Introduction to the eXtended Discrete Element Method

Chercheurs à l'école 2014

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Outline

- Granular material
- eXtended Discrete Element Method (XDEM)
  - What is XDEM ?
  - A XDEM toolbox
  - How does it work ?
- Applications

Granular material

XDEM(extended discrete element method)

Wikipedia: is a numerical technique that extends the dynamics of granular material or particles as described through the classical discrete element method (DEM) (Cundall [1] and Allen [2]) by additional properties such as the thermodynamic state, stress/strain or electro-magnetic field for each particle. Contrary to a continuum mechanics concept, the XDEM aims at resolving the particulate phase with its various processes attached to the particles. While the discrete element method predicts position and orientation in space and time for each particle, the extended discrete element method additionally estimates properties such as internal temperature and/or species distribution or mechanical impact with structures.

Discrete Particle Method (DPM), (A XDEM toolbox)

Multi-physics simulation toolbox modelling granular materials and processes:

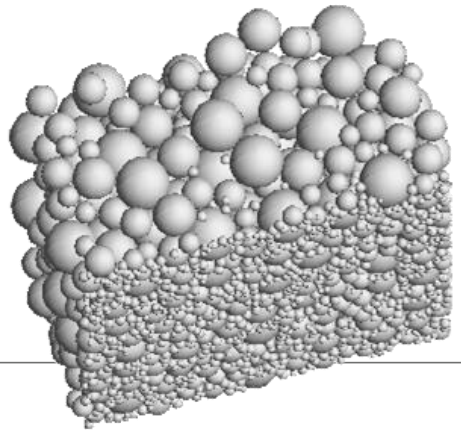
Particle Motion

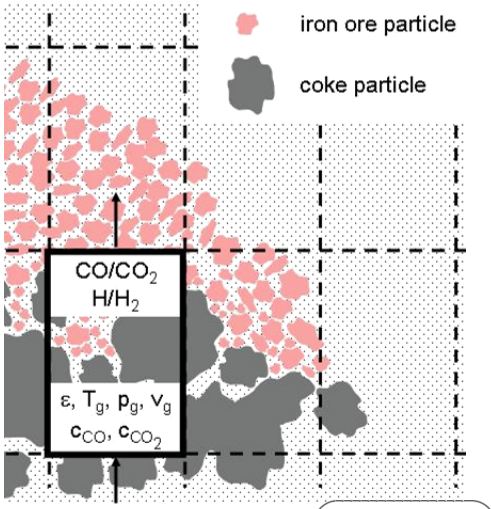
- Sand
- Snow
- …

&/or

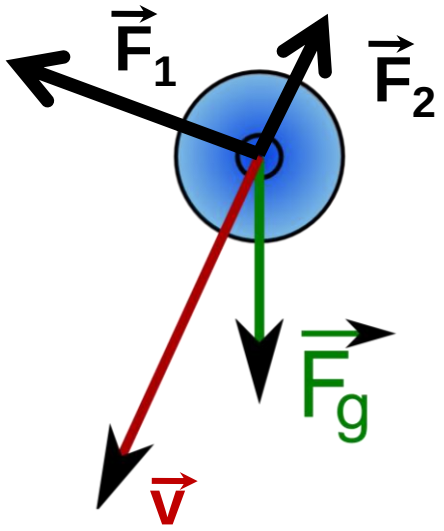
Chemical Reactions

- Coke
- WO3
- Biomass





DPM: How does it work ?



