Simulations of vibration-driven regolith segregation

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Summary

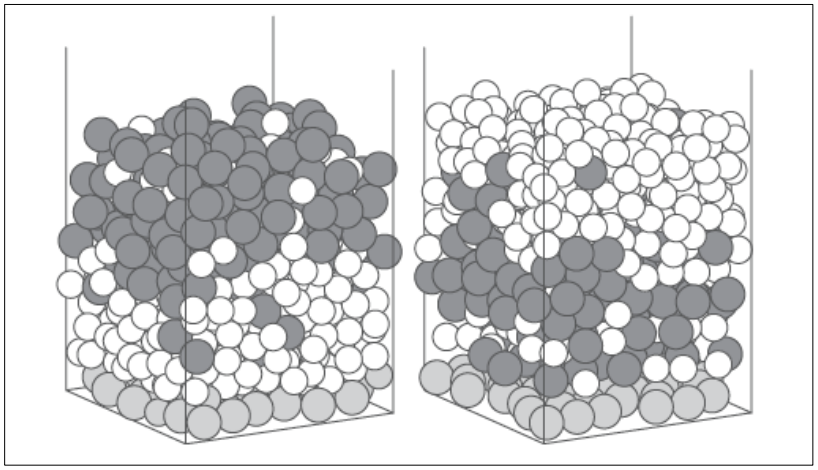
Introduction: context and on-going work

Simulations

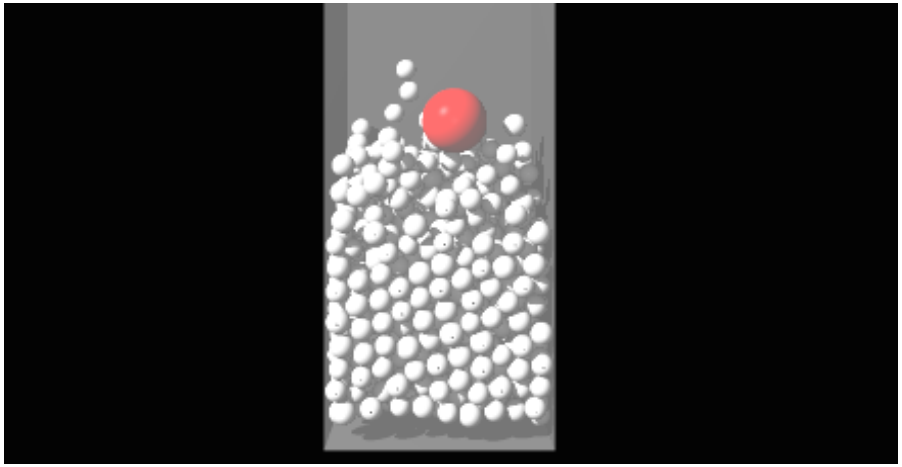
Density segregation: influential factors

