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The Detection of Impact Ejecta on the Lunar Surface

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Abstract

Based on the recent data, the LDEX (Lunar Dust EXperiment) sensor onboard lunar orbiter LADEE (Lunar Atmosphere and Dust Environment Explorer) already identified the existence of a dust cloud above the lunar surface down to 10 km [1]. Instruments placed on the lunar surface can monitor both secondary ejecta of interplanetary dust impact and lofted dust by electric force. This paper will fucus on the measurement for impact ejecta. Considering the trajectory of the ejecta, we suggest to mount the instrument with a elevation angle of + 15°. The detection of falling down ejecta population is considered as the main science goal. We recorded to add a articulate mechanism to allow the detector scanning by at lest ± 15°) in order to sperate the two ejecta populations.

1 Introduction

Hypervelocity impact are a fundamental process for the surface of lunar surface.The observed size distribution of lunar micro-craters usually do not agree with the interplanetary dust flux for particles which masses are not more than 10^{-10} g [2]. These microcraters probably created by the secondary ejecta impacts. Based on the experiment results from [3], the number of secondary impact pits from oblique impact angle is more than 2 orders of magnitude higher than normal impacts.

A former example instrument on lunar surface was LEAM (Lunar Ejecta and Meteorite Experiment) in Apollo 17 mission [4]. The instrument used three detectors: one faced to west and another one faced east, both with the elevation angles of 0°; the third mounted on the top of the instrument with an elevation angles of 90°. There are very limit number of ejecta grains were record by these detectors with the enter angle of ± 30° [5]. The difference between the ejecta flux obtained from lunar crater [2] and LEAM data [5] may be caused by the trajectories of the ejecta grains.

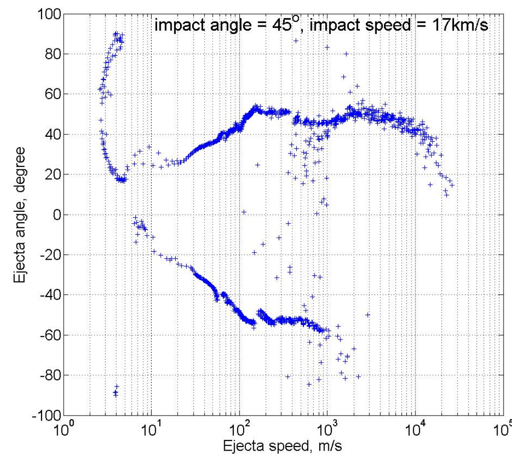

Figure 1: The distribution of ejecta incident angle and speed.

2 Ejecta Parameters

Autodyn14.0/2D software was used to study the ejecta velocity distribution above lunar surface. A sample result is shown in Figure 1 for projectile with 17 km·s^{-1} impact speed and 45° impact angle.

After impact, the individual ejecta fragments follow their own ballistic trajectories when assumed the grains are only effected by the gravity field (g = 1.62 m·s^{-2}). When put a detector above lunar surface, there are two cases for a ejecta grain flying into the detector: (1) on its direct way flying up from surface, as shown in Figure 2 (top), and (2) on its way falling down from apogee, as shown in Figure 2 (bottom). In the second case, the speed of ejecta has to be limited by first cosmic velocity of the moon (1.68 km·s^{-1}), as the ejecta with higher speeds will become a obiter of the moon and never fall down.

Figure 3 shows the entry angle od the second ejecta and effective distance for a detector at the height of 3 m above lunar surface with a elevation angle of 0°.

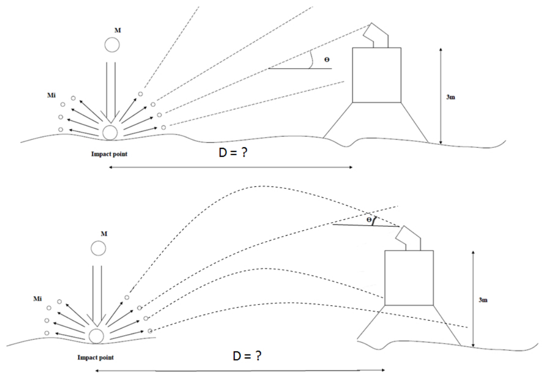

Figure 2: Impact generated ejecta cloud reaches the dust detector onboard a lunar lander.

We defined the effective distance is the pass from impact point to detector. In general, the incident angle of the ejecta of the detector can vary between 0° and + 90° when ejecta grains fly up to the detector. For this case, the effective distance is less than 100 meters. In contrast, when the ejecta grains fall down to the detector, they have a relatively narrow entry angles (-60° to -40°).

Figure 4 shows the effective distance for the detectors with different height above the surface. When ejecta fly up with positive angles from the lunar surface, the effective distance of the detector has a positive growth relationship with the its height, which means a detector mounted on the top of the lander has more chances to obtained the ejecta flying up from the lunar surface. There is almost no difference for the case when ejecta falling down from apogee.

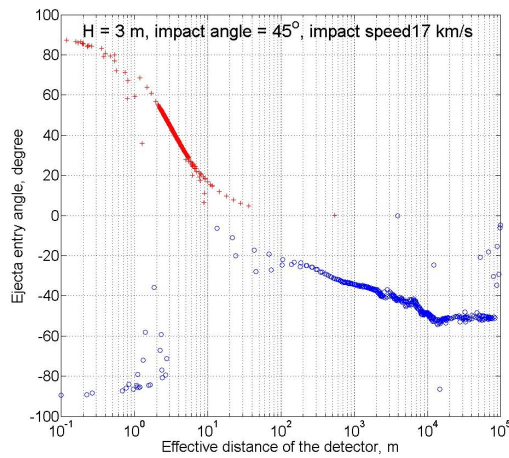

Figure 3: The ejecta angle and effective distance of the detector for the impact with angle of 45°. Red '+' are the ejecta flying up, and blue 'o' are the ejecta falling down.

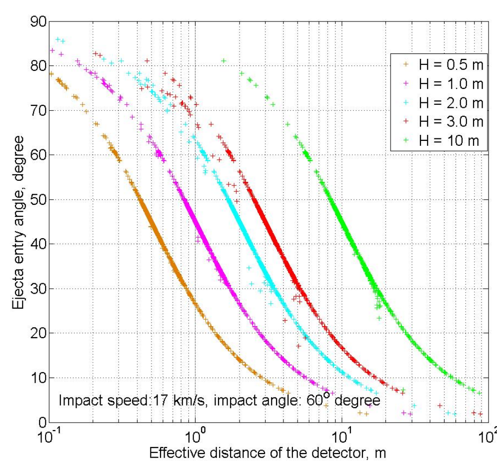

Figure 4: The ejecta angle (positive) and effective distance for the detectors with different height.

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