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Non-uniform bombardment by planetesimals on the Moon

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The Moon is in a state of the rotation-revolution synchronization. It is expected that the synchronous rotation of the Moon causes a spatial variation in crater production rate on lunar surface. The cratering rate varies as decreasing function of the angular distance from the apex of lunar orbital motion. The maximum and minimum cratering rates are at the apex and antapex, respectively. Previous studies [e.g., Wood, 1973, The Moon 8] have shown that the spatial variation in the cratering rate depends on two parameters; (1) the distance between the Earth and Moon, and (2) the mean encounter velocity of impactors. The ratio of the maximum rate to minimum rate increases with decreasing distance between the Earth and Moon and encounter velocity. However, previous studies are of limited value because of their simplifying assumptions (e.g., neglect of the Sun, or of the third dimension of space).

We simulate impacts of the Earth-Moon system with planetesimals which have low encounter velocities, and investigate a spatial distribution of impacts on the lunar surface. Planetesimals are fired at 15 Hill radii from the Earth, and their motions are calculated by using Hills equation [Hill, 1878, Am. J. Math. 1]. Hills equation is solved by means of the forth-order Runge-Kutta method. We investigate two cases with respect to the radius of the lunar orbit in order to understand the dependency on lunar orbital velocity; (1) present Earth-Moon distance, and (2) a half of the distance. The results show a conspicuous asymmetry between the impact rates on the leading and trailing sides in both the cases. The cratering rate on the leading side is 2 - 3 times higher than that of the trailing side. The degree of asymmetry of a half Earth-Moon distance is higher than that of the present Earth-Moon distance. The cratering rate as a function of angular distance from the apex shows a roughly sinusoidal pattern as expected theoretically.

There are asymmetries in the distributions of lunar maria and thickness of crust on the Moon. The density of impact basins on the nearside is approximately 2 times higher than that of farside. The ratio of the basin density is roughly consistent with the results from the simulation. However, the maximum is not at the apex but on the nearside. We propose a hypothesis that the present nearside was the leading side in a early time of the lunar history.