EPSC Abstracts
Vol. 5, EPSC2010-655, 2010
European Planetary Science Congress 2010

The Hypervelocity Impact Facility and Environmental Simulation at the Open University

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Abstract

The Open University hosts a wide range of facilities capable of simulating a range of environments and processes of interest within the solar system. Here we present the range of facilities available for planetary and solar system simulation. These cover two broad areas; impact simulation and environmental simulation.

Specialist environmental chambers have been commissioned in order to simulate a range of solar system environments, providing combined simulation of pressure, temperature and solar illumination. Using these parameters the environments in space, the surface of Mars and airless/icy bodies in the solar system (among others) are simulated.

The Mars simulation facility consists of a large 0.9 m diameter chamber 1.8 m in length, providing pressure and temperature conditions representative of the surface conditions on Mars. This chamber is configured with the capability to incorporate large scale regolith experiments not usually possible within standard vacuum systems.

A smaller Mars simulation facility (0.7 m diameter chamber, 1 m in length) provides a 'cleaner' simulated martian environment with dedicated solar illumination, more applicable to instrument qualification and astrobiology experiments. The configuration also permits automated variation of the environment, such as thermal diurnal cycling etc. A separate high vacuum chamber provides simulation of the environments in space and around airless bodies such as Mercury and icy moons such as Europa etc.

The hypervelocity impact area of the facility is provided by two 'guns' and a Van de Graaff particle accelerator with an additional offline source.

Impacts are simulated using a two-stage light gas gun (LGG) [1, 2] capable of firing in a horizontal, oblique and vertical configuration into 3 different target chambers. Projectiles up to 4 mm in diameter can be launched at up to 5 km s^{-1}. Selection of target material allows the simulation of small-scale meteoroid impacts in space (onto e.g. spacecraft surfaces) and extrapolation to planetary impact events. The unique capability of the LGG to fire over a range of orientations (horizontal to fully-vertical) permits realistic surface analogue materials to be used as targets, for example simulating impacts into (loosely packed) planetary / asteroidal regoliths, layered materials and liquids.

In addition, a low speed gun currently in development will provide the capability of impacting larger projectiles (up to 15 mm diameter) at slower impact speeds over a variety of impact angles, to simulate events such as penetrator impacts.

Micrometeoroid impacts (~1 μm) are performed using a Van de Graaff accelerator. A 2MV voltage accelerates charged particles to many tens of km s^{-1} onto a target, simulating the high impact velocity of dust particles encountered in space [e.g. 3]. Such a facility can simulate the micrometeoroid weathering of atmosphereless body surfaces over long periods of time and also impact damage to spacecraft surfaces.

These facilities provide an extensive capability in simulating environments and processes of great scientific interest within the solar system, and are designed in such a way as to be available for both pure research and instrument testing purposes for the wider community in a collaborative manner. Here we present the full capabilities of the various facilities, and initial results from experiments.

References

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