Conclusion and future work

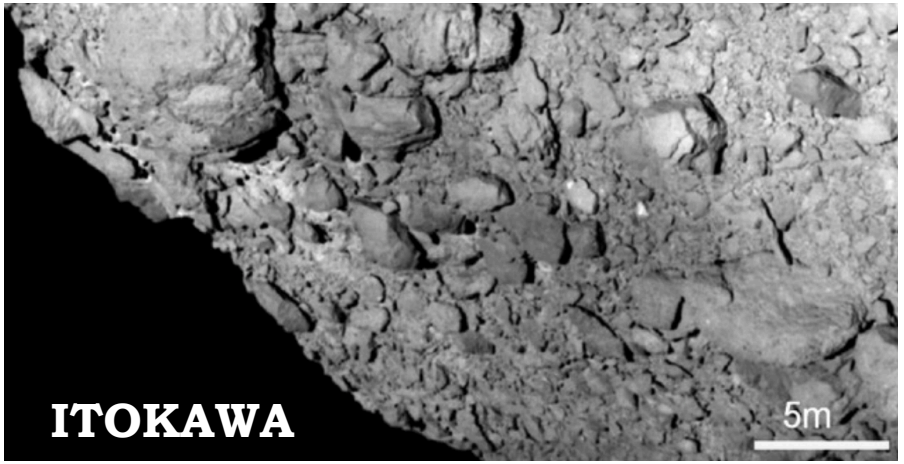
Introduction: context



M. Pica Ciamarra et al. (2006)

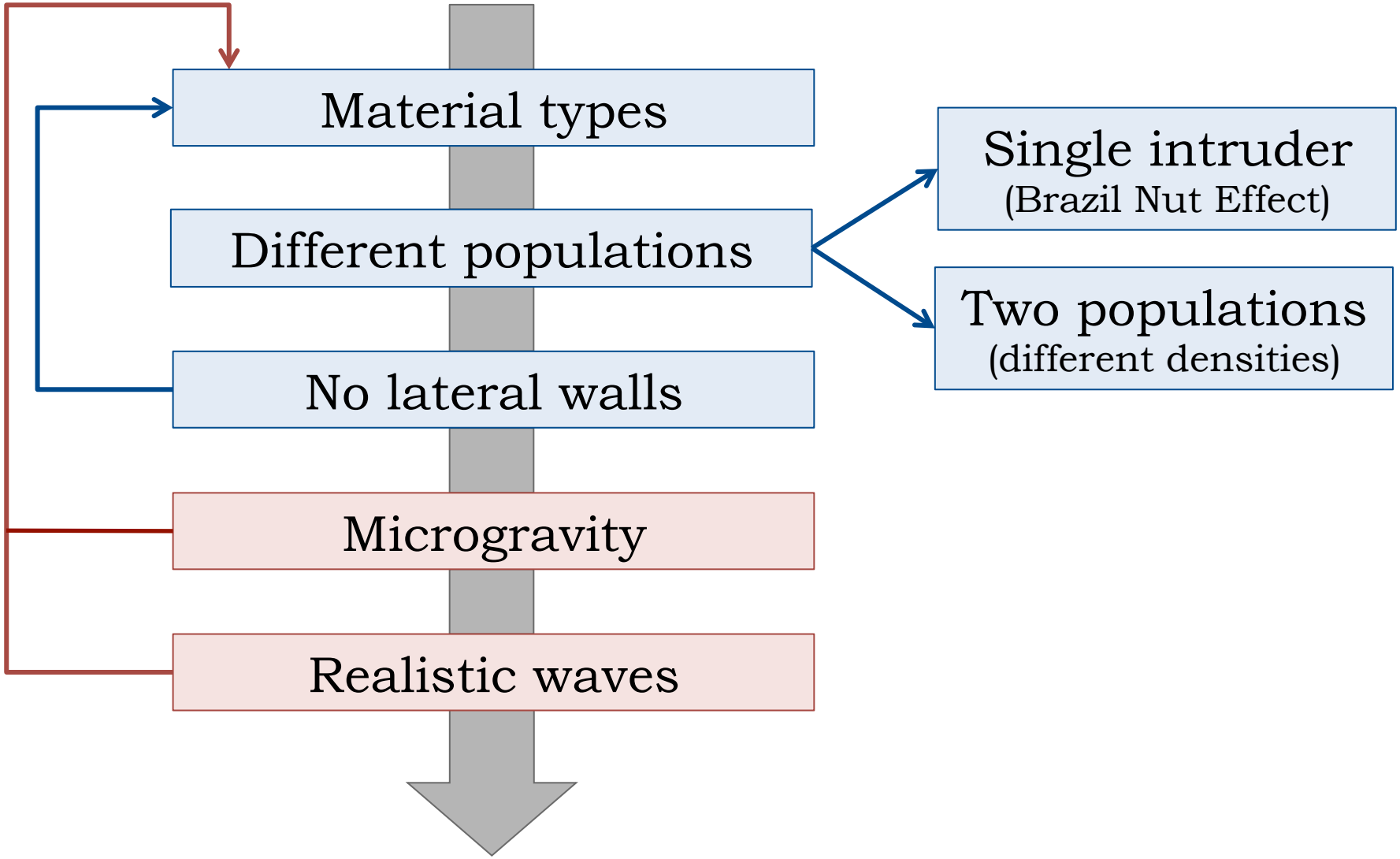


S. Matsumura (2014)



Miyamoto et al. (2007)

