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Active unjamming of confluent cell layers[1]

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Cell motion inside dense tissues governs many biological processes, including embryonic development and cancer metastasis, and recent experiments suggest that these tissues exhibit collective glassy behavior. Motivated by these observations, we have studied a model of dense tissues that combines self-propelled particle models and vertex models of confluent cell layers. In this model, referred to as self-propelled Voronoi (SPV), cells are described as polygons in a Voronoi tessellation with directed noisy cell motility and interactions governed by a shape energy that incorporates the effects of cell volume incompressibility, contractility and cell-cell adhesion. Using this model, we have demonstrated a new density-independent solid-liquid transition in confluent tissues controlled by cell motility and a cell-shape parameter measuring the interplay of cortical tension and cell-cell adhesion. An important insight of this work is that the rigidity and dynamics of cell layers depends sensitively on cell shape. We have also used the SPV model to test a new method developed by our group to determine cellular forces and tissue stresses from experimentally accessible cell shapes and traction forces, hence providing the spatio-temporal distribution of stresses in motile dense tissues.

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