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Particle size-segregation and roll waves in geophysical mass flows

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Particle size-segregation in geophysical mass flows can have a profound feedback on their local mobility, leading to the formation of resistive bouldery flow fronts, which spontaneously degenerate into leveed channels [1,2] that constrain the flow and enhance run-out. By including particle segregation [3], a composition dependent frictional coupling can be incorporated into depth-averaged geophysical mass flow models to capture both levee formation and flow fingering [4]. However, the channel wavelengths are crucially dependent on the underlying rheology of the flow, which is a second order effect that is still not fully understood. In this paper we analyze a simpler, but closely related, mono-disperse flow in which the granular rheology plays a crucial part in the formation, growth and coarsening of roll waves. Two regimes have been found experimentally:- (i) a classical continuous roll wave regime, and (ii) a novel discrete roll wave regime where the troughs between the wave peaks become completely stationary. This latter behaviour has been observed in debris flows in Fully, Switzerland, and the Jiangjia Gully, China.

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