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Crystallization of sheared hard spheres at 64.5% volume fraction<sup>1</sup> H.L. SWINNEY, University of Texas at Austin, F. RIETZ, Max-Planck-Institute for Dynamics and Self-Organization, M. SCHROETER, Max-Planck-Institute for Dynamics and Self-Organization, and Friedrich-Alexander-Universität Erlangen-Nürnberg, C. RADIN, University of Texas at Austin — A classic experiment by G.D. Scott (*Nature* 188, 908, 1960) showed that pouring balls into a rigid container filled the volume to an upper limit of 64% of the container volume, which is well below the 74% volume fraction filled by spheres in a hexagonal close packed (HCP) or face center cubic (FCC) lattice. Subsequent experiments have confirmed a "random closed packed" (RCP) fraction of about 64%. However, the physics of the RCP limit has remained a mystery. Our experiment on a cubical box filled with 49400 weakly sheared glass spheres reveals a first order phase transition from a disordered to an ordered state at a volume fraction of 64.5%. The ordered state consists of crystallites of mixed FCC and HCP symmetry that coexist with the amorphous bulk. The transition is initiated by homogeneous nucleation: in the shearing process small crystallites with about ten or fewer spheres dissolve, while larger crystallites grow. A movie illustrates the crystallization process.

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