سمینار هفتگی ماده چگال نرم

Journal Club:

Buckling transitions and soft-phase invasion of two-component icosahedral shells

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Abstract

What is the optimal distribution of two types of crystalline phases on the surface of icosahedral shells, such as of many viral capsids? We here investigate the distribution of a thin layer of soft material on a crystalline convex icosahedral shell. We demonstrate how the shapes of spherical viruses can be understood from the perspective of elasticity theory of thin two component shells. We develop a theory of shape transformations of an icosahedral shell upon addition of a softer, but still crystalline, material onto its surface. We show how the soft component "invades" the regions with the highest elastic energy and stress imposed by the 12 topological defects on the surface. We explore the phase diagram as a function of the surface fraction of the soft material, the shell size, and the incommensurability of the elastic moduli of the rigid and soft phases. We find that, as expected, progressive filing of the rigid shell by the soft phase starts from the most deformed regions of the icosahedron. With a progressively increasing soft-phase coverage, the spherical segments of domes are filed fist (12 vertices of the shell), then the cylindrical segments connecting the domes (30 edges) are invaded, and, ultimately, the 20 flat faces of the icosahedral shell tend to be occupied by the soft material. We present a detailed theoretical investigation of the first two stages of this invasion process and develop a model of morphological changes of the cone structure that permits noncircular cross sections. In conclusion, we discuss the biological relevance of some structures predicted from our calculations, in particular for the shape of viral capsids.

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