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Quadrupolar displacement fields in sheared amorphous materials

In this work, we investigate the mechanical response of two-dimensional jammed packings subjected to athermal, quasistatic simple shear. We demonstrate that quadrupolar non-affine displacement fields, which can be well described as a linear superpositions of Eshelby-like inclusions embedded in a homogeneous elastic medium, emerge in jammed systems primarily from interparticle contact breaks during applied shear. To explain the quadruploar displacement fields, we reformulate the classical Eshelby inclusion problem for discrete particle systems and reconstruct the non-affine displacement fields as a sum of Eshelby-like defects originating from local stiffness mismatches. To identify the inclusions, we decompose the system into Delaunay triangles, with each triangle's stiffness tensor separated into contributions from structural connectivity and pre-stress. Our analysis reveals that mismatches in structural stiffness caused by contact breaks drive the formation of quadrupolar displacement fields during shear.