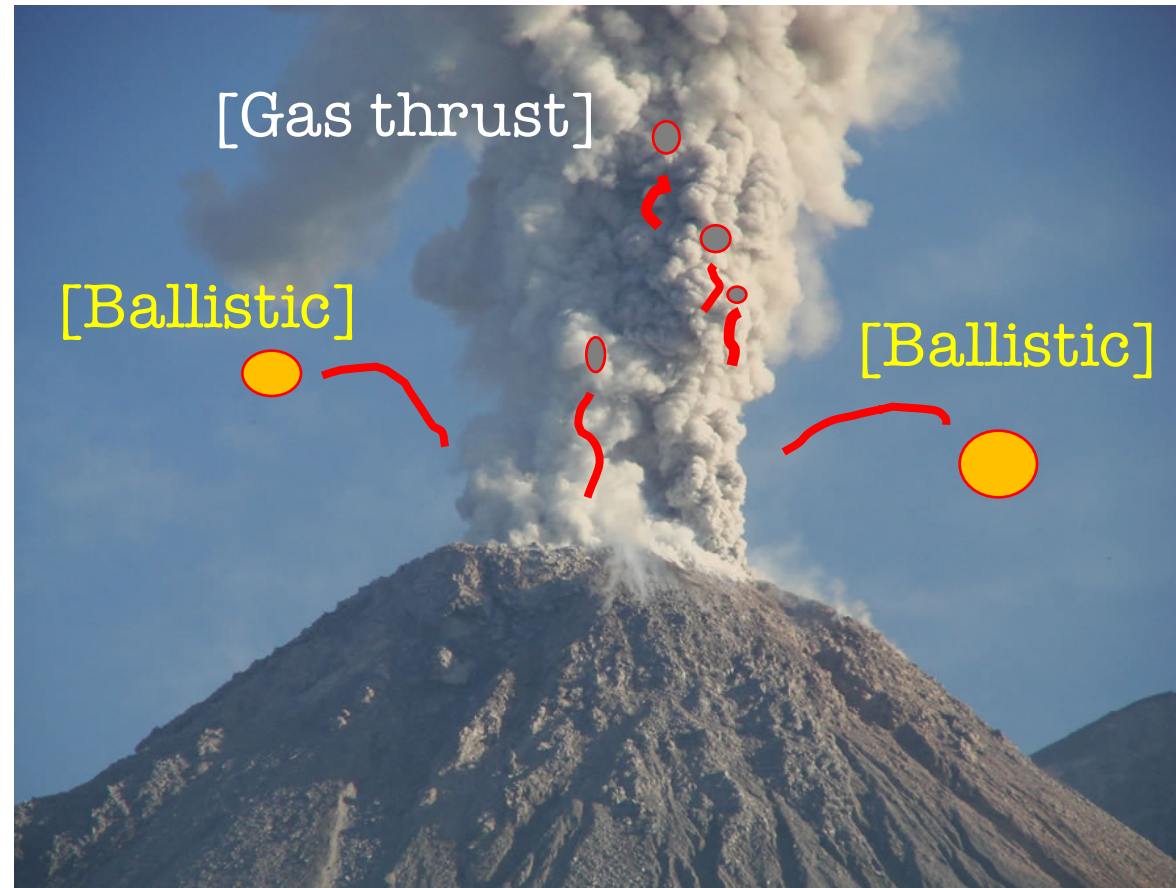


How to model ballistics with the model Great Balls of Fire (GBF)

