Large Meteoroid Impact on the Moon on 17 March 2013

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Since early 2006, NASA's Marshall Space Flight Center has observed over 300 impact flashes on the Moon, produced by meteoroids striking the lunar surface. On 17 March 2013 at 03:50:54.312 UTC, the brightest flash of an 8-year routine observing campaign was observed in two 0.35 m telescopes outfitted with Watec 902H2 Ultimate monochrome CCD cameras recording interleaved 30 fps video. Standard CCD photometric techniques, described in [1], were applied to the video after saturation correction, yielding a peak R magnitude of 3.0 ± 0.4 in a 1/30 second video exposure. This corresponds to a luminous energy of 7.1×10^6 J. Geographic Information System (GIS) tools were used to georeference the lunar impact imagery and yielded a crater location at 20.60 ± 0.17° N, 23.92 ± 0.30° W.

The camera onboard the Lunar Reconnaissance Orbiter (LRO), a NASA spacecraft mapping the Moon from lunar orbit, discovered the fresh crater associated with this impact by comparing post-impact images from 28 July 2013 to pre-impact images on 12 Feb 2012. The images show fresh, bright ejecta around an 18 m diameter circular crater, with a 15 m inner diameter measured from the level of pre-existing terrain, at 20.7135° N, 24.3302° W. An asymmetrical ray pattern with both high and low reflectance ejecta zones extends 1-2 km beyond the crater, and a series of mostly low reflectance splotches can be seen within 30 km of the crater – likely due to secondary impacts [2].

The meteoroid impactor responsible for this event may have been part of a stream of large particles encountered by the Earth/Moon associated with the Virginid Meteor Complex, as evidenced by a cluster of 5 fireballs seen in Earth's atmosphere on the same night by the NASA All Sky Fireball Network [3] and the Southern Ontario Meteor Network [4]. Assuming a velocity-dependent luminous efficiency (ratio of luminous energy to kinetic energy) from [5] and an impact velocity of 25.6 km/s derived from fireball measurements, the impactor kinetic energy was 5.4×10^9 J and the impactor mass was 16 kg. Assuming an impact angle of 56° from horizontal (based on fireball orbit measurements), a regolith density of 1500 kg/m^3, and impactor density between 1800 and 3000 kg/m^3, the impact crater diameter was estimated to be 8-18 m at the pre-impact surface and 10-23 m rim-to-rim using the Holsapple [6] and Gault [7] models, a result consistent with the observed crater.

References

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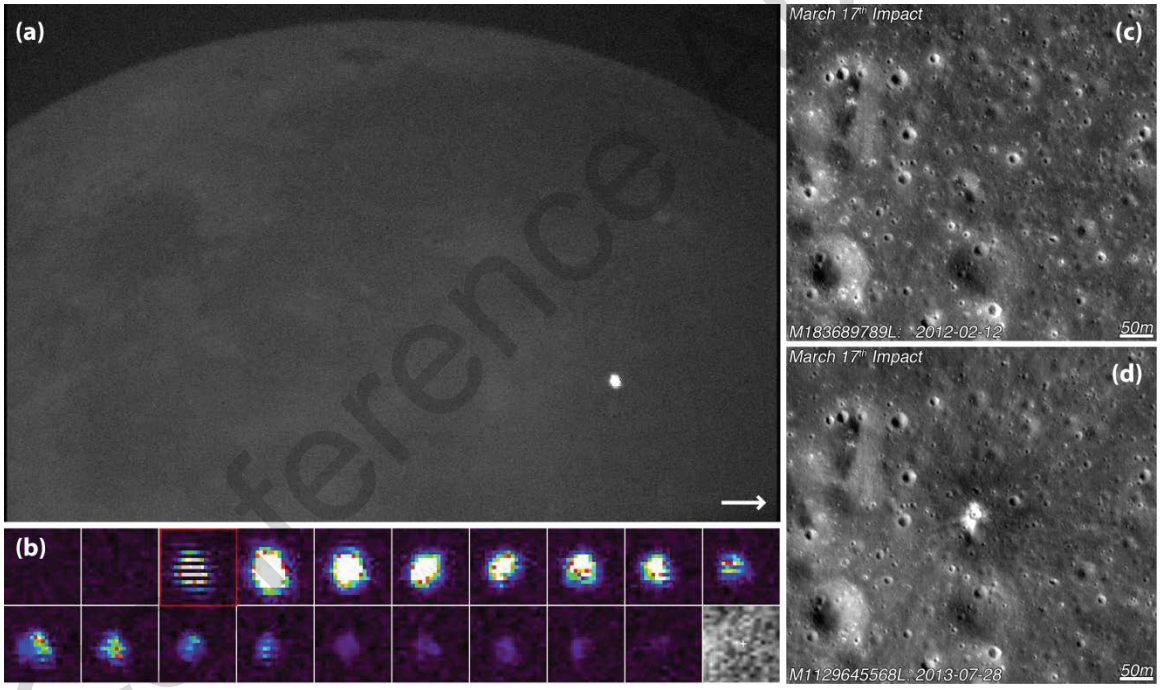

Figure 1. (a) Lunar impact flash seen on March 17. Width of the field of view is approx. 20 arcmin. Arrow indicates direction of selenographic north. (b) Impact flash time sequence, each square in the series is roughly 1.8×1.8 arcmin and covers 1/30 s. (c) Pre-impact and (d) post-impact lunar images from LRO [8].