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The Dynamics of a Cylinder Containing Granules Rolling Down an Inclined Plane

Short title: Cylinder containing granules rolling down an incline

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Abstract

The dynamics of a hollow cylinder containing granules and rolling down an inclined plane was investigated. A theoretical approach for investigating the behavior of such a cylinder was proposed. The critical angle of the plane that allows the system to roll downward is presented. A simple experiment using six types of granules consistently confirmed the theoretical predictions. We found that the critical angle is independent of the size distribution of the granules and the sliding angle of granules inside the cylinder is constant and is similar to the avalanche angle of the granules. Additionally, we derived the oscillation frequency of the system when it is slightly deviated from equilibrium, showing the frequency initially increases and then decreases with increasing granular volume. The oscillation is absent when the cylinder is empty or fully filled with granules. Furthermore, the dissipation of energy as a function of volume fraction and mass fraction of the cylinder system were determined.

Keywords: rolling dynamics; granules; critical angle; avalanche angle; log normal.

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