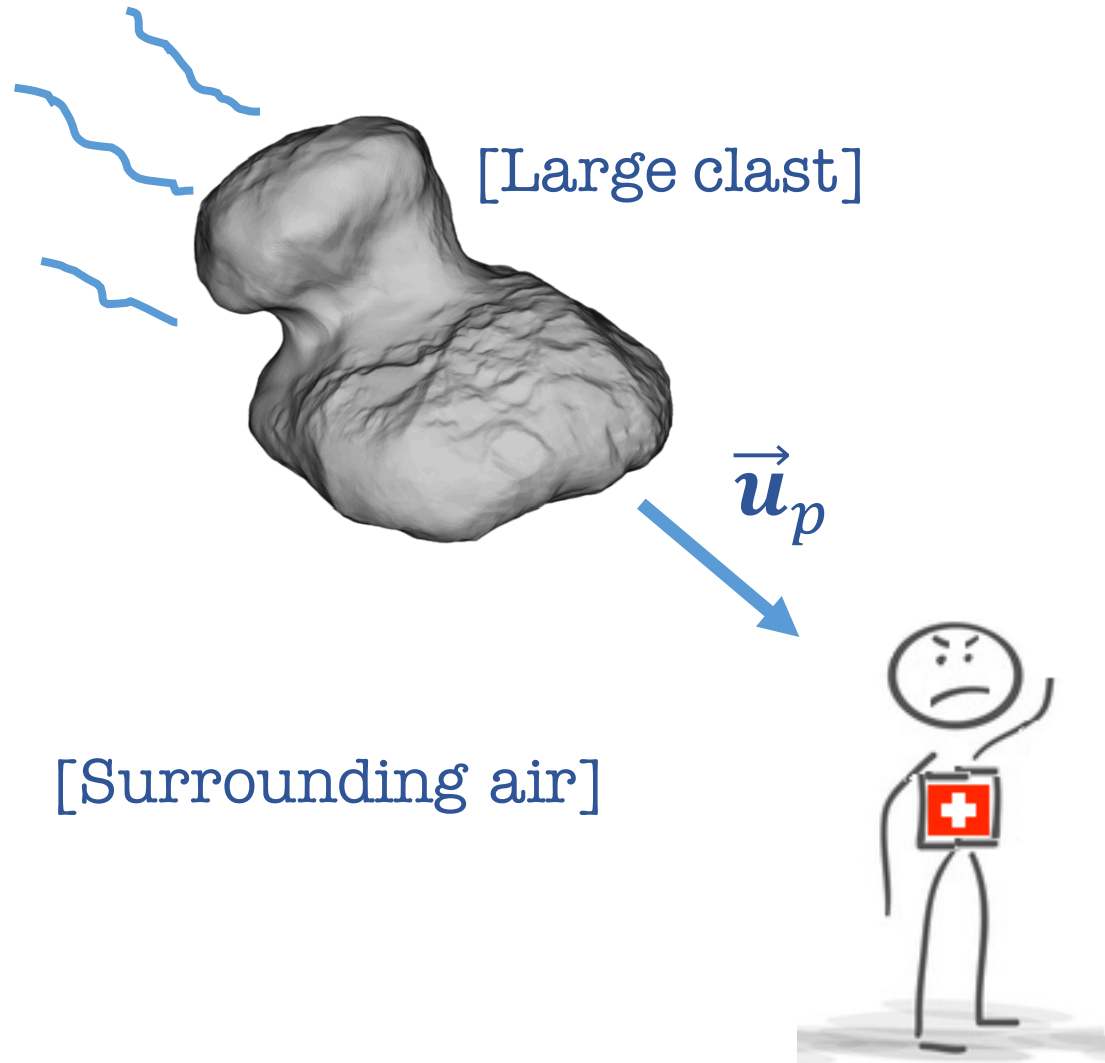
Dr. Eduardo Rossi

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University of Geneva

Ballistics

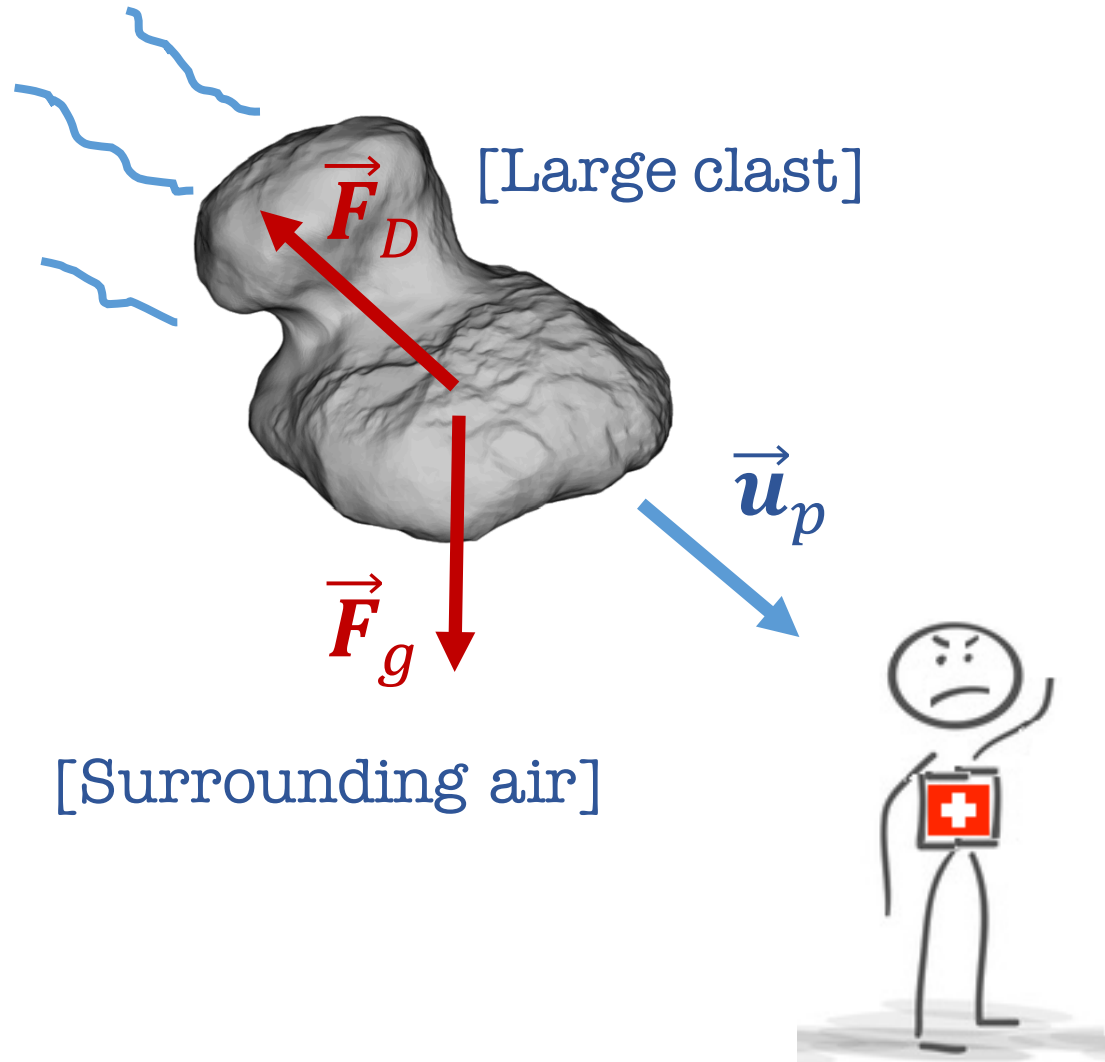


Ballistics



Which forces?

Ballistics



Which forces?

The drag force on the clast

$$\vec{F}_D = - \frac{\rho_f \cdot A \cdot C_d \cdot |\vec{u}_p - \vec{u}_f| \cdot (\vec{u}_p - \vec{u}_f)}{2}$$

The drag force on the clast

$$\vec{F}_D = - \frac{\rho_f \cdot A \cdot C_d \cdot |\vec{u}_p - \vec{u}_f| \cdot (\vec{u}_p - \vec{u}_f)}{2}$$

Diagram illustrating the drag force equation with labels for the variables:

- Fluid density (ρ_f)
- Projected area (A)
- Drag coeff. (C_d)
- Fluid velocity (\vec{u}_f)
- Clast velocity (\vec{u}_p)

