The first confirmed lunar impact flash observed from Brazil

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During the Geminids meteor shower in 2017, a campaign organized by BRAMON (Brazilian Meteor Observation Network) called on Brazilian amateur astronomers to monitor the Moon during the shower's peak night. Several people across the country set up their observation points and two teams, one in Araruna in Paraíba and another in Maceió in Alagoas, managed to register at 07:13:46 (UTC) on December 14, 2017, at the selenographic coordinates of 9.9° N and 45.4° E. This was the first impact lunar flash confirmed on video by Brazilian observers.

1 Introduction

Planet Earth is bombarded daily by dozens of tons of debris from space that enter its atmosphere and can be seen in the form of meteors (Murad and Williams, 2002). It is no different on the Moon. Space rocks may strike it at any moment, but since it has no atmosphere, the impact on its surface is direct, generating flashes that are commonly called TLP, or Transient Lunar Phenomena (Kim et al., 2015).

During a meteor shower, the likelihood of observing a TLP increases considerably (Rembold and Ryan, 2015), and it was during one such shower, the 2017 Geminids, that the National Lunar Impact Observing Campaign was launched in Brazil in order to monitor the Moon's surface on the day of the shower's peak and to detect possible meteoroid impacts on its surface.

The campaign was conceived when members of BRAMON (Brazilian Meteor Observation Network) realized that the Moon's altitude and phase during the shower's peak would place it in a privileged position for impact observation, according with Figure 1.

2 Organizing the Campaign

Once it was established that the window of opportunity would be on December 14th 2017, the campaign's organization got started and Brazilian amateur astronomers were called upon to take part in the event.

Live broadcasts were held to address technical aspects and communicate the event, explanatory texts about the campaign were shared on social media to gather the highest number of participants, and supporting material was put together for those who were interested in participating.

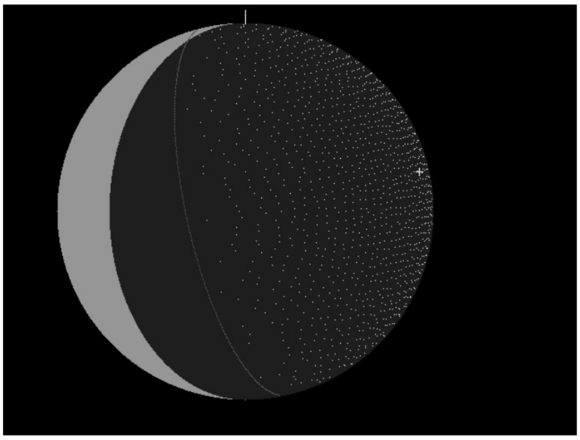

Figure 1 – Prediction of impact geometry for December 14, 2017 – generated by LunarScan 2.00

3 Methodology

To determine whether a lunar impact has actually occurred, the same phenomenon must be watched by two independent observers placed at different locations far from each other. This will eliminate the possibility of it not having occurred on the satellite's surface, but being otherwise caused by cosmic rays, satellite flares, meteors and other phenomena.

In order to confirm that the phenomenon seen by two different observers is really a TLP, a few criteria have to be met:

- Both events must have occurred at the same moment, which requires time synchronization between the computers used to perform the observations.
- Both events must have occurred on the same region of the lunar surface.
- Both events must have similar duration and magnitude when observed under the same conditions,

