Soda forming: sequential ring buckling of uniaxially compressed beverage cans

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Abstract

When uniaxially compressed empty cylinders buckle, they typically form periodic structures that break both axial and radial symmetry. By contrast, thin membranes develop undulations that break the symmetry along the axis of compression. We make a surprising observation that when a beverage can, mostly filled with a liquid, is compressed under uniaxial loading, the system buckles axisymmetrically. The resulting ring buckles are localised and appear sequentially, eventually filling the entire can surface. The final periodic pattern has a predictable wavelength that scales with the shell thickness and radius. We characterise the material properties of the cans experimentally in order to model their post-buckling behaviour. The results of our model, which is similar to the 1-D nonlinear Swift-Hohenberg equation, suggest that the sequential appearance of ring buckles occurs via homoclinic snaking. Our system provides a novel experimental demonstration of this mechanism, thereby linking nonlinear dynamics of localised patterns and mechanics of shell buckling

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