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# Modeling of dry granular avalanches by means of the Discrete Element Method

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Most common used avalanche models are based on continuum mechanics. The theory of Savage and Hutter describes the flow of granular avalanches along two - dimensional avalanche tracks. Although the theory was extended for more complex three - dimensional geometries, the calculation of arbitrary three dimensional topographies and the interaction between avalanches and obstacles is still an open matter of research.

Many physical experiments based on sand avalanches rushing down an inclined plane were performed to evaluate mathematical models. The recent work is focused on the investigation of the interaction between avalanches and obstacles. Obstacles like dams involving enormous topographic changes on the sliding surface. These big gradients in geometry can cause numerical problems solving the partial differential equations. Further problems occur by the depth integration of the conservation equations because curvatures of the topography are restricted by the flow depth and surface normal velocities are neglected. These components are usually vanishingly small but if the avalanche hits a dam these components obtain importance.

An alternative way to simulate granular avalanches is investigated in the recent studies, using the discrete element method in three - dimensional space. The program PFC3d (Particle Flow Code) is used to simulate the physical sand avalanche experiments on chutes with different inclinations, basal- and internal friction angles of the sand. Primary investigations are focused on the implementation of the material behavior of sand in PFC3d. Further studies will be done on tests with different shaped

obstacles interfering or deflecting the avalanche track. An important aim of this work is the calculation of depositions in the run out zone and deposition heights in front of an avalanche protection dam. These simulations should help to draw conclusions for the dimensioning of dams in order to effect most efficiency for avalanche protection.