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A system-spanning vortex in granular shear flow explains a stress anomaly¹ PRABHU NOTT, KRISHNARAJ K P, PETER VARUN DSOUZA, Indian Institute of Science — Rheometry of fluids is often conducted in a cylindrical Couette device, but when it is used for granular materials, unexpected behaviour emerges. Recent studies in our group have shown a striking anomaly in the stress: the vertical shear stress changes sign upon shearing, and the magnitudes of all components of the stress increase roughly exponentially with depth. This behavior is contrary to previous experiments, and the predictions of plasticity theories. In this presentation we show that the stress anomaly is caused by a novel secondary flow – a single toroidal vortex that spans the entire granular column. The vortex differs fundamentally in its origin and manifestation from the Taylor-Couette vortices in fluids. It is driven by dilatancy, and is sustained by gravity. Our results raise the possibility of similar secondary flows arising in other flow geometries, and call for caution in the interpretation of rheological measurements for granular materials.

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