$$\vec{F} = m \cdot \vec{a} \qquad \text{Newton's 2nd law of motion}$$

$$\vec{F} = m \cdot \vec{a}(t)$$

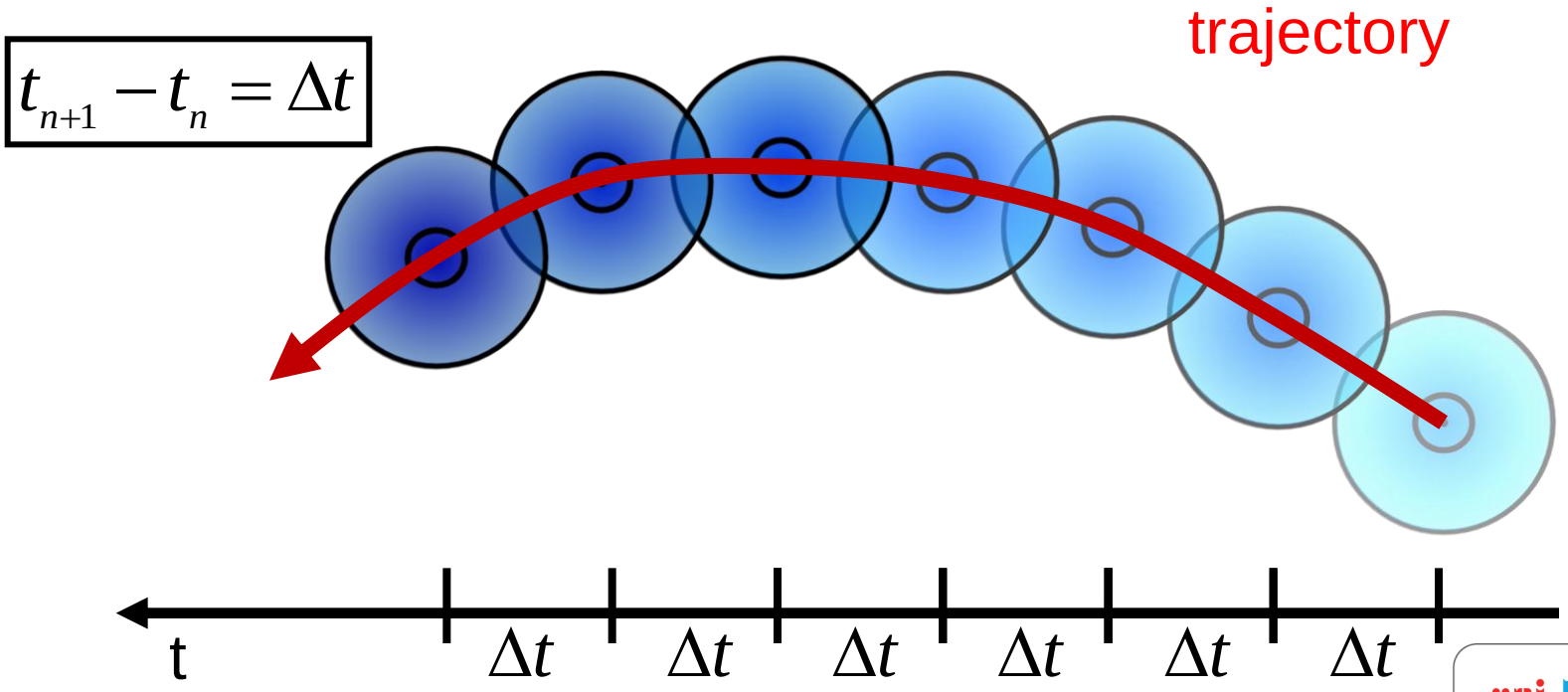
$$\vec{a}(t) = \frac{\sum \vec{F}}{m}$$

$$\xrightarrow{\int_{t_0}^{t_1}(\ldots)dt} \vec{x}(t_1) = \vec{v}(t_1) = \vec{v}_0 + \frac{\sum \vec{F}}{m} \cdot (t_1 - t_0)$$

