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Structural rearrangements that govern flow in colloidal glasses

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We use colloidal glasses to obtain insight into the flow of amorphous materials. In three dimensions and real time, we track the individual colloidal particles in a flowing glass, and we visualize structural rearrangements that occur during flow. The individual particle trajectories are used to identify regions of non-affine deformation, in which shear concentrates. Under slow shear, we observe thermally activated 'shear transformation zones' embedded in an otherwise elastic amorphous material. Connections between these zones result in flow, which is homogeneous on macroscopic length scales. We calculate correlation functions for the fluctuations of non-affine displacements, and find a remarkable scaling, indicating that the flow of glasses is highly correlated in space. By reconstructing the entire three-dimensional strain distribution, we demonstrate that these system-spanning correlations arise from the elastic interactions between shear transformations.