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Plastic Failure Events in 2D Sheared Granular Systems[1] TRUSH MAJMUDAR, ROBERT BEHRINGER, Physics Department, Duke University —
We present experimental measurements of plastic failure events in a two dimensional granular system consisting of polymer photoelastic disks, placed horizontally, and confined within a rectangular biaxial cell. The bi-refringence of these disks allows us to determine the normal and tangential components of contact forces. We image the system at various deformation states and measure the stress changes and displacements of the disks during one complete shear cycle. The stress changes are found by computing the stress tensor of each disk and the displacements are measured by particle tracking. We obtain bulk stress-strain curves by spatial averaging and find that the system exhibits regions of reversible deformation interrupted by irreversible plastic failure events. We also obtain the behavior of shear modulus of the system. The spatial distribution of reversible and plastic deformations found by studying the displacements of the disks show that in two corners, the disks move uniformly but in a central band aligned along a principal strain direction, we observe multiple vortices. Reversing the direction of shear causes maximum plastic deformation which results in disruption of the vortex structure. We compare our results to the shear transformation zone (STZ) theory.

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