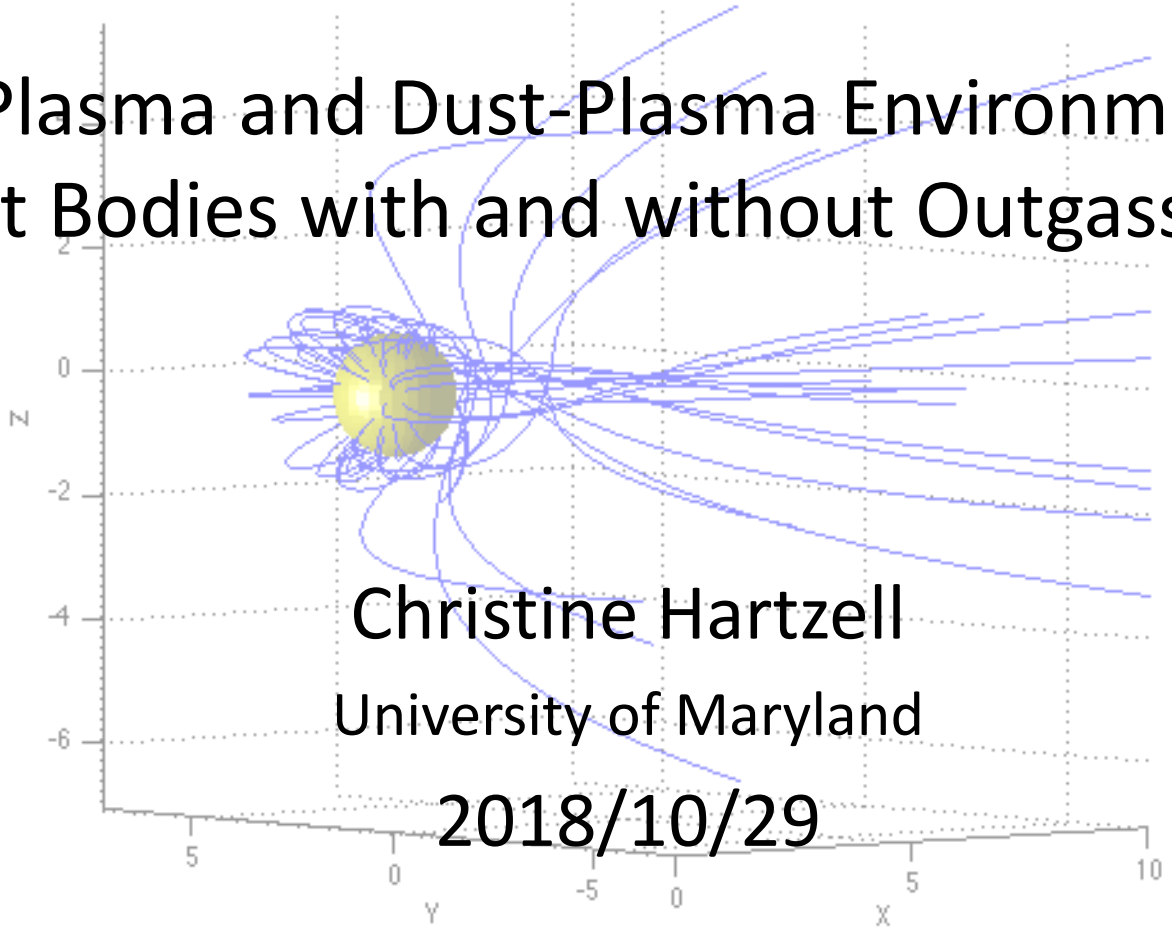
Plasma and Dust-Plasma Environment at Bodies with and without Outgassing



