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Complex ordered patterns in mechanical instability induced geometrically frustrated triangular cellular structures SUNG KANG, SICONG SHAN, ANDREJ KOSMRLJ, WIM NOORDUIN, SAMUEL SHIAN, JAMES WEAVER, DAVID CLARKE, KATIA BERTOLDI, Harvard University — Geometrical frustration arises when a local order cannot propagate throughout the space due to geometrical constraints. It plays a major role in many natural and synthetic systems including water ice, spin ice, and metallic glasses. All of these geometrically frustrated systems are degenerate and tend to form disordered ground-state configurations. Here, we report a theoretical and experimental study on the behavior of buckling-induced geometrically frustrated triangular cellular structures. To our surprise, we find that mechanical instabilities induce complex ordered patterns with tunability. For structures with low porosity, an ordered symmetric pattern emerges, which shows striking correlations with the ideal spin solid. In contrast, for high porosity systems, an ordered chiral pattern forms with a new spin configuration. Our analysis using a spin-like model reveals that the connected geometry of the cellular structure plays a crucial role in the formation of ordered states in this system. Since in our study geometrical frustration is induced by a mechanical instability that is scale-independent, our findings can be extended to different materials, stimuli, and length scales, providing a general strategy to study and visualize the physics of frustration.

Sung Kang
Harvard University

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