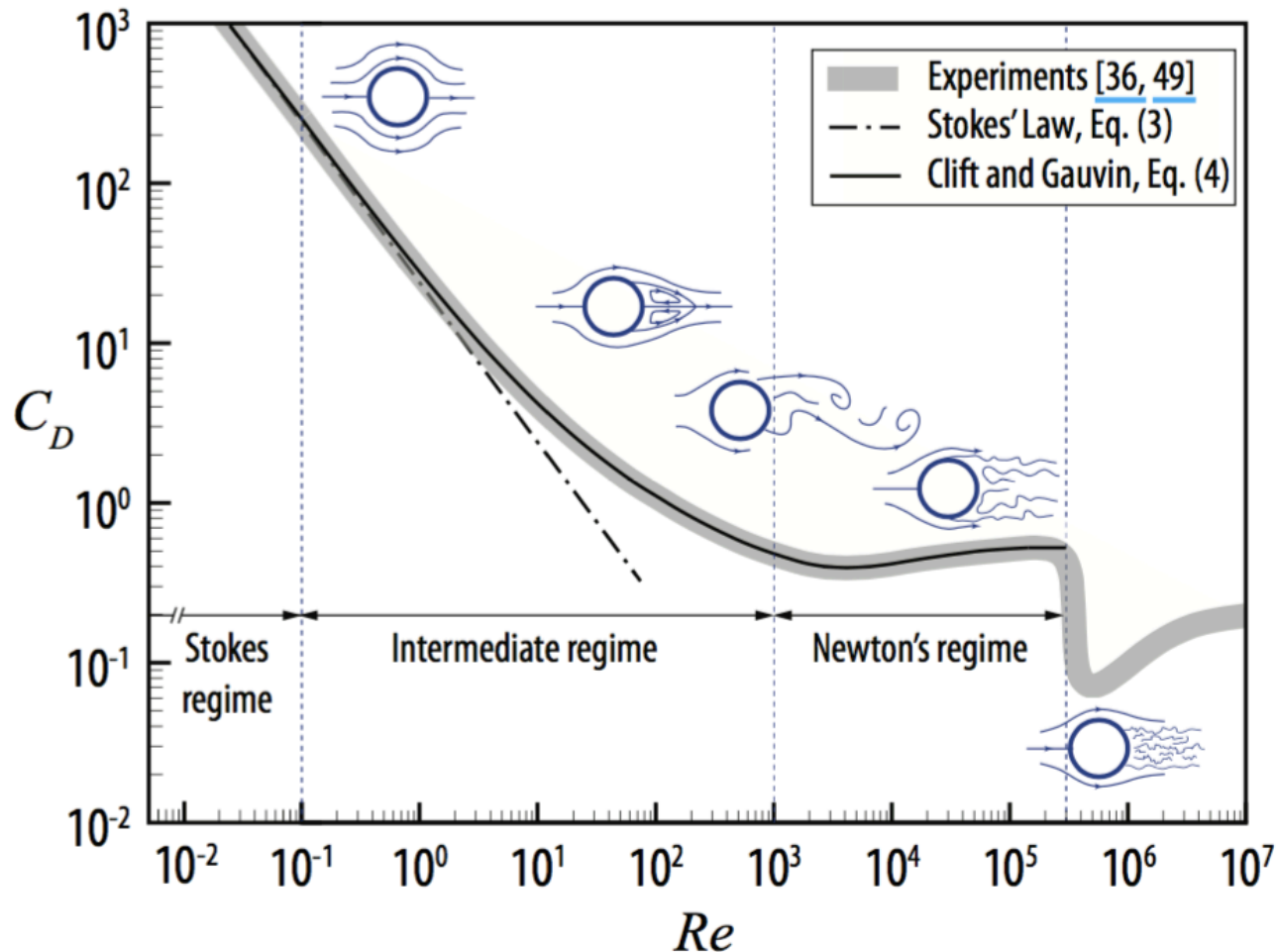
The drag force on the clast

$$\vec{F}_D = - \frac{\rho_f \cdot A \cdot C_d \cdot |\vec{u}_p - \vec{u}_f| \cdot (\vec{u}_p - \vec{u}_f)}{2}$$

Fluid density Projected area Drag coeff. Fluid velocity Clast velocity

$$\vec{F}_D = - \frac{\rho_f \cdot A \cdot C_d \cdot |\vec{u}_p| \cdot \vec{u}_p}{2}$$

