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Granular packings with sliding, rolling and twisting friction

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*Developers of new LAMMPS granular package

Motivation

Packings of granular materials are generated by industrial processes and natural phenomena. The packing characteristics depend on the process and the material properties. Resistance to rolling and twisting can have a large impact of packing structure, but has yet to be studied systematically.

Discussion

Packings with large amounts of sliding, rolling and twisting friction have:

- many rattlers (zero-coordinated particles)
- few contacts (but more than theory predicts)
- Low density

The packed state of frictional grains depends on the particle properties and preparation protocol.

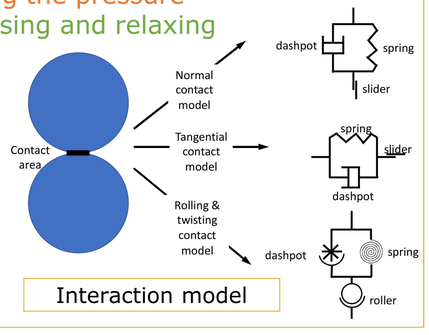
Methods

Discrete element, particle-based modeling (implemented within LAMMPS[a]).

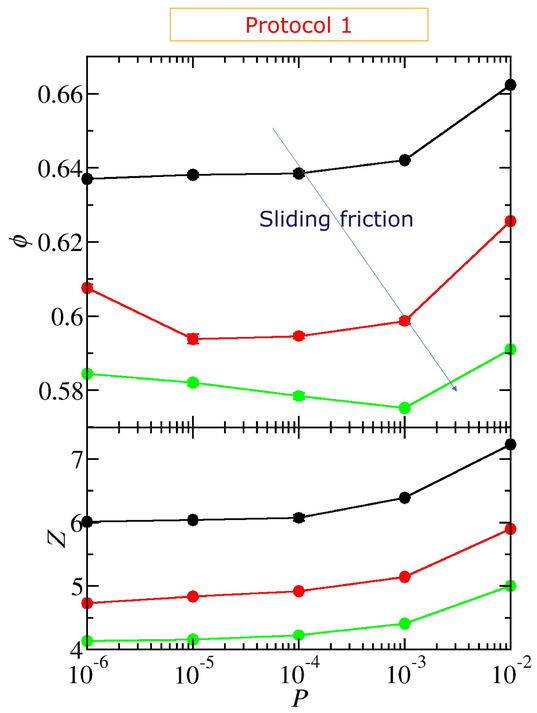
Packing protocols: specify pressure tensor and bring system to final state via:

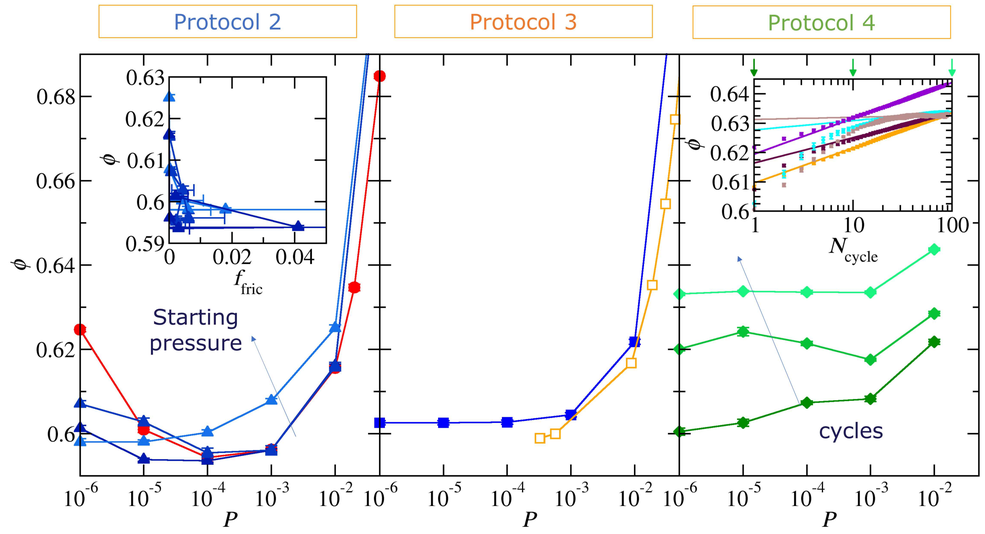
1. from a very low pressure
2. after over-compression
3. after progressively lowering the pressure
4. by cyclically over-compressing and relaxing

