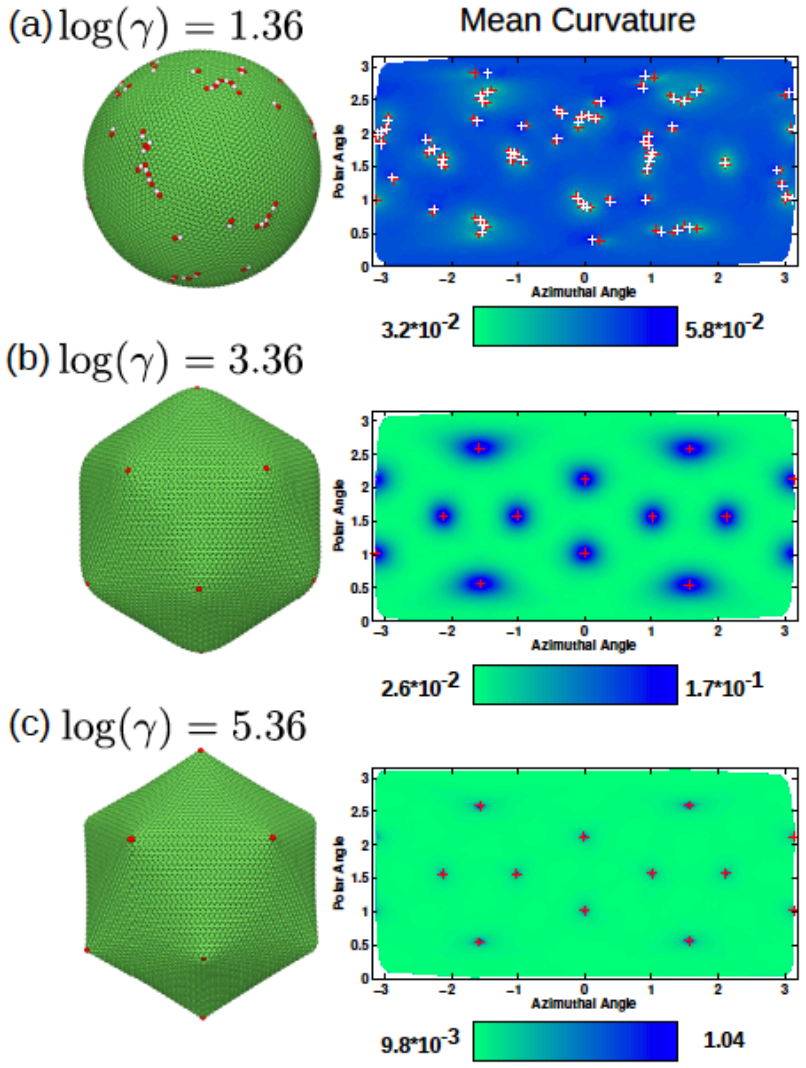

Figure: Final configurations and mean curvature in units of l_0^{-1} for three systems with no volume constraint, with excess defects at log(γ) = 1.36 (a), and no excess defects at log(γ) = 3.36 (b) and log(γ) = 5.36 (c) where γ is the Föppl-von Kármán number. Fivefold disclinations are shown in red and sevenfold in white, on both the surface plots and two-dimensional projections of the surface plotting mean curvature. When excess defects are present, they arrange to form dislocations and lines of defects. As the structure buckles, excess defects are no longer favorable in the absence of a volume constraint.

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