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Echoes in x-ray speckles track nanometer-scale plastic events in colloidal gels under shear ROBERT LEHENY, Johns Hopkins University, MICHAEL ROGERS, University of Ottawa, KUI CHEN, Johns Hopkins University, LUKASZ ANDRZEJEWSKI, University of Ottawa, SURESH NARAYANAN, Argonne National Laboratory, SUBRAMANIAN RAMAKRISHNAN, FAMU, JAMES HARDEN, University of Ottawa — Any solid under applied stress possesses an elastic limit above which it yields. The microscopic signatures of yield are irreversible changes to the material's structure. We describe x-ray photon correlation spectroscopy experiments on a concentrated nanocolloidal gel subject to in situ oscillatory shear strain that provide information about the spatial character of rearrangements above yielding at the nanometer scale. The oscillatory strain causes periodic echoes in the x-ray speckle pattern, creating peaks in the intensity autocorrelation function. The peak amplitudes are attenuated above a threshold strain, signaling the onset of irreversible particle rearrangements. The gel displays strain softening well below the threshold, indicating a range of strains at which deformations are nonlinear but reversible. Above the threshold strain, the peak amplitudes decay exponentially with the number of shear cycles, demonstrating that all regions in the sample are equally susceptible to yielding and that the probability of a region yielding is independent of previous shear history. The wave-vector dependence of the decay rate reveals a power-law distribution in the size of rearranging regions, suggesting a nonequilibrium critical transition at yielding.

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