EXCISS: EXPERIMENTAL CHONDRULE FORMATION ABOARD THE INTERNATIONAL SPACE STATION ISS.

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Introduction: The EXCISS experiment was developed to acquire new insights in one of the most enigmatic processes in planetary science — the formation of chondrules. The experiment will be carried out inside a 1.5 U Nanoracks Nanolab aboard the ISS in 2018. The purpose of the EXCISS experiment is to investigate if chondrule formation via "nebular lightning" [1–5] is a viable process. At conditions of long-term micro gravity synthetic forsterite (Mg_2SiO_4) dust particles will be exposed to electrical discharges.

The nebular lightning theory was introduced by Whipple et al. [1] and revised by different authors [2,3]. Recently, a study regarding the generation of lightning in the solar nebular was published [4] suggesting a further mechanism leading to nebular lightning.

Experimental Set-up: The experiment will be performed inside a NanoRacks NanoLab, an aluminium box with a size of approx. 10 x 10 x 15 cm^3. It is connected via USB to the ISS which provides up to 900 mA at 5 V. Well characterized dust particles consisting of synthetic forsterite Mg_2SiO_4 with a grain size of 80–120 µm will be levitating between two W-electrodes in an optically transparent glass sample chamber, filled with Ar at 100 mbar pressure. During the anticipated available runtime of 30 days, approx. 100 electrical discharges will be performed.

The limitation of available space challenges the implementation of such an experiment considering especially the generation of high voltages as well as the optical system. Due to the substantial peak power demands, EXCISS is one of the first experiments carried out in a NanoLab requiring batteries substantially bigger than coin cells. An appropriate circuit was designed in which a DC-DC converter is used to charge a capacitor to up to 600 V. After being triggered by a high voltage peak generated from an ignition coil, the stored energy is released into an arc discharge.

Summary and Outlook: With EXCISS, we expect new insights into the formation of chondrules and the aggregation of partly molten dust particles. Furthermore, this experiment will provide a basis for future experiments, in which a broad range of parameters (e.g. dust mineralogy and composition, particle size and shape, crystallinity, temperature) will be varied to understand the very diverse morphology, internal structure and thermal history of chondrules. After sample return, the dust particles and aggregates will be analyzed with a comprehensive set of state of the art micro- and nanoanalytical techniques.

References:

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