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(A7)Science Goals and Drivers for Future Exoplanet, Space Astronomy, Physics, and Outer Solar System
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Author: Ms. Marine Martin-Lagarde

Commissariat à l'énergie atomique et aux énergies alternatives (CEA), France

Mr. André Guerra

Ceia - Centro De Engenharia, Portugal

Mr. Jonas Greif

Friedrich-Schiller-Universität Jena, Germany

Mr. Fabio Fabozzi

University of Rome "La Sapienza", Italy

Mr. Mattia Reganaz

OHB System AG, Germany

Mr. John McClean

Imperial College London, United Kingdom

Ms. Lisa Jonsson

Department of Space Engineering, Lulea University of Technology, Sweden

Mr. Adrián Baños García

Universidad Politécnica de Madrid, France

Mr. Adrián Castanón Esteban

University of Innsbruck, Serbia

Ms. Marta Goli

Warsaw University of Technology (WUT), Poland

Dr. Anton Ivanov

Skolkovo Institute of Science and Technology, Russian Federation

Dr. Kieran Leschinski

University of Vienna, Austria

Ms. Victoria Lofstad

University of Oslo, Norway

Ms. Julia Seibezeder

University Graz, Austria

Ms. Esmee Stoop

Leiden University, The Netherlands

Mr. Gwenaël Van Looveren

KU Leuven – University of Leuven, Belgium

Mr. Jophiel Wiis

Niels Bohr Institute, University of Copenhagen, Denmark

MAGRATHEA: A PROPOSAL FOR A SATELLITE MISSION ON PROTOPLANETARY DUST
GROWTH EXPERIMENTS

Abstract

The process of planet formation, from dust to protoplanetary disks, is not very well understood. The physics of both particle growth in protoplanetary disks and small particle dust gravity dynamics are well studied. However, the link between the two, *i.e.* the growth gap between dust grains and mm-sized particles, is still not understood. Additionally, current methods cannot model the full complexity of interactions in this phase of planet formation. Therefore, experiments in microgravity are crucial to revealing the underlying physics. Previous experiments have several limitations in particular their short duration and constrained dimensions. Accurately representing the conditions in the protoplanetary disk, such as the dust particle mean free path and large spatial extent of the dust, is very demanding, especially with larger, longer duration experiments.

In order to create the best conditions for these experiments to be scientifically sound, with a reasonable solution, here we present a concept satellite with a 6 m^3 chamber. The payload bay provides different measurements of ongoing collision processes, and samples of collision products. Its modularity and capacity is designed to carry several instruments in a carousel, with 28 experiment canisters. Those experiments have a range of compositions (including silicates and Fayalite, both with or without ice layers), size distribution (between $1\text{ }\mu\text{m}$ and 100 mm), and shape properties, probing the conditions that could benefit grain growth. Each experiment will last up to one month allowing the record of approximately 10^6 collisions, with relative velocities of up to 5 mm/s , obtaining statistically meaningful results.

With the science objectives and requirements formulated, payload solutions were prepared, and a conceptual mission and spacecraft design was developed. Considering the experiment phase will last up to 5 years, and during that time external influences should be minimised, the three most complex systems are the structure, thermal control, and attitude control. After several trade-offs and a cost analysis, a 1000 kg spacecraft solution was reached, set on a 800 km Sun-synchronous orbit. The mission would cost around 438 MEuros .

The full work was developed during the 10 days of the 2017 Alpbach Summer School, by a group of fifteen young scientists and engineers, with various backgrounds, from all across Europe, with the support of two dedicated tutors. A concurrent engineering approach, with participants divided among several teams has been used to evaluate more than one scenario, and thus reach a concise solution.

Submitted for A7 symposium. Can also be considered for the A2.3 session.