Title:
Buckling of Thin Shells and Nanoindentation of Icosahedral Viruses

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Abstract:

The protein shells (capsids) of icosahedral viruses are modeled as thin solid shells within the framework of two-dimensional Foppl-von Karman elasticity. This model is the basis for finite element numerical simulations of atomic force microscopy nanoindentation of capsids. The effects of geometry, and pre-stressing are examined to elucidate the mechanics of the wide variety of icosahedral capsids. The Foppl-von Karman number, a dimensionless parameter previously shown to govern the faceted shape of icosahedral viruses [1], is here shown also to influence the structural stability of capsids during indentation. Capsids with Foppl-von Karman (FvK) number less than a critical value are nominally spherical and experience no buckling during indentation. Capsids with FvK numbers greater than the critical value are faceted and do buckle when indented. The results of the model are consistent with the limited experimental data available, and offer predictions which can be tested by future experiments.

[1] J. Lidmar, L. Mirny, and D.R. Nelson, Virus shapes and buckling transitions in spherical shells, Phys. Rev. E 68, 051910 (2003).