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Development of Closures for Collisions Between Realistic Particles

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ABSTRACT

Systems consisting of solid particles can exhibit fluid-like motion and are common in industrial applications such as pharmaceutical or food processing. Such granular flows are often studied using simulation methods. One common simulation method is the discrete element method (DEM), which solves for the motion of individual particles based on Newton's laws. However, large-scale particulate systems are difficult to study using DEM due to excessively long simulation times. The goal of this study is to reduce the computational load of these large-scale simulations. Instead of resolving particle trajectories throughout each collision, a scattering function is developed that directly relates the post-collision state to pre-collision properties. By bypassing the process of fully resolving particle collisions, the measured scattering functions can be used to decrease computational costs. The scattering function was formed by simulating many collisions between randomly oriented identical particles and determining the direction they rebound after each collision. The scope of this study includes the effect of elasticity, friction, and particle shape on the scattering function. The results of this study show elasticity, friction, and particle shape all influence the scattering function. Decreasing the elasticity, which increases the loss of energy in collisions, shows the scattering function favors forward scattering. Friction has the opposite effect on the scattering function as it tends to cause more backward scattering. Finally, collisions between more realistic non-spherical particles result in significant rotation and changes in the scattering behavior as compared to spherical particles.

KEYWORDS

Granular flows, collision dynamics, non-spherical particles, discrete element method