Compact Electrostatic Dust Analyzer (CEDA) for Measuring Dust Lofting on Asteroids

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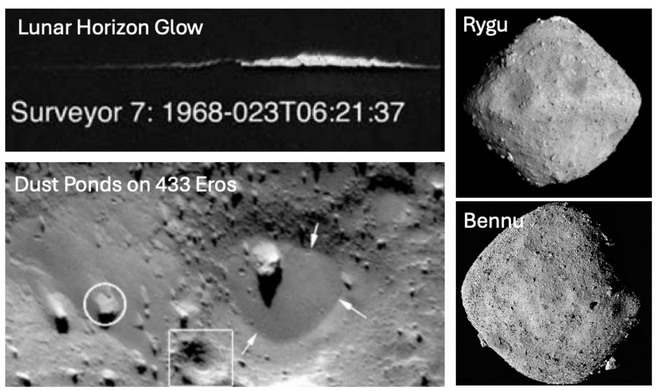
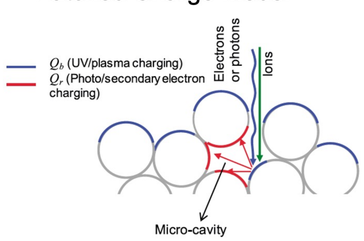
Motivation



- Electrostatic dust charging, lofting, and transport on airless bodies across the solar system is a longstanding problem.

Patched Charge Model



Dust Lofting in Laboratory

- Laboratory experiments greatly advanced the fundamental understanding of this electrostatic process

- To date, there are no missions that have explored the properties and efficiency of electrostatic dust lofting on any airless bodies.

- Due to low gravity on small asteroids, lofted dust particles may escape their parent bodies, resulting in profound effects on their surface properties (**e.g., lack of fine grains on Rygu and Bennu**).

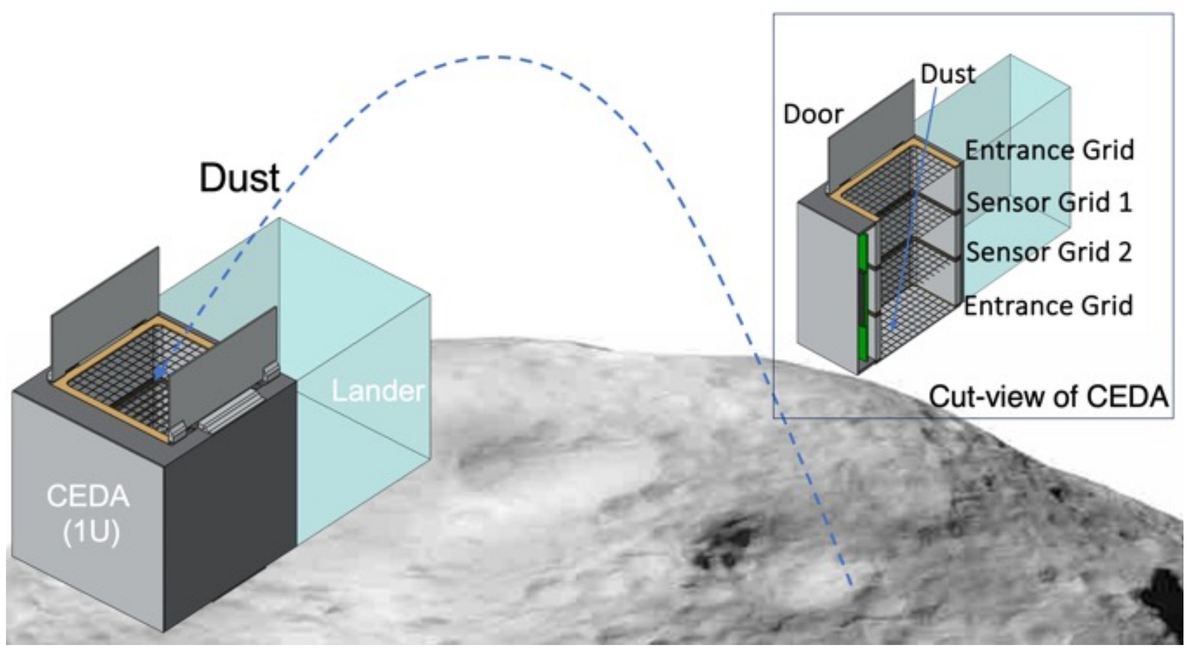
- **It is important to understand this electrostatic process and its effect on the regolith properties of asteroids to help future exploration and in-situ resource utilization (ISRU) on these bodies.**

Science Questions

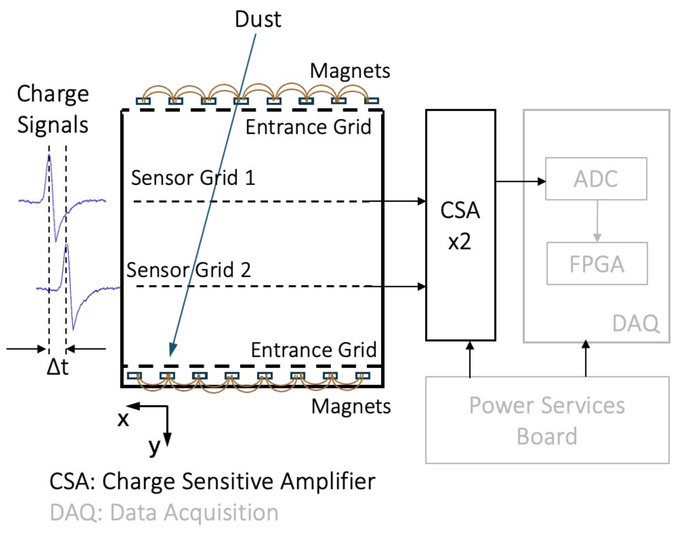
1) What are the velocity, charge, and size distributions, and the flux of electrostatically lofted dust on small airless bodies?

2) How does electrostatic dust lofting respond to changes in the solar wind plasma and UV radiation conditions?

CEDA Concept



- Hard-landing on the surface of small airless bodies in a size range of 1 - 5 km in radii
- Landing position independent



CSA: Charge Sensitive Amplifier
DAQ: Data Acquisition

Charge: 1.5 – 200 fC
Velocity: 0.05 – 5 m/s
Size: 2 – 200 μm in radius
Flux: 0 – 0.1 particles cm^{-2} s^{-1}

Power: ~3 W
Size: 1U (10 x 10 x10 cm)
Mass: ~1.5 kg

One technical challenge is to develop CSAs for ultra-slow dust particles (min: 0.05 m/s)

To increase CEDA's capability for more mission opportunities, the CSA can be extended to measure a larger velocity range, allowing CEDA to be accommodated on a spacecraft in-orbit to characterize escaped dust from the surface of an asteroid.

Summary

- A Compact Electrostatic Dust Analyzer (CEDA) will be developed to measure electrostatic dust lofting and transport on small airless bodies
- CEDA will be advanced from TRL 3 to TRL 6.
- The project is funded by NASA PICASSO (Award #: 80NSSC24K1421).