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A Local, Geometrical Probe for Jamming

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When jammed disordered materials such as Lennard-Jones systems, granulates and foams are forced externally, the resulting deformation fields exhibit large scale vortical patterns and are strongly non-affine. Here we introduce the distribution P(alpha) as a local probe of the non-affine nature of this response. Alpha denotes the angle between the bonds and the local deformations of pairs of particles in contact - hence alpha = pi/2 corresponds to particles sliding past each other, while particles squeezed together or moving apart correspond to alpha = 0 or pi. We find that near jamming, P(alpha) becomes strongly peaked around pi/2, with the width and height of the peak scaling with the distance to the jamming point. Grains then predominantly slide past each other, which signals an increasingly non-affine response of the material caused by the proximity of floppy modes. We relate this local measure to the global, anomalous scaling of the elastic moduli and contact numbers near jamming, and show the first experimental determination of P(alpha) in sheared, 2D foams.