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Strangely stable sphere stacking in yield-stress fluids PIYUSH SINGH, SCOTT ROGMAN, JONATHAN FREUND, RANDY EWOLDT, University of Illinois at Urbana-Champaign — We have previously observed a novel phenomenon whereby spheres sediment and form a single, stable vertical stack in a yield-stress fluid. Individually, the spheres settle to the bottom, since the yield stress is insufficient to suspend a single sphere. However, cooperative effects result in surprisingly stable stacking. Here, we further explore this phenomenon experimentally in a simple yield stress fluid, a carbopol microgel. Depending on the yield stress of the fluid, the sphere density, and the precise alignment of the spheres, a varying number of spheres can be stacked. Although a taller stack is observed for spheres of the same size, smaller stacks are frequently formed for spheres with mixed sizes and offset centers. This stacking phenomenon is not amenable to a simple force balance analysis because of the complex interplay of viscous and yield stresses and the non-trivial deformation zone in a yield-stress fluid. This study provides new insights on the collective flow behavior of objects in structurally complex and widely used yield-stress fluids. Furthermore, this observed phenomenon can be used to check the predictive efficacy of past, present, and future constitutive models for rheologically-complex fluids.

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