Cometary Delivery of Lunar Water: A Parametric Study

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Analysis of hydrogen isotopes in lunar apatite suggests a cometary source for lunar water (Greenwood et al, 2011). Here, we simulate the impact on the Moon of a comet, 2km in diameter, traveling at 30km/s, at impact angles of 45 and 60 degrees. The two sets of results are compared in the short term (~30s after impact) and implications for long-term retention of cometary water are analyzed. The physics of the impact, such as crater formation and impact vaporization, are simulated using the SOVA hydrocode, and a Direct Simulation Monte Carlo (DSMC) code is used to track the evolution of the water vapor plume.

In the short term, the two plumes show significant differences in shape and velocity, with less downrange focusing of the vapor for the 60 degree impact, as well as lower downrange and upward velocities. A larger fraction of water travels at speeds lower than the lunar escape velocity for the 60 degree impact, and is thus more likely to be retained in a transient atmosphere. Temperature contours reveal that in both impacts, the cooling of the vapor cloud as it expands does not compensate for initial high temperatures.

In the long term (months after impact), 0.1% of the total comet mass was estimated to be deposited in lunar cold traps for the 45 degree impact (Stewart et al, 2011). A similar long term simulation is to be run for the 60 degree impact, with a view to investigating whether cometary delivery can account for current observations, and the influence of parameters such as impact angle, velocity and location on the extent and nature of final retention of water.

Presenter Information

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