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Active Jamming: Self-propelled particles at high density[1]

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What determines the mechanical properties of dense collections of active particles? The answer to this question is highly relevant to a wide range of physical and biological phenomena from tissue formation to the dynamics of vibrated granular layers. We present a numerical study of the phases and dynamics of a dense collection of self-propelled particles with soft repulsive interactions and polar alignment in a two-dimensional confined geometry. The phase diagram consists of a polar liquid phase at low packing fraction and high self-propulsion speed, and an active jammed phase at high density and low self-propulsion speed. The liquid phase exhibits local alignment and giant number fluctuations typical of the Vicsek class of models. The dynamics of the jammed phase is dominated by oscillations along the low frequency modes of the underlying packing. We show analytically that at long times the energy is carried entirely by the lowest available excitations of the system. Recent experiments on epithelial cell monolayers using force traction microscopy have revealed stress distributions that resemble those observed in granular materials. We measure and compare the local stresses in our active system, with added attraction, to both granular materials and the tissue experiments.

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