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A rigidity transition and glassy dynamics in a model for confluent 3D tissues MATTHIAS MERKEL, M. LISA MANNING, Syracuse University —
The origin of rigidity in disordered materials is an outstanding open problem in statistical physics. Recently, a new type of rigidity transition was discovered in a family of models for 2D biological tissues, but the mechanisms responsible for rigidity remain unclear. This is not just a statistical physics problem, but also relevant for embryonic development, cancer growth, and wound healing. To gain insight into this rigidity transition and make new predictions about biological bulk tissues, we have developed a fully 3D self-propelled Voronoi (SPV) model. The model takes into account shape, elasticity, and self-propelled motion of the individual cells. We find that in the absence of self-propulsion, this model exhibits a rigidity transition that is controlled by a dimensionless model parameter describing the preferred cell shape, with an accompanying structural order parameter. In the presence of self-propulsion, the rigidity transition appears as a glass-like transition featuring caging and aging effects. Given the similarities between this transition and jamming in particulate solids, it is natural to ask if the two transitions are related. By comparing statistics of Voronoi geometries, we show the transitions are surprisingly close but demonstrably distinct. Furthermore, an index theorem used to identify topologically protected mechanical modes in jammed systems can be extended to these vertex-type models. In our model, residual stresses govern the transition and enter the index theorem in a different way compared to jammed particles, suggesting the origin of rigidity may be different between the two.

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