Estimate of Impact Crater Sizes for 2007 Geminids Lunar Impact Flashes

Masahisa Yanagisawa[1]; Hiromi Ikegami[2]; Masayuki Ishida[3]; Hideyoshi Karasaki[3]; Shinsuke Abe[4]; Jun Takahashi[5]; Kouji Ohnishi[6]

[1] Univ. Electro-Communications
; [2] Infomation & Communication Engineering, U.E.C; [3] none; [4] NCU, Taiwan; [5] Earth & Planetary Sciences, Kobe Univ; [6] Nagano Nat. College of Technology

http://www.yanagi.ice.uec.ac.jp/

Shooting stars are bright streaks due to the burn out of meteoric particles when they enter the earth's atmosphere at velocities of several tens of km/s. Since optical flashes are common in high velocity impact experiments in laboratory, flashes are expected for the impact of meteoric particles on the lunar surface. However, the flashes by average meteoric particles would be too faint to be observed from the ground because of the long distance between the earth and the moon. Large particles that cause the flashes bright enough to be observed from the ground (e.g. 1 kg) would be scarce, and the detection of the flashes had been thought very difficult. The lunar impact flashes were first detected and confirmed during the 1999 Leonids meteoric activity [1-3]. The flashes during the 2001 Leonids and 2004 Perseids activities have also been observed and confirmed [4-5]. Recently, 54 lunar flash candidates detected by a NASA observation system in US are reported [6].

During the Geminids activity on 14, 15, and 16 December 2007, many observers in Japan tried to detect the flashes due to the Geminids impacts on the moon. Three flashes (B, C, D) have been confirmed by multiple observers quite separated from each other. A flash (A) was detected simultaneously by two cameras in an observatory. These four flashes were all observed on 15 December (Table 1).

Table 1: Summary of 2007 Geminids Lunar Impact Flashes

Flash	Time(UT)	lat.	lon.	mag.	mass	impact angle	crater diameter
A	17:28:18	+1	-83	9	0.12 kg	51	4 m
B	17:54:25	-16	-62	6	1.80 kg	57	8 m
C	17:55:26	-17	-84	5	3.02 kg	42	9 m
D	19:08:10	-20	-75	5	5.34 kg	47	11 m

Selenographic latitude and longitude of the flashes in degrees are preliminary and their error would be more than 1 degree. Brightness magnitude (mag.), Geminids impact velocity of 33 km/s, and optical efficiency of 0.2 % [7] are used to calculate the mass of impactors. The optical efficiency is the ratio of the optical energy to the kinetic energy of an impactor. The impact angles measured from lunar local horizon are also shown in Table 1. The diameters of the craters excavated by the impacts are calculated by Gault's formula [8] assuming the density of both meteoroids and lunar material to be 1.6 g/cm^3 (the last column). Impact ejecta would be distributed widely beyond the crater size, and the traces of these impact events may be found by some lunar probes.

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