Introduction: overall approach



Simulations

Pkdgrav with Soft Sphere option *Schwartz et al. (2012)*

Material parameters

(restitution) normal ε_n & tangential ε_t
(friction) static μ_s & rolling μ_r

Source: Yu et al. (2014) :

SMOOTH

$\varepsilon_n = 0.95$ $\varepsilon_t = 1.0$ | $\mu_s = 0.0$ $\mu_r = 0.0$

GLASS BEADS

$\varepsilon_n = 0.95$ $\varepsilon_t = 1.0$ | $\mu_s = 0.43$ $\mu_r = 0.1$

GRAVEL

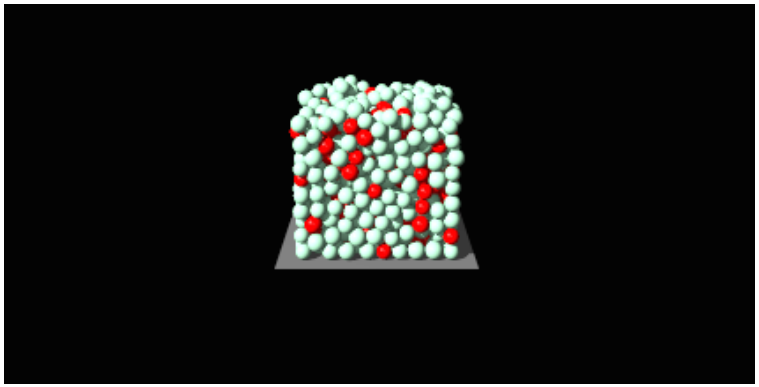
$\varepsilon_n = 0.55$ $\varepsilon_t = 0.55$ | $\mu_s = 1.31$ $\mu_r = 3.0$

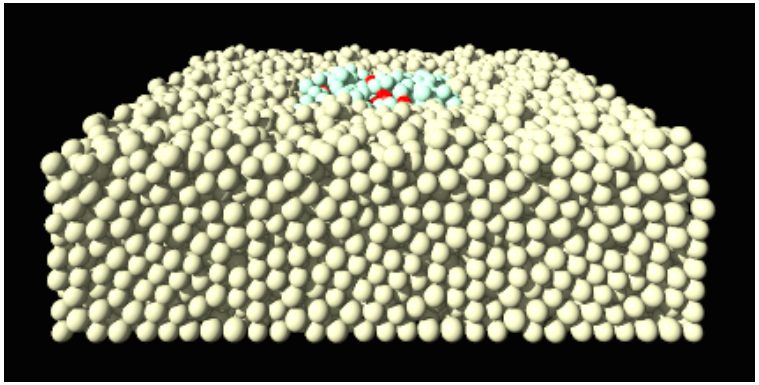
Source: Matsumura et al. (2014) :

MODERATE FRICTION

$\varepsilon_n = 0.5$ $\varepsilon_t = 0.5$ | $\mu_s = 0.8$ $\mu_r = 0.2$

Periodic Boundary Conditions





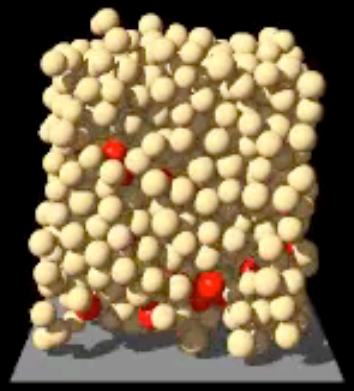
Density segregation

Influential factors

Walls

Material: friction parameters

Density ratio
D/d



Amplitude and frequency of the oscillation:
$\Gamma = A\omega^2 / g$

Population ratio
N/n

Gravity

(video approximately 10 times slower than real speed)

Density segregation

At the surface of an asteroid?

Walls !

Density ratio ?

Population ratio ?

Material: friction parameters ?

?