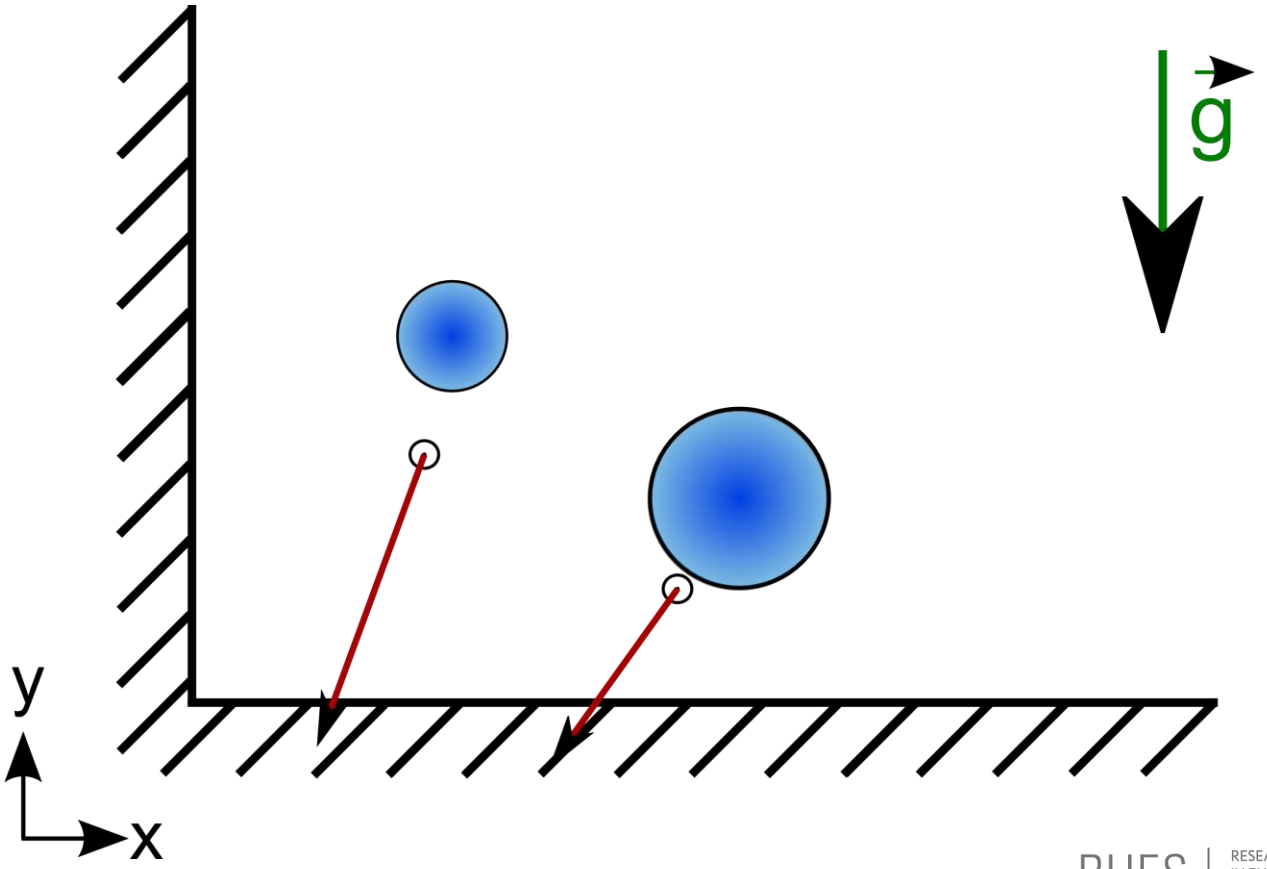
$$\xrightarrow{\int_{t_0}^{t_1}(\ldots)dt} \vec{x}(t_1) = \vec{x}_0 + \vec{v}_0 \cdot (t_1 - t_0) + \tfrac{1}{2} \cdot \frac{\sum \vec{F}}{m} \cdot (t_1 - t_0)^2$$

DPM: How does it work ?