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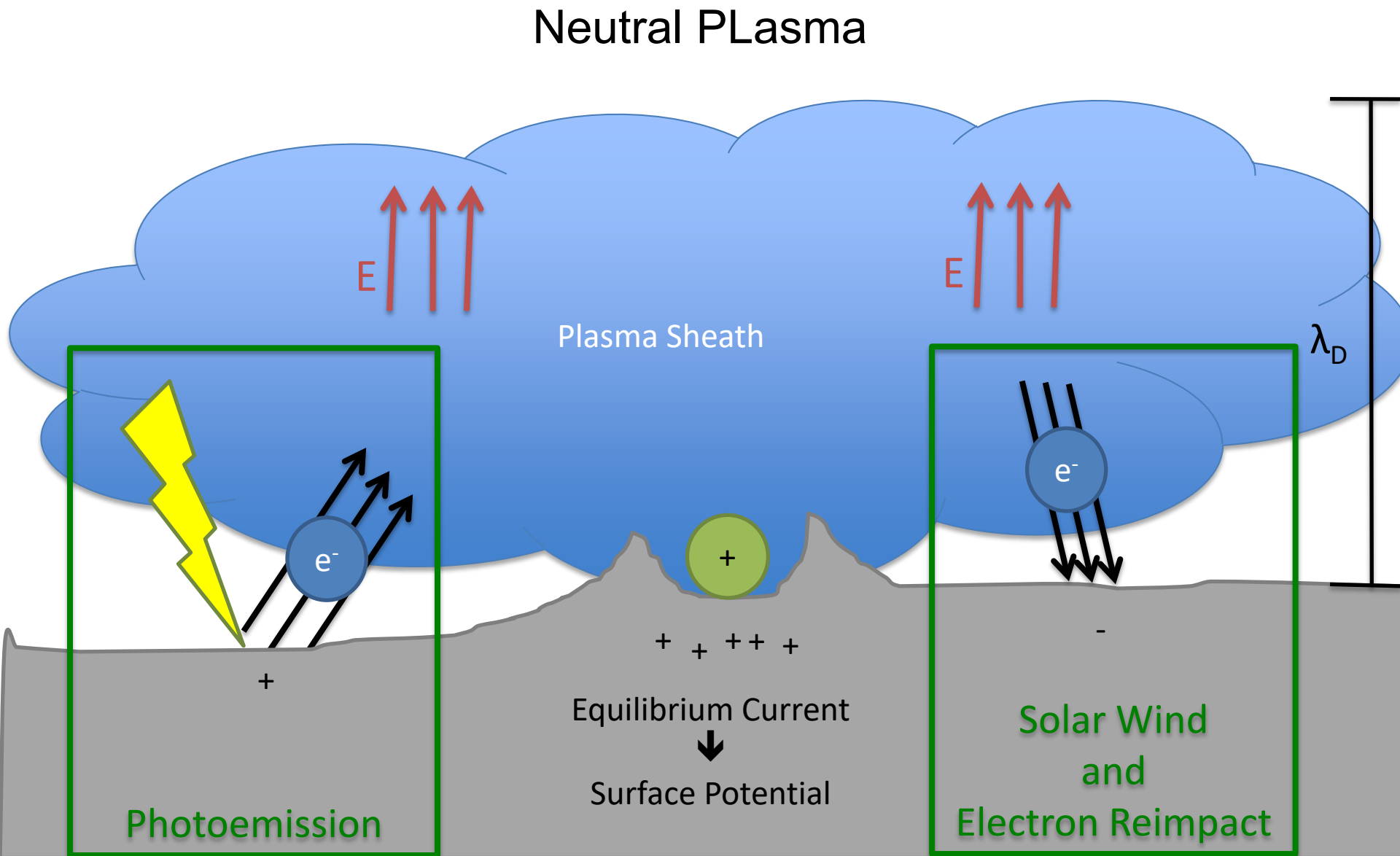
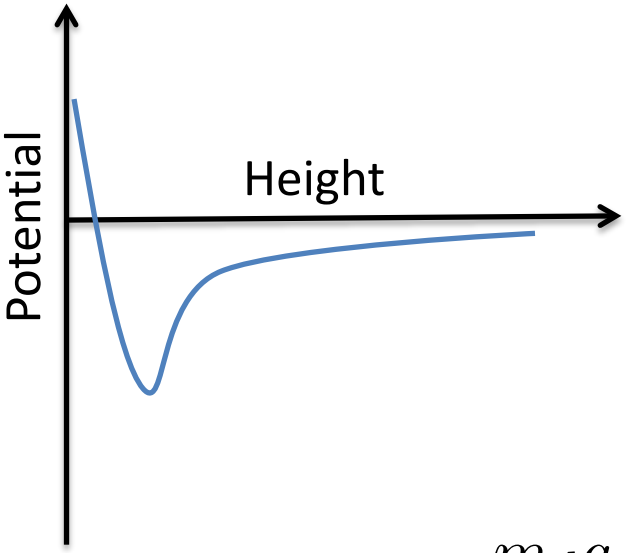
Intro to Electrostatic Dust Motion



