Compact Electrostatic Dust Analyzer (CEDA) for Measuring Dust Lofting from Asteroids. X. Wang[1,2], D. Hansen[2], J. Drouet[2], C. Fisher[2], A. Cabra[1,2], and M. Horanyi[1,2]. [1]NASA SSERVI's Institute for Modeling Plasma, Atmospheres and Cosmic Dust, [2]Laboratory for Atmospheric and Space Physics, Univeristy of Colorado Boulder, Boulder, CO. (Email: xu.wang@colorado.edu)

Introduction: Electrostatic dust lofting and transport is a longstanding problem, which has been indicated from observations on the surfaces of the Moon, asteroids, and other airless bodies. One of the observations is dust ponding formed on asteroids 433 Eros. Recent laboratory experiments have greatly advanced the fundamental understanding of the dust charging and lofting mechanisms [1]. This electrostatic process is expected to play a more pronounced role in changing the surface properties of small bodies, such as asteroids. Base on the lab results, a recent work [2] shows that electrostatically lofted dust can escape from smaller asteroids, which may explain the lack of fine dust particles observed on Rygu and Bennu. It is important to understand this natural surface process and its effects on the reglith properties on asteroids to help future exploration and in-situ resource utilization (ISRU) on these bodies. Here we introduce a Compact Electrostatic Dust Analyzer (CEDA) to measure dust lofting and transport on small airless bodies, including asteroids,

Technology Development: CEDA inherits from Electrostatic Dust Analyzer (EDA) developed for measuring dust lofting and transport on the lunar surface [3]. CEDA was originally designed to be deployed on the surface of an asteroid to measuring ultra-slow dust particles (0.05 – 5 m/s) lofted from the surface of asteroids and is designed for hard landing. Compared to the EDA, CEDA is more compact with the size approximately 1U (10 cm x 10 cm x 10 cm). Its estimated mass is ~1.5 kg and estimated power consumption is ~3 W.

As shown in Fig. 1, the CEDA sensor module consists of two sensor grids that are connected to two Charge Sensitive Amplifiers (CSAs) to directly measure the charge, velocity, and flux of electrostatically lofted dust particles that enter the instrument. Unlike EDA, CEDA does not have particle deflection electrodes, this mass (size) of lofted dust particles will be derived based on the relationships between the dust charge, velocity and size established from the laboratory experiments.

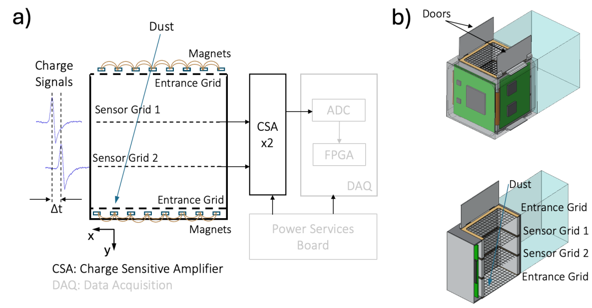

Fig. 1 Schematic of the CEDA instrument

CEDA is a sysmetric design with dust particles can enter the instrument from either end, allowing for hard landing. Once landed, a sun senor will determine which side of the door to open for dust to enter the instrument. The door is also used as a shade to prevent solar UV and solar wind ions from entering the instrument. Solar wind electrons will be shielded away using an array of permanent magnets. One of the key developments will be the CSA for ultra-slow particle detection. Several candidate circuits will be designed and tested to find an optimal solution.

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

Summary: CEDA is under development for measuring electrostatically lofted dust from the surface of asteroids. The CEDA measurements are expected to provide insights into how electrostatic dust lofting and transport, as a new process, contributes to the surface evolution of these small airless bodies and how this would help plan future exploration and ISRU on these bodies.

References: [1] Wang et al. (2016), GRL, 186, 104879; [2] Hsu et al. (2022), Nature Astronomy, 6, 1043-1050; [3] Wang et al. (2024), PSJ, 5:41.