Numerical Simulations of Granular Dynamics: Method and Tests

Patrick Michel

Observatoire de la Cote d'Azur (France)

We present a new particle-based numerical method for the simulation of granular dynamics, with application to motions of particles (regolith) on small solar system body and planetary surfaces [1]. The method employs the parallel N-body tree code pkdgrav [2] to search for collisions and compute particle trajectories.

Particle confinement is achieved by combining arbitrary combinations of four provided wall primitives, namely infinite plane, finite disk, infinite cylinder, and finite cylinder, and degenerate cases of these. Various wall movements, including translation, oscillation, and rotation, are supported. Several tests of the method are presented, including a model granular “atmosphere” that achieves correct energy equipartition, a series of tumbler simulations that compare favorably with actual laboratory experiments [3], as well as avalanches under different gravity conditions, and seismic shaking of particles with two different sizes. We will also briefly present a micro-G experiment of granular material shear flow performed using parabolic flights, that we also aim at reproducing by numerical simulations, and that has implications in the mobility of regolith on small body (low-gravity) surfaces. These works will allow us to help in the interpretation of small body images, and in constraining the surface conditions that lead to the observed features such as the angle of repose of regolith resulting from land-slides. Moreover, it will be helpful for the design of efficient sample mechanisms in the framework of sample return missions.

[1] Richardson et al. 2010, Icarus, under revision;
[2] Cf. Richardson et al. 2009, P&SS 57, 183 and references therein;
[3] Brucks et al. 2007, PRE 75, 032301-1-032301-4.