

Granular Mechanics and Geotechnical Engineering Laboratory University of Tsukuba

筑波大学 粒状体力学・地盤工学研究室

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What is granular matter?

The research of our group focuses on

Mechanics of Granular materials

(geo-materials in particular)

Granular materials are ubiquitous in our life,
but their mechanics has **not** fully understood.

Because of their **dissipative** nature,

- * statistical mechanics **cannot** be applied easily
- * packing structure is **random** and **not** uniquely-determined
- * phase-change occurs **differently** from molecular systems

Also, **grain properties often change** during mechanical process

Examples of our research topics

[1] Civil Engineering research (土木工学分野の研究)

*Geotechnical Engineering (地盤工学)

Evaluation of geo-disasters (slope failure, liquefaction, etc.)
(斜面崩壊や液状化などの土砂災害の危険度評価)

*Energy Engineering (エネルギー工学)

Methane hydrate exploitation (メタンハイドレート開発)

*Railway Engineering (鉄道工学)

Dynamic stability of ballasted track (バラスト軌道の安定性)

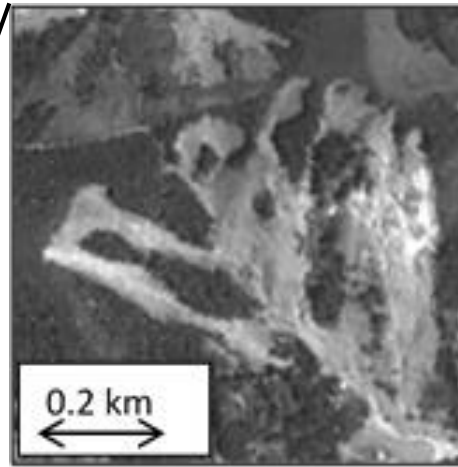
[2] Interdisciplinary research (学際融合研究)

* **Statistical physics on granular matter** (粒状体の統計力学研究)

* **Formation and evolution of surface geo-materials on solid planets** (on the Earth, the Moon or Asteroids) (固体惑星表層土の形成・進化研究)

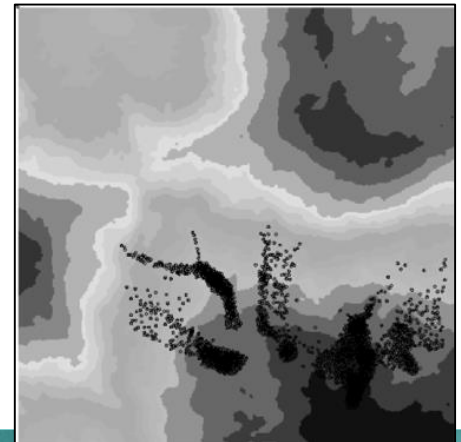
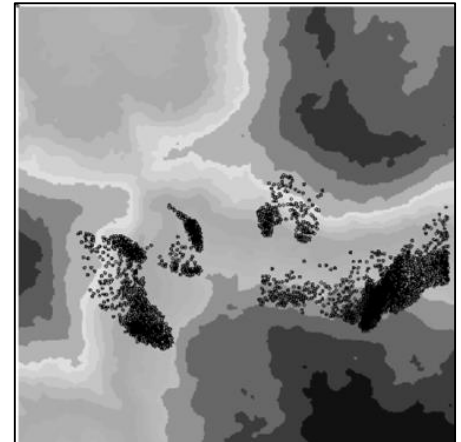
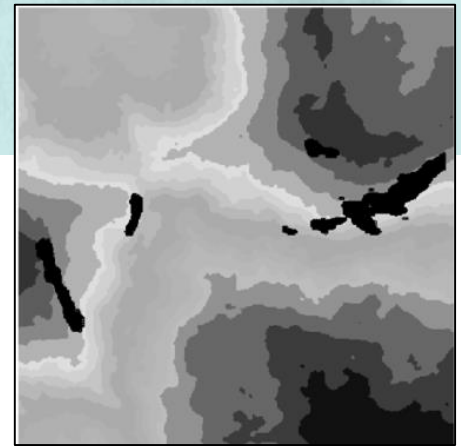
[1] Risk evaluation of Geo-hazard

Numerical simulation of slope failure and flow by particle method and ALOS satellite image



