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The Role of Dilation in Discontinuous Shear Thickening Suspensions

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Concentrated suspensions of hard particles such as cornstarch in water exhibit Discontinuous Shear Thickening, a non-Newtonian fluid behavior in which an increasing shear rate causes the effective viscosity of the fluid to increase, and even crack like a solid. In recent years, the mechanics have been understood as a transition from a low-stress state to a high stress state as particles are pushed into frictional contact. Experimental measurements of the local shear profile and under different boundary conditions reveal that the local constitutive relation of the high-stress state is effectively frictional, where shear stress is proportional to normal stress, but not shear rate. The high-stress state is found intermittently along with dilation, indicating that stresses are transmitted along effectively frictional intermittent contact networks that form as dilation pushes the particle packing against the boundary. As the particles push against the boundary, it responds with a restoring force that is transmitted along the particle contact network. The scale of the stress in the high-stress state is thus determined by the effective stiffness of the boundary, which is usually determined by surface tension at the suspension-air interface in experiments.