Description of the System

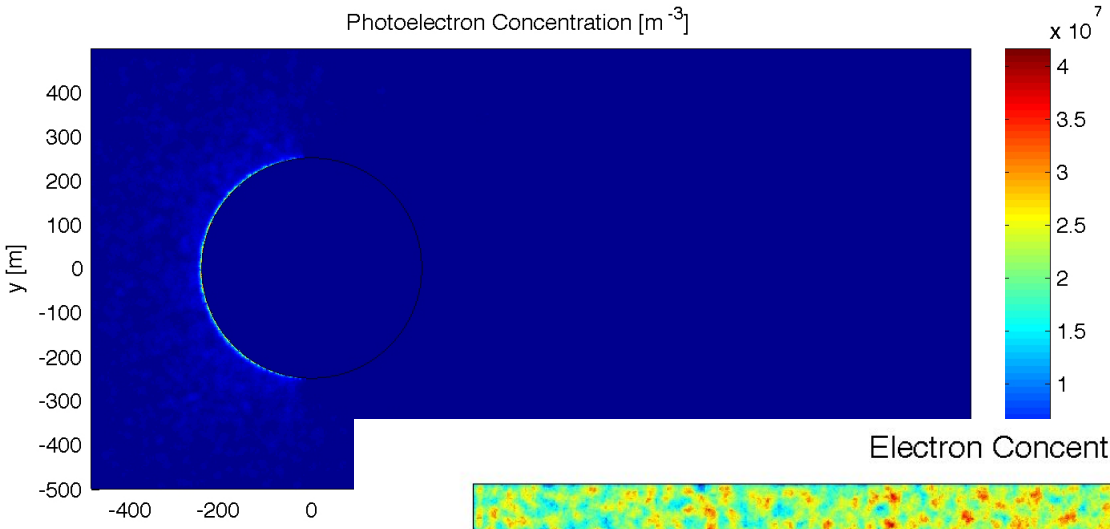
- Surface of an asteroid charges due to interaction with the solar wind ions, solar wind electrons and photoemission of the surface (neglecting any spacecraft charging effects)
- Photoemission current scales with $1/d^2$
- Plasma sheath potential may be monotonic or non-monotonic
- Strong electric fields likely to be present near topographical features causing shadow and sunlight to be in closer proximity