Amplitude and frequency of the oscillation:

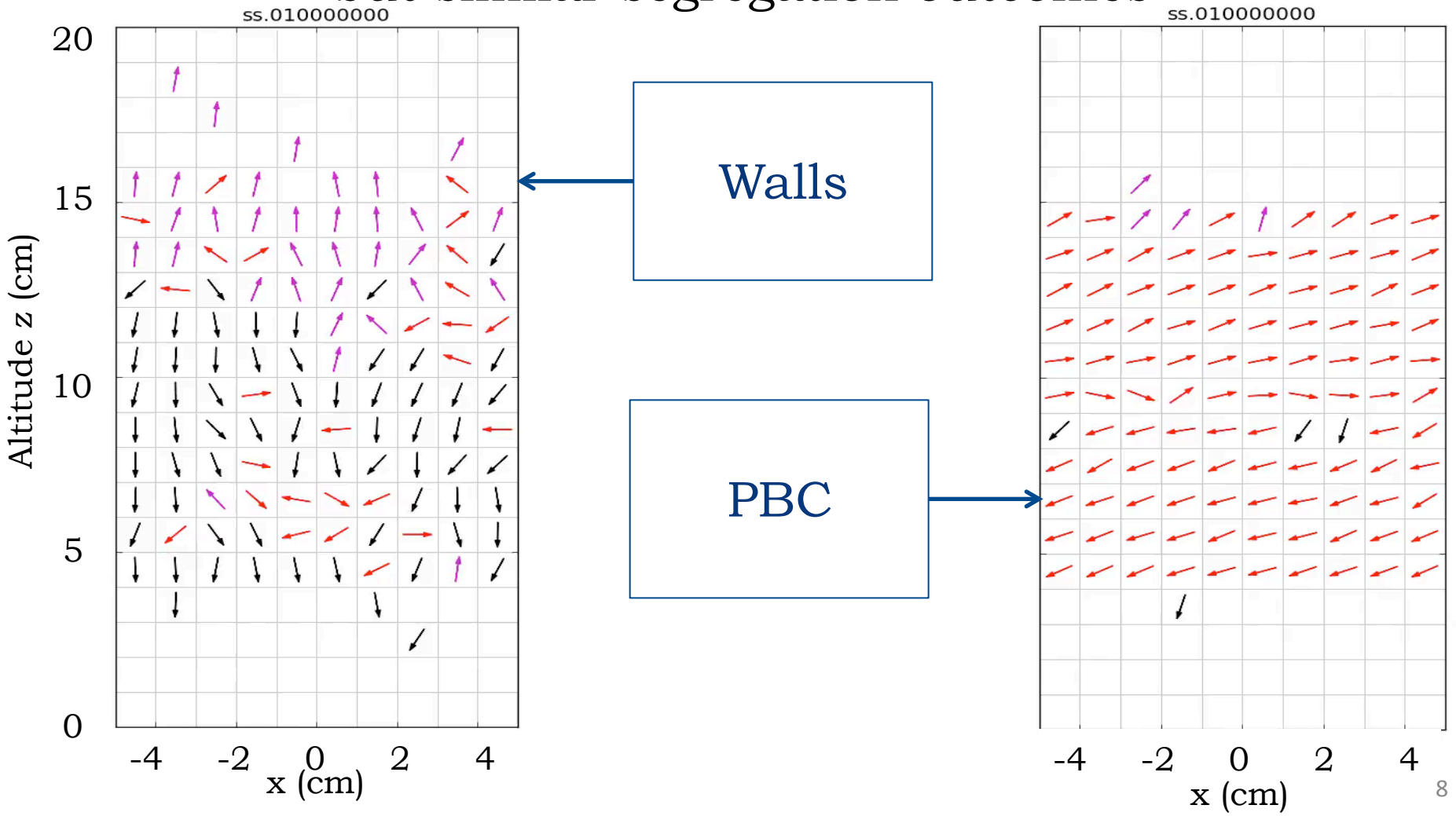
$\Gamma = A\omega^2 / g$?

