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Capillarity-driven folding of a thin floating annular film JOSEPH D. PAULSEN, Syracuse University, VINCENT DÉMERY, PCT-ESPCI, France, K. BUGRA TOGA, Eastman Chemical Company, ZHANLONG QUI, BENNY DAVIDOVITCH, THOMAS P. RUSSELL, NARAYANAN MENON, Univ of Mass - Amherst — A thin elastic sheet that is compressed on a substrate will form wrinkles to gather excess material while conforming to its foundation. When compressed further, the sheet may form folds, which can be understood as minimizing the sum of the bending energy and the energy to deform the substrate[1].Here we demonstrate in a simple planar geometry a folding transition that is independent of the mechanical properties of the sheet. We study the deformations of a thin polymer film that is cut into an annular shape and floated onto a flat air-water interface. By increasing the concentration of surfactant outside the film, we reduce the surface tension that pulls on the outer boundary of the annulus. The larger, inward tension causes the film to wrinkle and fold. Folding occurs at a threshold ratio of inner to outer tension that depends on the geometry of the sheet, but is independent of its bending rigidity. Our results are consistent with the simple geometric principle that the sheet assumes the unstretched shape that minimizes the interfacial energy of the exposed liquid surface. A similar principle was found to control how a thin elastic sheet wraps a liquid drop[2].

1. Pocivavsek et al., Science 320, 912 (2008).
2. Paulsen et al., BAPS.2015.MAR.G34.4

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