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Modelling the interactions between grain, hydraulics, and local topography to understand the impact on incipient motion

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Sediment transport plays the key role in the forming fluvial systems, and it has become a major issue for the management and operation of hydropower plants and shipping channels as well as for the understanding of flooding hazards.

The interactions between grain, hydraulics, and local topography are complicated, and it is difficult to quantify them in the laboratory, in the field, or in simple theoretical models based on two-dimensional force balances. In many theoretical models of incipient motion, grains are assumed to have simple geometrical shapes (usually spheres), despite the fact that in the real world grain shapes can vary from platy to elongated to symmetrical, and from angular to rounded. In addition, grain shape may influence protrusion and angle of repose for a grain sitting in the same pocket, and both local grain environment and grain shape in turn influence the local flow field around the grain, and thus the forces acting on it.

In this project a numerical model will be developed that is capable of resolving the interaction between the grain and the flow. The model will be used to study the influence of the grain environment and grain shape on initiation of motion. The aims of the project are three-fold. First, we want to develop a numerical model that is adapted to and can efficiently deal with the specific problems occurring in the study of initiation of bedload sediment motion in streams. Second, we want to identify which of the parameters describing grain shape and local topography (e.g., protrusion, angle of repose, grain angularity) dominantly influence the initiation of motion of an individual grain. Third, we want to clarify when and where simple analytical approximations of the sort that have been used in many previous models are applicable. In three tasks we will develop the model, validate it against laboratory and field data, and perform a number of systematic numerical experiments to better understand incipient motion.