Case study in Rio de Janeiro disaster

Simulation by
depth-integrated
particle method



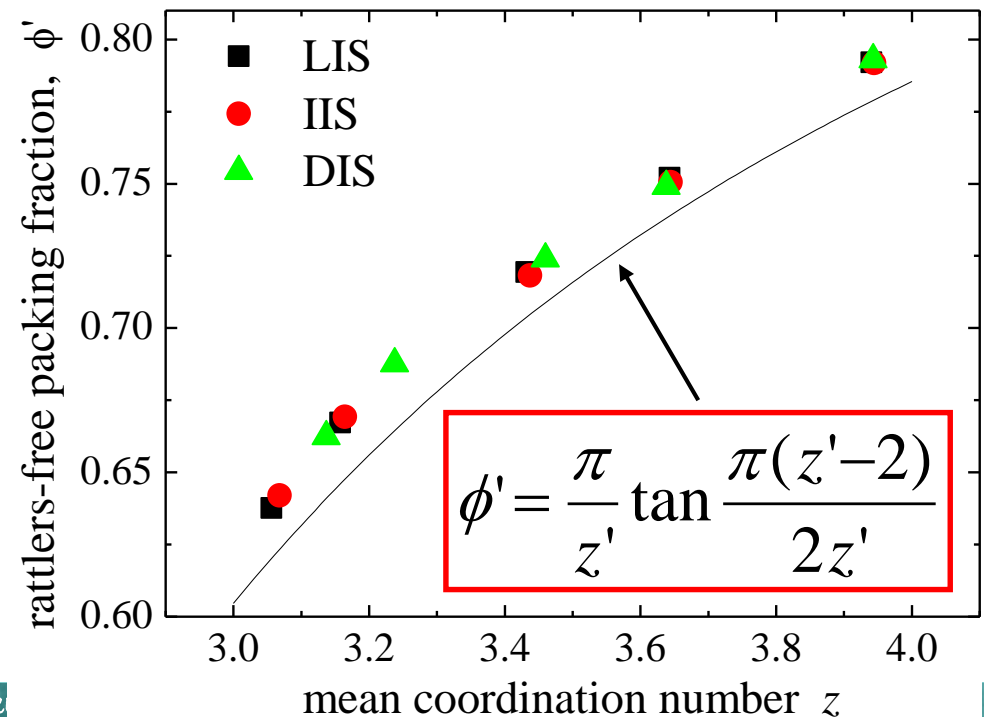
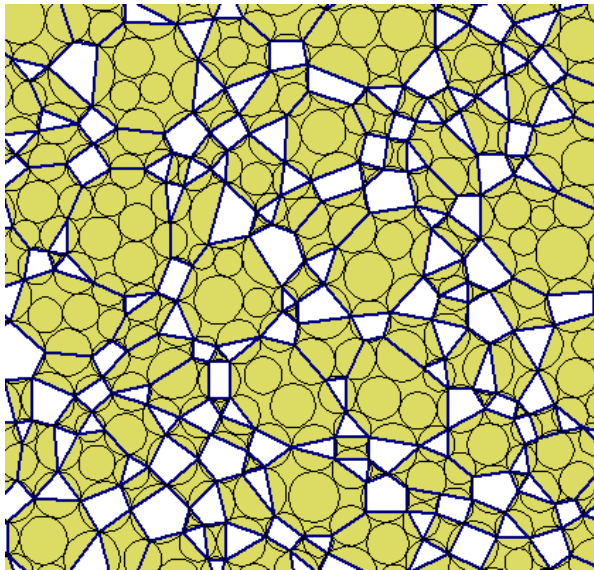
[2] Statistical physics on granular solid

Matsushima and Blumenfeld, *Physical Review Letters*, 112(9), 2014.

Solid fraction of 2D granular solid, ϕ , and **mean coordination number**, z , do not have one-to-one correspondence in general.

However, if we re-calculate those quantities after removing **rattlers** (no-contact grains), we get **a unique relation independent of friction and packing protocols**.

We also derived lower-bound solution for the relation.



[3] Physical properties of surface materials on asteroid Itokawa and the Moon

Tsuchiyama, Uesugi, Matsushima, et al. *Science*, 333, 2011.

Grain size and shape of the surface geomaterials retrieved from asteroid **Itokawa** was similar to those obtained by single impact experiments, but was different from those on the **Moon** (Apollo retrieved samples).

This implies Itokawa has been exposed to meteoroid bombardment for shorter time than the Moon.