$$m_d\ddot{h} = qE - \frac{m_d g_s}{\left(\frac{h}{r_c} + 1\right)^2}$$

$$\dot{q} = \sum I(h, q)$$

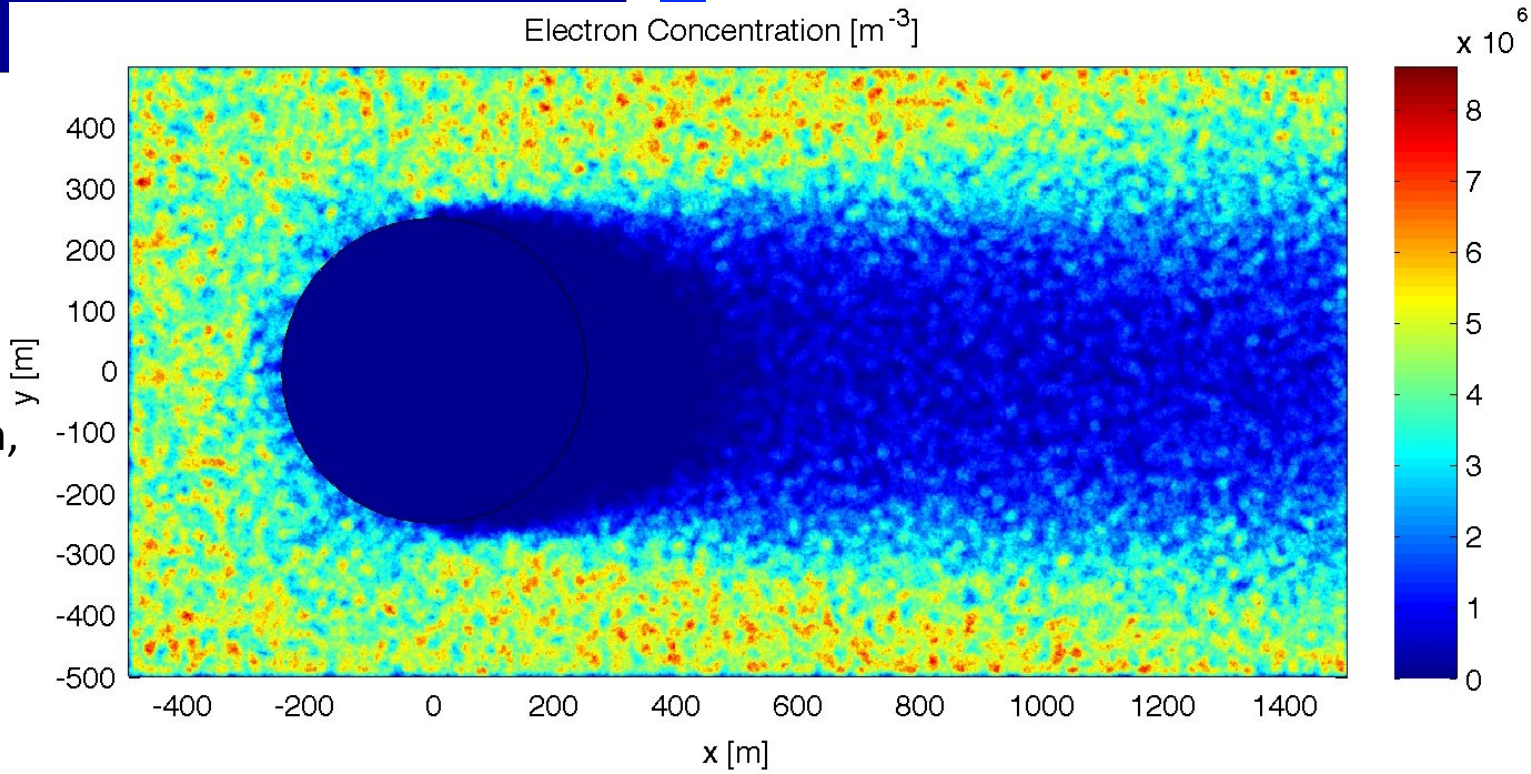
Treecode Plasma Model



- Solar wind flowing in +x direction
- Left half of sphere illuminated

Code Interface:

