

The ICAPS Sounding Rocket Experiment

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Abstract

The ICAPS Sounding Rocket Experiment was successfully flown on the TEXUS-56 rocket from Esrange (Sweden) on November 15th, 2019. The aim of the ICAPS experiment was to study the growth of fractal dust agglomerates under conditions equivalent to those in protoplanetary disks, in particular under microgravity conditions and in rarefied gas.

The ICAPS hardware and modes of operation

The ICAPS (Interactions in Cosmic and Atmospheric Particle Systems) experiment, flown in 2019 onboard a 6-minute suborbital rocket, consisted of an experimental chamber in which a tenuous gas atmosphere was held. Into this atmosphere, a dense cloud of micrometer-sized silica particles was injected. Around the center of the chamber, a four-ring Cloud Manipulation System (CMS) acted as a thermal trap for the dust cloud against any residual accelerations. Inside the CMS, the silica particles could freely move by translational and rotational Brownian motion, which led to frequent collisions among the grains. As the Brownian velocities are very small, each collision resulted in adhesion of the particles, which led to the growth of highly fluffy (fractal) agglomerates. These agglomerates and their translational and rotational Brownian motion were imaged by a long-distance microscope with a high-speed camera attached. To expand the field of view of the optical diagnostics, the CMS could also move the entire dust cloud back and forth. In this mode, the mass-

frequency distribution of the growing dust agglomerates can be obtained.

First results

Although the data analysis is still ongoing, it is already evident that the trapping and scanning modes of the CMS worked flawlessly, providing the science team with plenty of high-quality data on the Brownian motion and the resulting agglomeration of the dust particles (see Figure for examples).

However, another operational mode of the CMS, dynamical cloud squeezing, experienced a software malfunction so that the dust cloud was lost. As this failure was immediately detected during the flight, a re-injection of the dust cloud was initiated so that another two minutes of Brownian-motion-induced agglomeration could be achieved.

In the presentation, we will give a detailed description of the functionality and operation of ICAPS, show example movies of the Brownian motion and rotation of the agglomerates and will review the status of the scientific data analysis with respect to the growth speed, mass-frequency distribution and three-dimensional structure of the formed agglomerates.

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Figure Insert: Examples of the agglomerates found in the ICAPS suborbital flight.