Statistical Mechanics of Pressurized Amorphous Shells*

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It is well known that thermal fluctuations strongly modify the large length scale elastic behavior of flat solid membranes. A thin amorphous spherical shell may be considered a solid membrane with a uniform nonzero curvature. This curvature couples the in-plane stretching modes [of the constituent membrane] with the out-of-plane undulation modes, giving rise to qualitative differences in the fluctuations of spherical shells compared to flat membranes. In addition, a shell can support a pressure difference between its interior and exterior. We study the statistical mechanics of deformations of a spherical shell using perturbation theory and Monte Carlo simulations, explicitly including the effects of curvature and pressure. Thermal corrections to the predictions of classical shell theory for point indentation and pressure-induced buckling experiments on microscale shells diverge as the shell radius tends to infinity.