- Electric field => Electrostatic Force
- Species Densities => Current



Plasma Model:
Mike Zimmerman,
APL

Plasma Environment at Comets

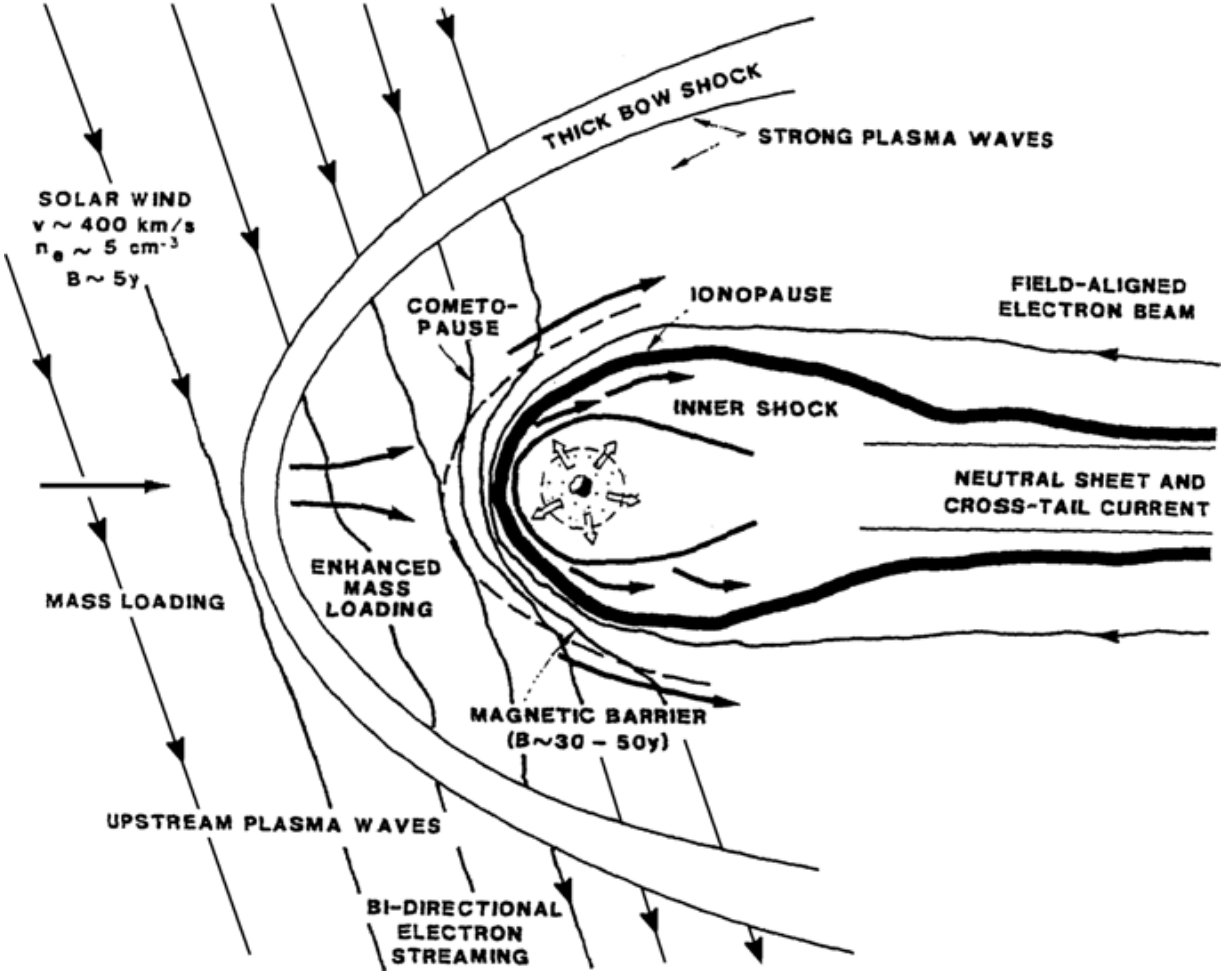


Figure 1. Schematic diagram of the particles and field environments of an actively outgassing comet (Mendis 1988).

As the production rate (activity) of the comet increases, the distance of the bow shock and ionopause from the nucleus also increases.