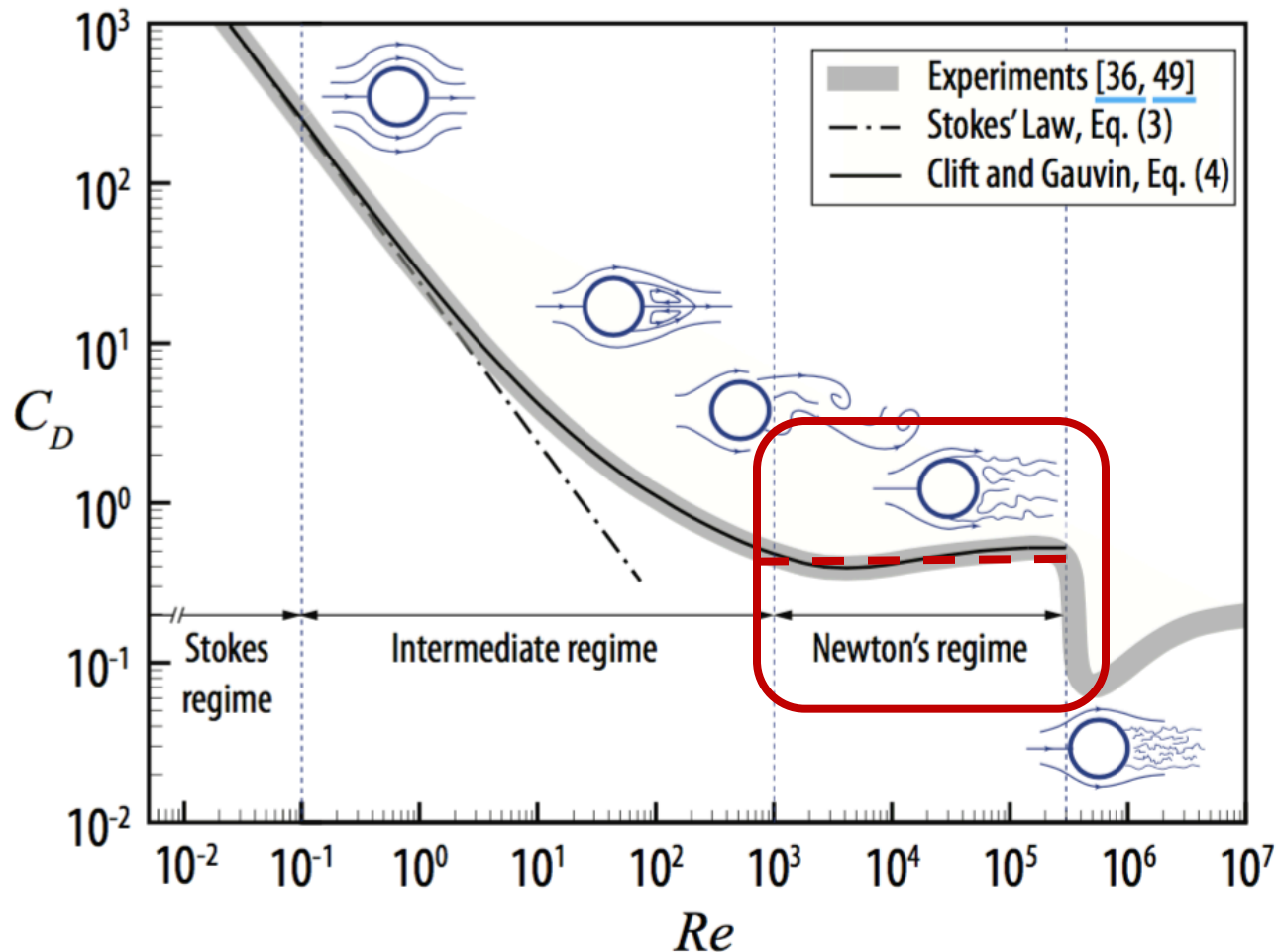
The drag force on the clast



Bagheri & Bonadonna (2016)

$$\vec{F}_D = - \frac{\rho_f \cdot A \cdot C_d \cdot |\vec{u}_p| \cdot \vec{u}_p}{2}$$

The drag force on the clast



Bagheri & Bonadonna (2016)

$$\vec{F}_D = - \frac{\rho_f \cdot A \cdot C_d \cdot |\vec{u}_p| \cdot \vec{u}_p}{2}$$

Exercise

1) Getting started with GBF [to be done together]

Exercise 1.1

Exercise 1.2

Exercise 1.3

2) What is the effect of the drag on the clasts?

Exercise 1.4

3) What are the energies of the impacts?

Exercise 1.5

The drag force on the clast

$$m \vec{a} = \vec{F}_D + \vec{F}_g \quad \longrightarrow \quad \vec{a} = -\frac{\rho_f \cdot A \cdot C_d \cdot |\vec{u}_p| \cdot \vec{u}_p}{2 m} + \cancel{\frac{m \vec{g}}{m}}$$

$$\longrightarrow \quad \vec{a} = -\frac{\rho_f \cdot \left(\frac{\pi}{4} d^2\right) \cdot C_d \cdot |\vec{u}_p| \cdot \vec{u}_p}{2 \left(\rho_p \cdot \frac{\pi}{6} d^3\right)} + \vec{g}$$

$$\vec{a} = -\left(\frac{6}{8} \frac{\rho_f C_d}{\rho_p}\right) \cdot \frac{|\vec{u}_p| \cdot \vec{u}_p}{d} + \vec{g} \quad \longrightarrow \quad \vec{a} = \boxed{-K \cdot \frac{|\vec{u}_p| \cdot \vec{u}_p}{d}} + \vec{g}$$

Drag