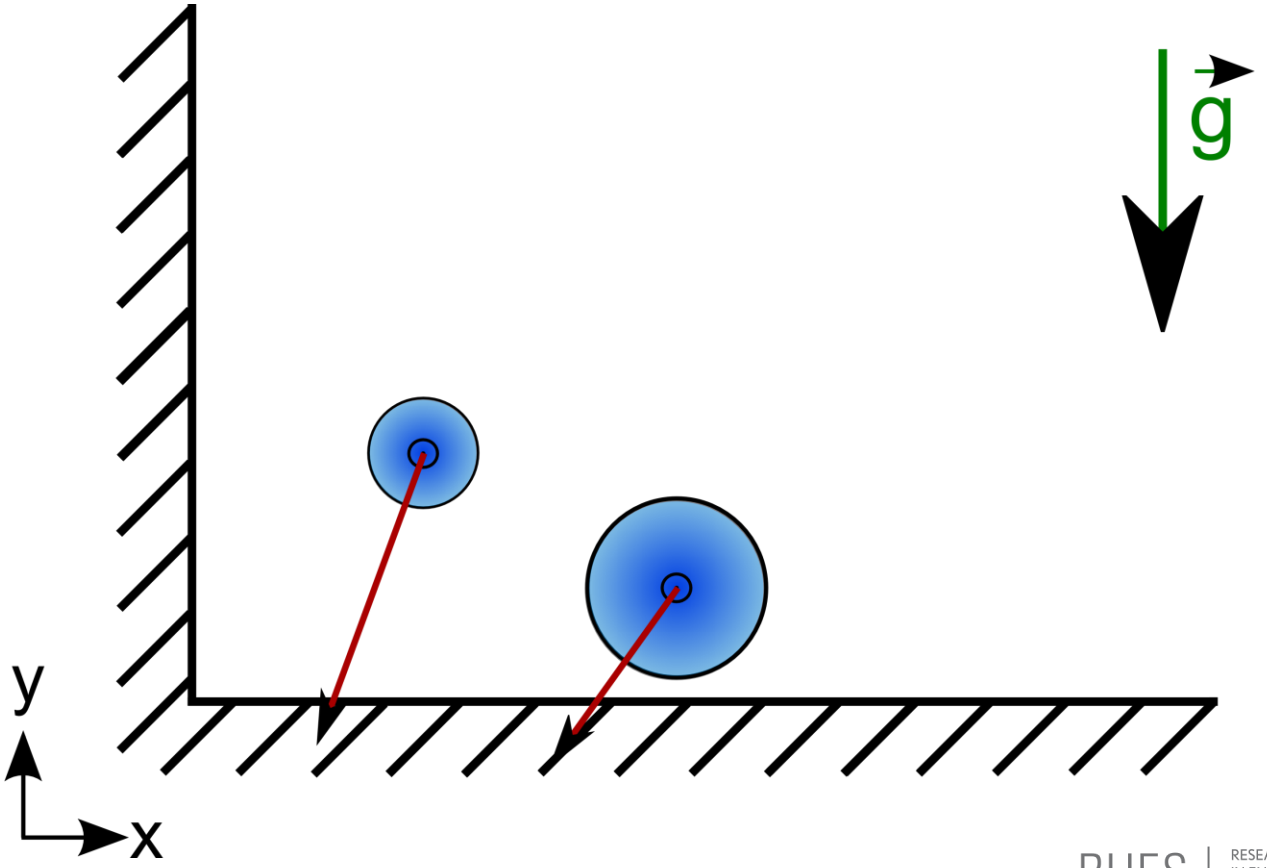
How can we calculate the trajectory of a particle ?