Observability

- Given the solar wind temperatures and velocities assumed for Rosetta, Mendis and Horanyi predicted:
  - well-defined bow shock when d<1.52AU
    - size=3,100km
    - max size at perihelion=15,000km
  - ionopause when d<1.61AU
    - size=1.4km
    - max size at perihelion=25km
- Observations:
  - magnetic field free region at 172km close to perihelion [36]

Giotto observed (at 0.89AU) the ionopause at 4,300km and bow shock at ~1M km [35]

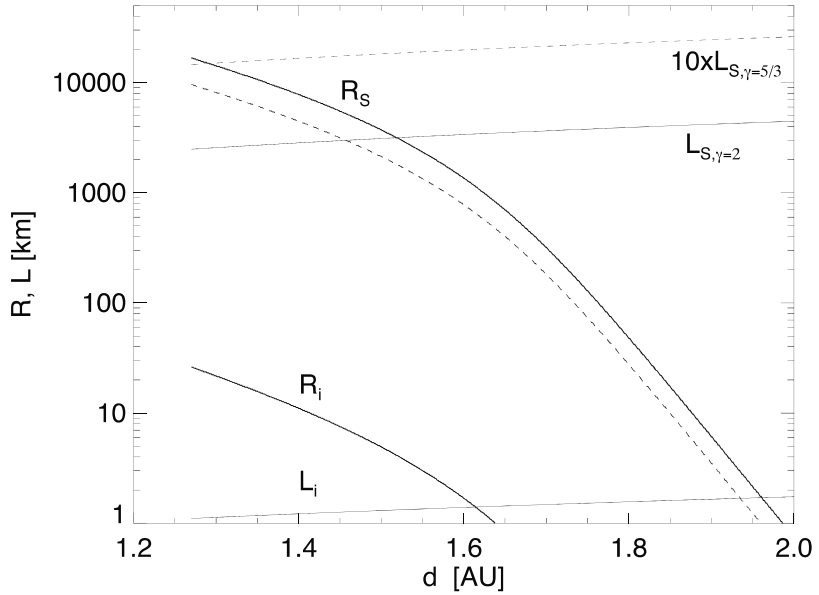
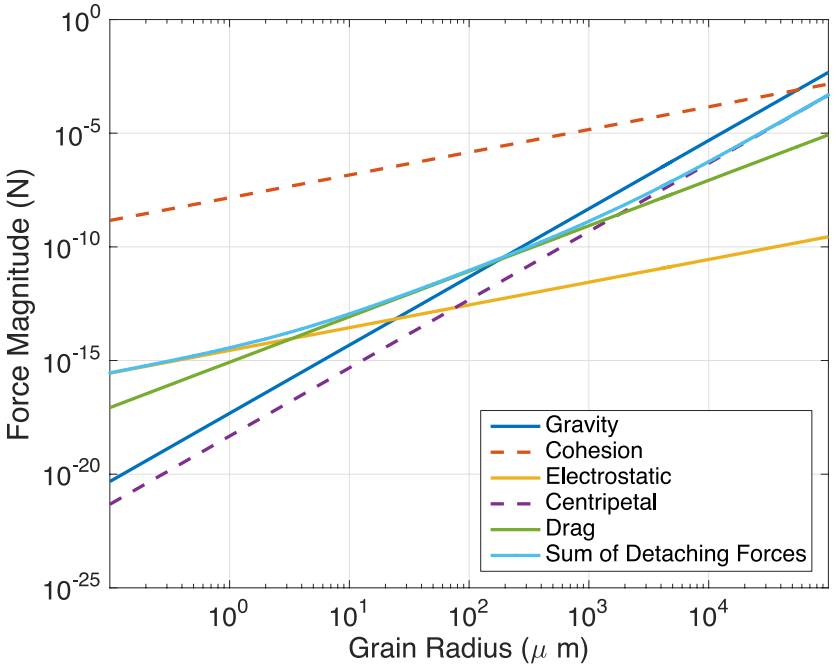


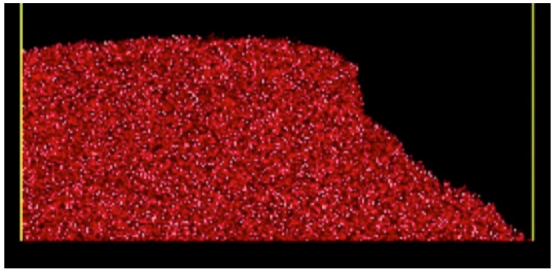
Figure 3. Heliocentric variation of the nucleo-centric distance of the bow shock, R_S, for both the $\gamma = 2$ (continuous line), the $\gamma = 5/3$ (dashed line) cases, and the ionopause, R_i, ahead of the comet. The Larmor radius of a picked up cometary ion just ahead of the shock, L_{iS}, $10 \times L_{iS}$, and just outside the ionopause, L_i, are also shown.

