A tug-of-war between stretching and bending in living cell sheets

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The balance between stretching and bending deformations characterizes shape transitions of thin elastic sheets. While stretching dominates the mechanical response in tension, bending dominates in compression after an abrupt buckling transition. Recently, experimental results in suspended living epithelial monolayers have shown that, due to the asymmetry in surface stresses generated by molecular motors across the thickness e of the epithelium, the free edges of such tissues spontaneously curl out-of-plane, stretching the sheet in-plane as a result. This suggests that a competition between bending and stretching sets the morphology of the tissue margin. In this study, we use the framework of non-Euclidean plates to incorporate active pre-strain and spontaneous curvature to the theory of thin elastic shells. We show that, when the spontaneous curvature of the sheet scales like $1/e$, stretching and bending energies have the same scaling in the limit of a vanishingly small thickness and therefore both compete, in a way that is continuously altered by an external tension, to define the three-dimensional shape of the tissue.