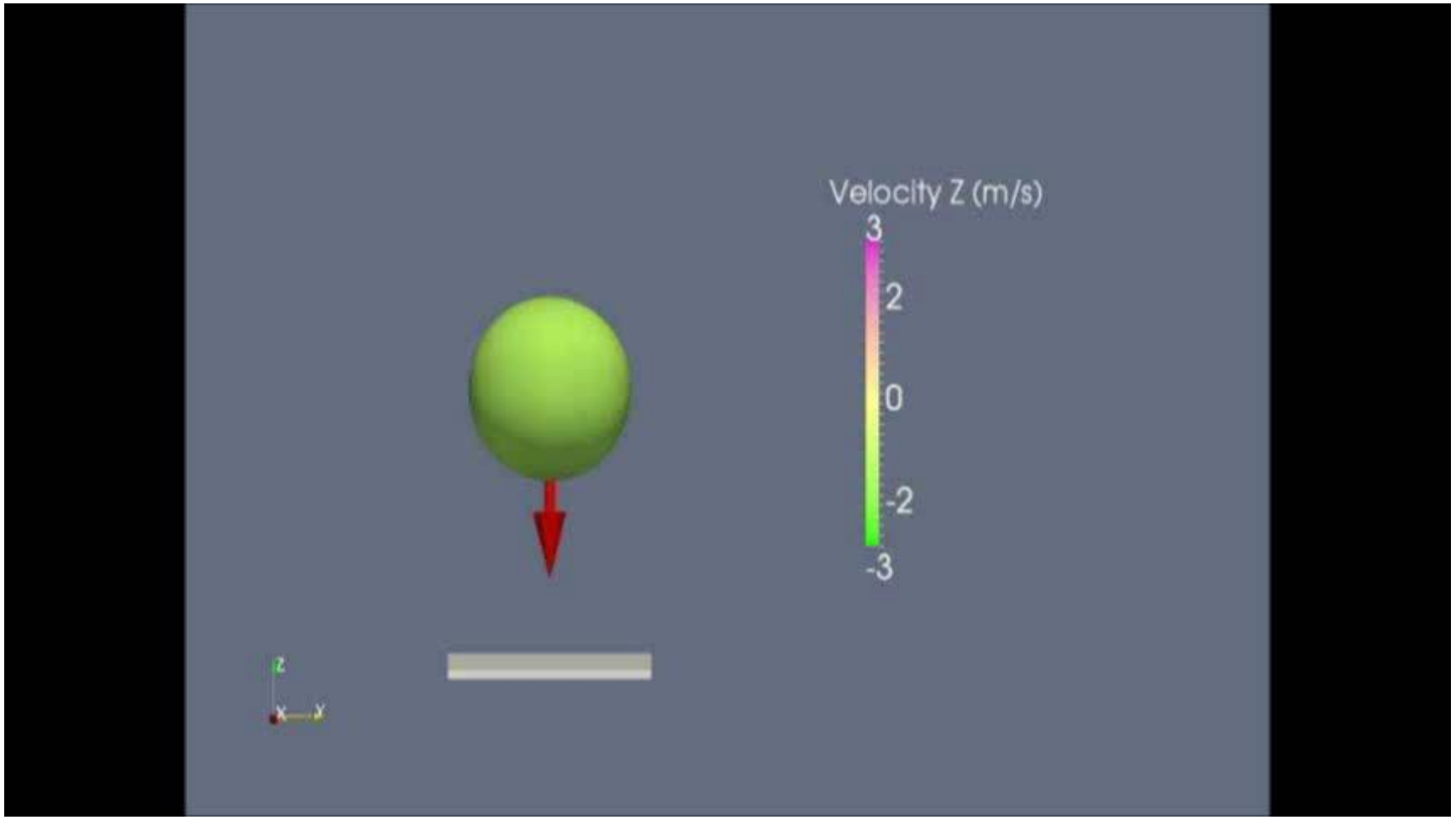
DPM: Newton's 2nd Law



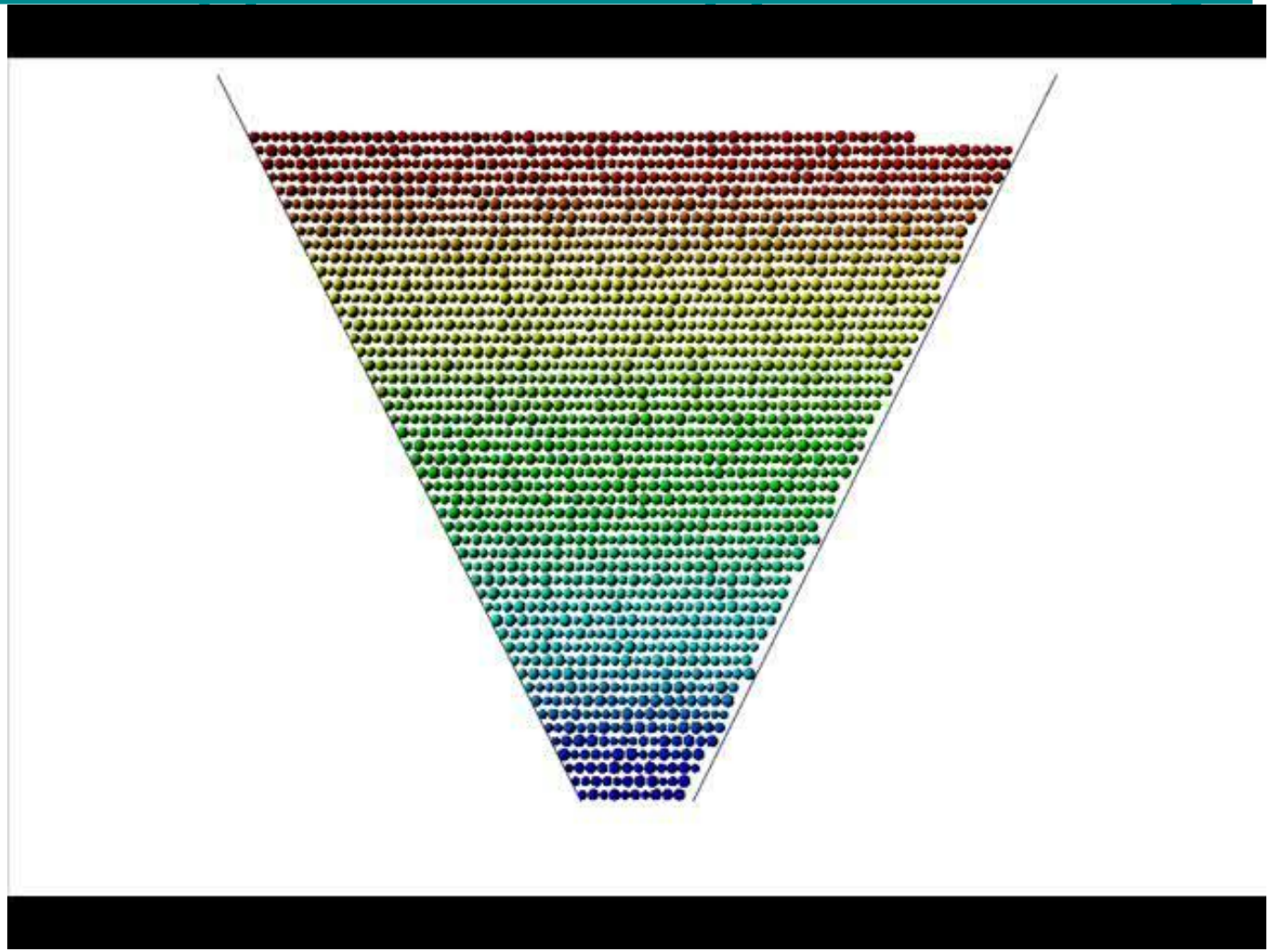
DPM: Newton's 2nd Law



XDEM Application: Contact



XDEM Application: Hopper Discharge



XDEM Application: Tire-Snow Interaction

Thank you for your attention

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