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. GIS tools were used to georeference the lunar impact imagery and yielded a crater location at $20.60 \pm 0.17°$ N, $23.92 \pm 0.30°$ 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 (15 m inner diameter measured at 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 and the Southern Ontario Meteor Network. Assuming a velocity-dependent luminous efficiency (ratio of luminous energy to kinetic energy) from [3] 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 [4] and Gault [5] models, a result consistent with the observed crater.

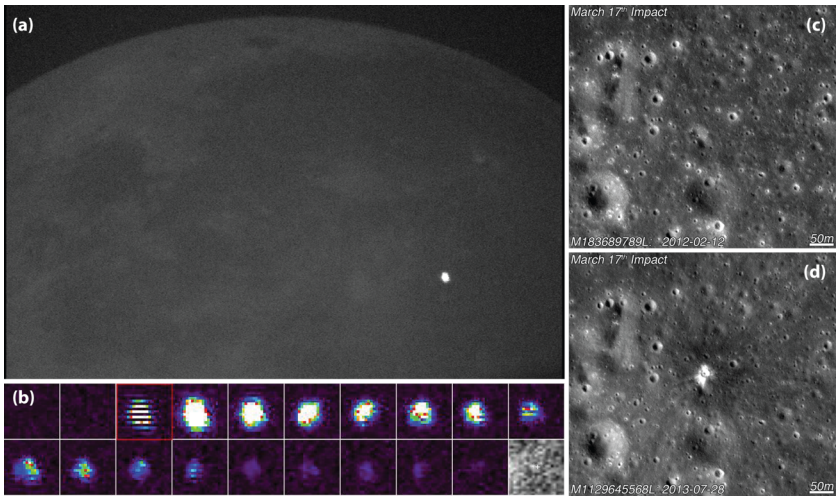

Figure: (a) Lunar impact flash seen on March 17. (b) Impact flash time sequence, each square covers 1/30 s. (c) Pre-impact and (d) post-impact lunar images from LRO [6].

References: [1] Suggs, R. M. et al. Icarus, submitted. [2] Robinson, M. S. et al. (2014) 45th LPSC, 2164. [3] Moser, D. E. et al. (2011) NASA/CP-2011-216469, 142. [4] Holsapple, K. A. (1993) Annu. Rev. Earth Planet. Sci. 21, 333. [5] Gault, D. E. (1974) In: A Primer in Lunar Geology, 137. [6] Robinson, M. (2013) LROC Featured Image, posted 14 Dec 2013. http://lroc.sese.asu.edu/news/index.php?/archives/843-New-Crater!.html