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Inhibition of carbonate synthesis in acidic oceans on early Mars 423
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A Taylor vortex analogy in granular flows 433
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Fluids sheared between concentric rotating cylinders undergo a series of three-dimensional instabilities. Since Taylor's archetypal 1923 study, these have proved pivotal to understanding how fluid flows become unstable and eventually undergo transitions to chaotic or turbulent states. In contrast, predicting the dynamics of granular systems—from nano-sized particles to debris flows—is far less reliable. Under shear these materials resemble fluids, but solid-like responses, non-equilibrium structures and segregation patterns develop unexpectedly. As a result, the analysis of geophysical events and the performance of largely empirical particle technologies might suffer. Here, using gas fluidization to overcome jamming, we show experimentally that granular materials develop vortices consistent with the primary Taylor instability in fluids. However, the vortices observed in our fluidized granular bed are unlike those in fluids in that they are accompanied by novel mixing–segregation transitions. The vortices seem to alleviate increased strain by spawning new vortices, directly modifying the scale of kinetic interactions. Our observations provide insights into the mechanisms of shear transmission by particles and their consequent convective mixing.

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