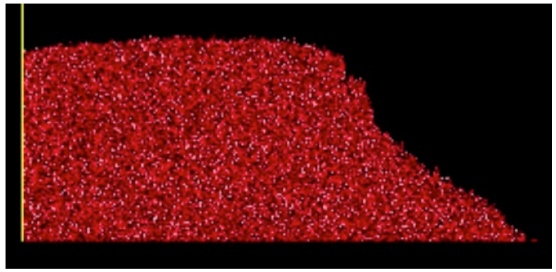
Dust Force Inventory

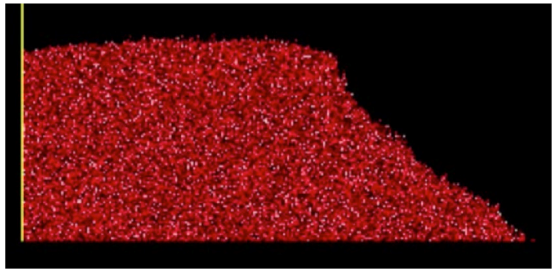
Relevant to formation of planetesimals and evolution/structure of observed bodies

- Gravity
- van der Waals Cohesion
- Electrostatics
- Solar Radiation Pressure
- Magnetics(???)
- Gas drag

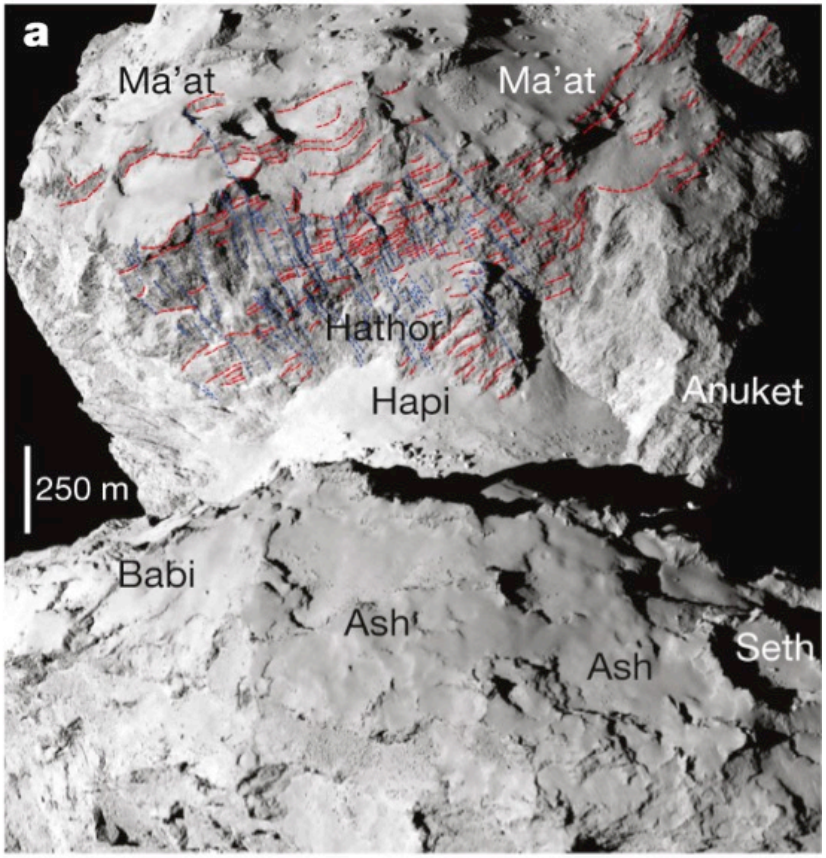








Questions?



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