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Active Tension Network model reveals an exotic mechanical state realized in epithelial tissues NICHOLAS NOLL, Univ of California - Santa Barbara, MADHAV MANI, Northwestern University, IDSE HEEMSKERK, Rice University, SEBASTIAN STREICHA, BORIS SHRAIMAN, Kavli Institute for Theoretical Physics — Mechanical interactions play a crucial role in epithelial morphogenesis, yet understanding the complex mechanisms through which stress and deformation affect cell behavior remains an open problem. Here we formulate and analyze the Active Tension Network (ATN) model, which assumes that mechanical balance of cells is dominated by cortical tension and introduces tension dependent active remodeling of the cortex. We find that ATNs exhibit unusual mechanical properties: i) ATN behaves as a fluid at short times, but at long times it supports external tension, like a solid; ii) its mechanical equilibrium state has extensive degeneracy associated with a discrete conformal - "isogonal" - deformation of cells. ATN model predicts a constraint on equilibrium cell geometry, which we demonstrate to hold in certain epithelial tissues. We further show that isogonal modes are observed in a fruit fly embryo, accounting for the striking variability of apical area of ventral cells and helping understand the early phase of gastrulation. Living matter realizes new and exotic mechanical states, understanding which helps understand biological phenomena.

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