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Relaxation and deformation in glassy materials

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Amorphous solids such as glassy polymers, colloidal glasses, and physical gels are invariably characterized by slow dynamics. The inability to reach equilibrium on experimental timescales is due to the many geometric constraints that the molecules experience in dense, "jammed" configurations. The ensuing relaxation or aging processes modify material properties such as creep compliance and yield stress. Our understanding of how such amorphous materials yield and flow under the application of stress or strain is much less developed than in crystals, where well-defined defects such as dislocations are the carriers of plastic deformation. This talk will give an overview of recent work in my group, where we use molecular simulations and phenomenological models to gain insight into the microscopic origins of elastoplastic behavior of disordered solids. We will show how particle mobility controls plastic flow, and how aging appears to be reduced in solids under load. Interesting modifications to the structural relaxations can be achieved by adding nanoparticle fillers. By decomposing single particle trajectories into intermittent hopping events, we will obtain a statistical description of the molecular rearrangements in terms of a continuous time random walk, which provides insight into the origin of aging at the molecular level.