Gravity:

Tancredi et al. (2012) ; Matsumura et al. (2014) ; …

Removing walls: Periodic Boundary Conditions (PBC)

Different macroscopic behavior of the whole system but similar segregation outcomes



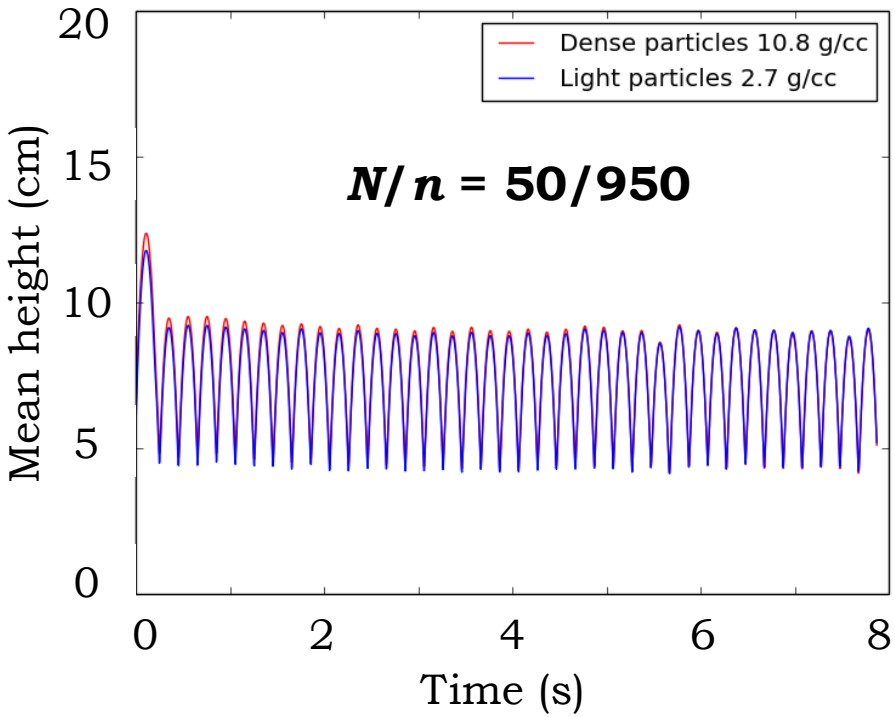
Density segregation

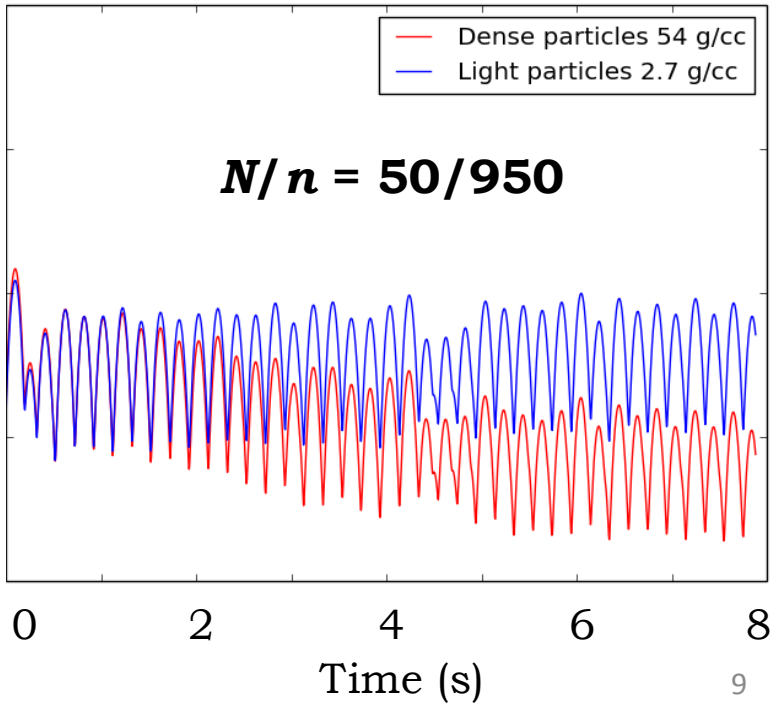
Density ratios

Same friction parameters: **GRAVEL**

$$\frac{D}{d} = 4$$

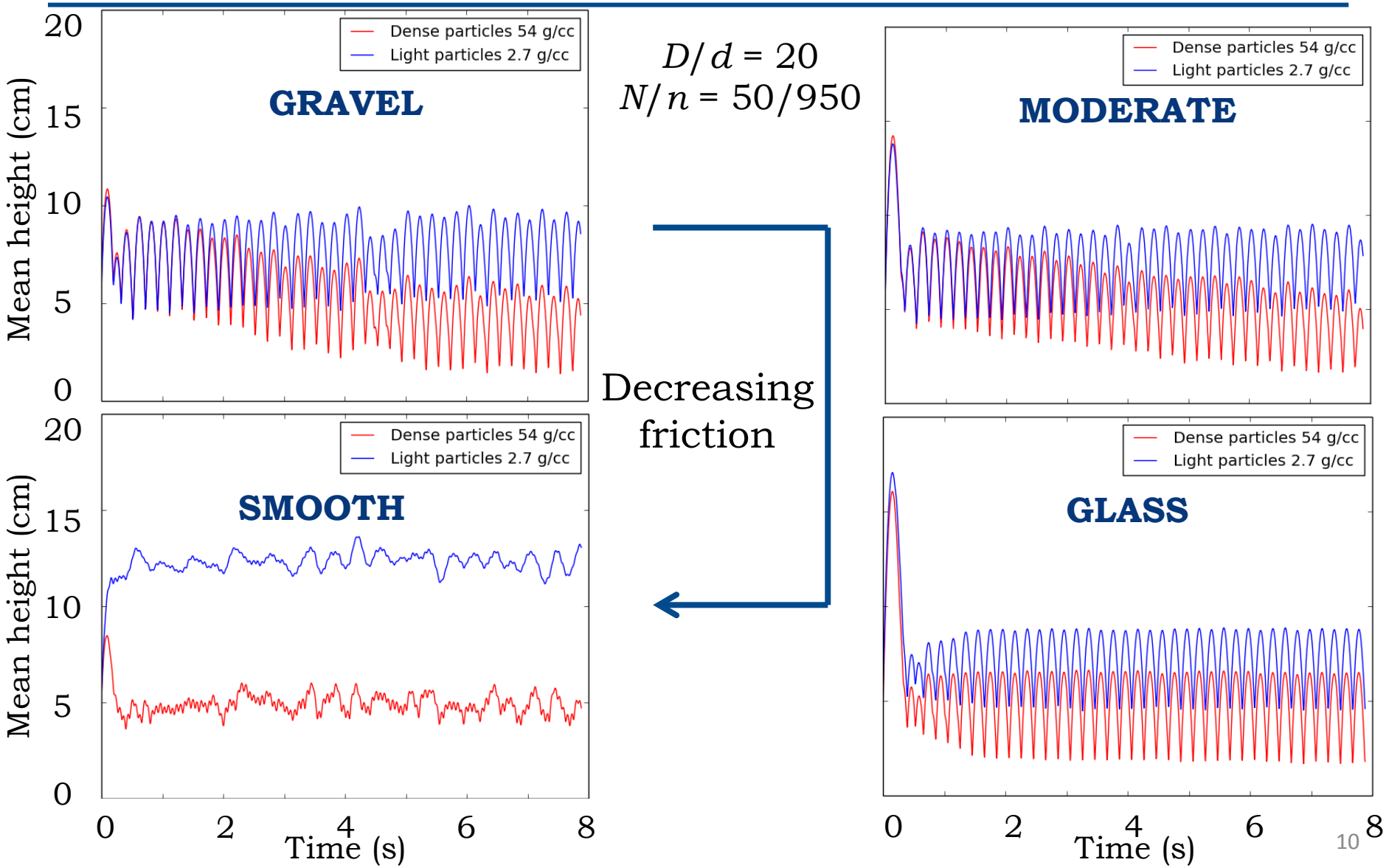
$$\frac{D}{d} = 20$$





Density segregation

Friction



$D/d = 20$

$N/n = 50/950$

Decreasing friction

Conclusion and future work

Different types of density segregation

Outcomes HIGHLY dependent on parameters and conditions

Criteria for segregation in Earth gravity

Working toward the asteroid environment:

More realistic system

Microgravity

More realistic amplitudes and frequencies
Shock waves [*Murdoch et al. (2015)*]