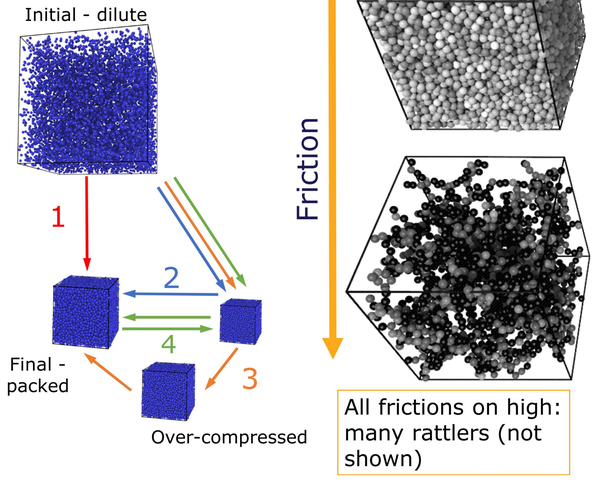
Packings can have a non-monotonic dependence of packing fraction with pressure, yet not in the average number of contacts, depending on the method.

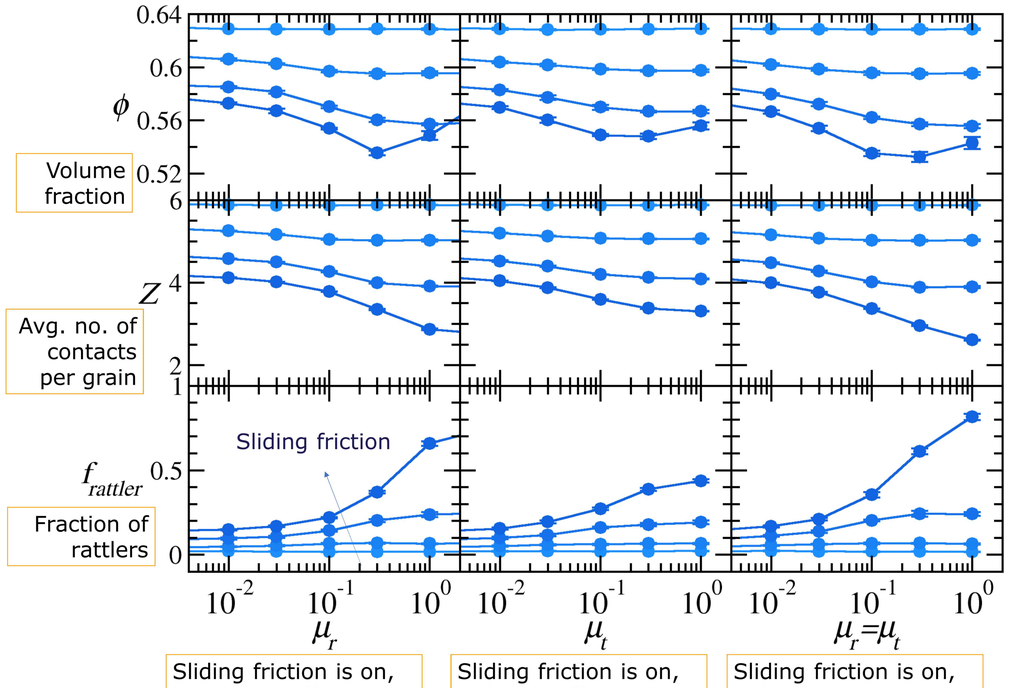


Interaction model









Sliding friction is on, twisting is off

Sliding friction is on, rolling is off

Sliding friction is on, rolling equals twisting

Citations

[a]Plimpton S. (1995). Fast Parallel Algorithms for Short-Range Molecular Dynamics. J. Comput. Phys., 117, 1-19

[b]Santos A et al. Granular packings with sliding, rolling and twisting friction. *In preparation*

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