Rheology of non-spherical down inclined planes

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ABSTRACT

We numerically studied the flow of non-spherical, rod-shaped particles down an inclined plane, using a hybrid CPU/GPU implementation of the discrete element method. The goal of this study is to extend existing theories of frictional avalanching flows of spherical particles in steady-state situations to the case of non-spherical grains.

The system's response was systematically tested by varying the particle aspect ratio and the inclination of the plane. Similarly to the case of spheres, we observed a regime characterized by steady uniform flow. The flow morphology was quantified by exploring the solid fraction profiles and the distribution of particle orientations. We observed that the preferential orientation of the rods is not parallel to the flow velocity but forms a small angle $\Delta\Theta = \Theta c$ with it. The angle Θc is independent of the local shear rate and, for a given particle elongation, Θc decreases when the particle aspect ratio is increased. Remarkably, these results are in excellent agreement with previous experimental findings. Furthermore, the particle orientation distribution allowed us to identify the most relevant length scale in the precess *dc*. We have found that *dc* is the projection of the particle longer side on the direction of the shear.

To connect the micro- and macro-behavior of the flow we used a coarse-graining (CG) technique. Thus, the macroscopic kinetic and dynamic fields were derived from the microscopic data. Based in our data analysis, we showed that the μ(I) rheology is also applicable to granular flows of non-spherical particles if we account for the correct length scale in the definition of the inertial number I.