On the Scaling of Small Impact Craters on the Moon

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Small projectiles derived from beyond the orbit of Mars interact dynamically with celestial bodies, so that they occasionally encounter the terrestrial planets of the inner Solar System. On Earth and in recent times, the vast majority of these small meteoroids burn up during their passage through the atmosphere. However, a smaller number of larger objects occasionally disrupt in the atmosphere causing blast wave damage (e.g., the Chelyabinsk meteor). For higher energies, these objects can reach the Earth's surface, leading to the formation of an impact crater structure (e.g., Barringer crater). A vital component of impact hazard assessment is the accurate estimation of the rate at which objects of different sizes collide with the investigated target object. The Moon is nearly the only object for which we can measure crater frequencies in a directly time-calibrated frame, thus, it is the ideal "witness plate" for constraining the flux of impactors in near-Earth space. The inactive, unprotected lunar surface is an excellent recorder of collisions with objects at all sizes. Meter-sized objects create craters tens of meters in size that are occasionally detected in orbital images.

Previous approaches on calibrating the lunar impact flux history of small bodies has encountered several challenges, for examples: (1) the crater size–frequency distributions (CSFDs) on same aged units show apparently both different densities and slopes (e.g., craters on melt pools vs. ejecta blankets), (2) it is still controversial on whether or not most of the small crater population on the Moon is dominated by secondaries, and (3) large uncertainties exist in linking the size of the final crater with both seismic energy detected by in situ Apollo missions and impact illumination detected by Earth-based telescope. One of the critical threshold in solving the problem is that the scaling of small impact cratering ($D<1$ km) is not well known. The shape of CSFDs for young lunar surfaces (rayed craters) show variation due to e.g., target properties, secondary cratering and saturation, and undermines the determination of ages of geologically young features by crater counting. We will present preliminary results from our observation of numerical simulations.