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Self-channelisation in Dry Granular Flows

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Dense granular flows can spontaneously self-channelise by forming a pair of parallel-sided static levees on both sides of a central flowing channel. This process prevents lateral spreading and maintains the flow mobility for longer, enabling the avalanche to run out considerably further than a spreading flow. Since levees commonly form in hazardous geophysical mass flows, such as snow avalanches, debris flows, and pyroclastic flows, this has important implications for risk management in mountainous and volcanic regions. In this talk, we will discuss the process of self-channelisation and levee formation in three different scenarios, starting with the fundamental ingredients responsible for self-channelisation in monodisperse avalanches down an inclined plane. By applying a depth-averaged model we show that not only a non-monotonic friction law is required to incorporate frictional hysteresis, but higher-order viscous-like terms are crucial in uniquely selecting the fully-developed state observed experiments. This equilibrium state will then be used to gain insight into the three-dimensional particle-size segregation which occurs in bidisperse self-channelised flows. To conclude, we will discuss a monodisperse avalanche down a cone, where the granular front becomes unstable and breaks into a series of self-channelised channels, generating an unexpected and beautiful fingering pattern, in striking contrast to a flow down an inclined plane.

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