

Abstract Submitted  
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**Breakdown of Granular Constitutive Relations for Flow through a Narrow Vertical Channel**<sup>1</sup> DONALD CANDELA, KEVIN FACTO, University of Massachusetts Amherst — We have used NMR/MRI techniques to study flow profiles and fluctuations in the dense, gravity-driven flow of a granular medium through a relatively narrow vertical channel (channel diameter approximately 20 grain diameters). Although the flow is macroscopically steady, the NMR experiments reveal large velocity fluctuations that can be characterized as random, short-lived jamming of the flow. Constitutive relations have been successfully developed for granular shear flows in constant pressure conditions, such as flow in open chutes or wide vertical channels. For the narrow-channel flow probed in our experiments, the constant-pressure constitutive relations are not appropriate. An alternative equation of state based on constant-volume conditions may be appropriate for the narrow-channel case, or it can be modeled using a piling-jamming model that abandons the constitutive-equation approach altogether.

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