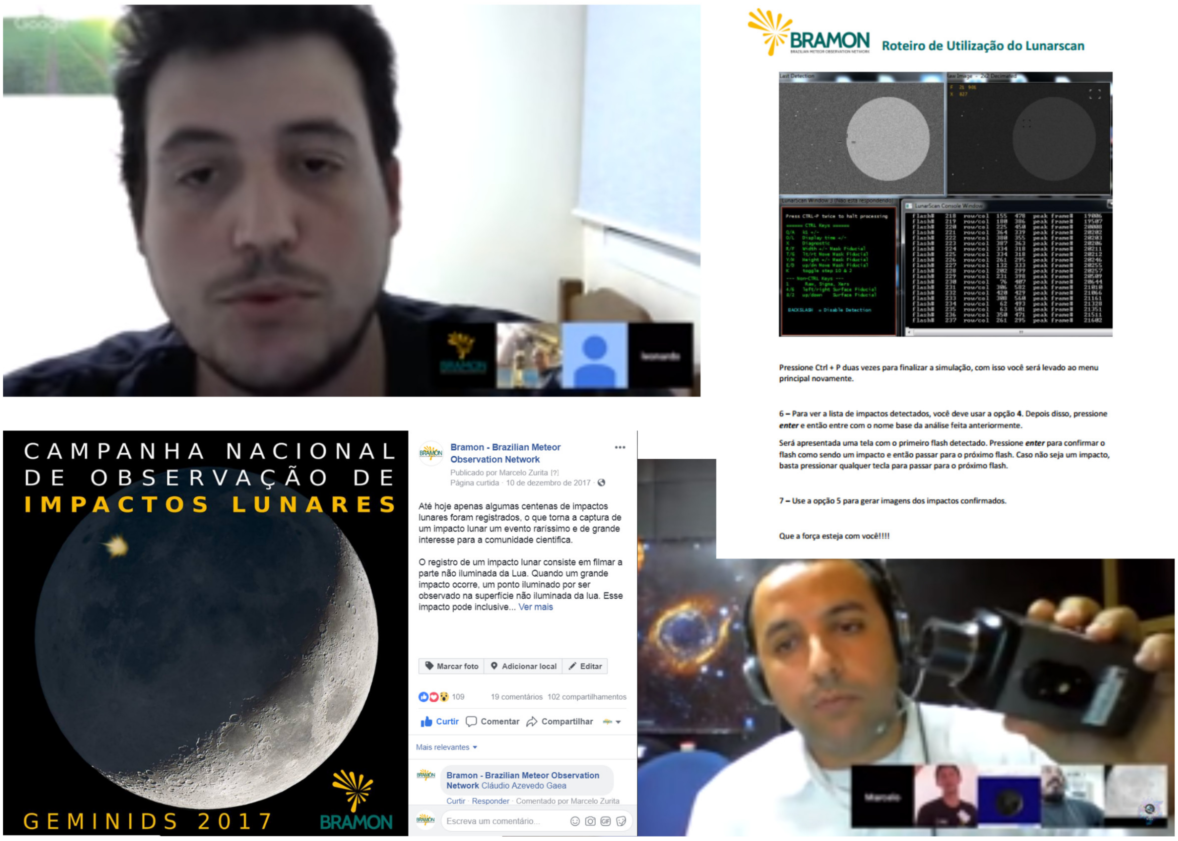

Figure 2 – Live broadcasts, call to amateurs in social media and LunarScan Tutorial in Portuguese

or after calibration when under different conditions.

The minimum equipment required to collect data is:

- A video camera or astronomical CCD with a frame rate of at least 24 frames per second.
- A minimum resolution of 640 × 480 pixels.
- A telescope equipped with automatic sidereal tracking.
- A computer with a fair amount of disk space.

Software used to capture and compress data:

- SharpCap (or equivalent) – Imaging.
- NTP (Network Time Protocol) – Time synchronization.
- LunarScan – Automated TLP search.

4 Results

Despite the unfavorable weather conditions, some observers managed to implement the TLP search with footage of the Moon recorded during much of the stipulated period. Among the observers, Marcelo Zurita (APA/BRAMON) as well as Romualdo Caldas (CEAAL/BRAMON) and David Duarte (CEAAL) succeeded in capturing a flash on the Moon's surface at 07:13:46 UT on Dec 14, 2017, caused by an impact at the selenographic coordinates of 9.9° N and 45.4° E.

David Duarte and Romualdo Caldas, from the city of Maceió, in the state of Alagoas, Brazil, at the geographical coordinates of 9°37'14.1" S and 35°43'12" W, at a height of 45 m had recorded the flash using a 200mm F/10 Schmidt-Cassegrain Telescope (MEADE LX90-SC 8-inch) with the computerized mount NexStar 8SE and ZWO ASI 1600MM-Cool camera, which is monochrome and cooled, bearing a 4/3" CMOS sensor working at 5 frames per second in 1320 × 1320 resolution.

Marcelo Zurita, from the city of Ararura, in the state of Paraíba, Brazil, at the geographical coordinates of

Figure 3 – Setups used in Moon footage. Left: Skywatcher 130mm F5 + Samsung SCB 2000 camera. Right: Meade LX80 8" + ASI 1600 CCD

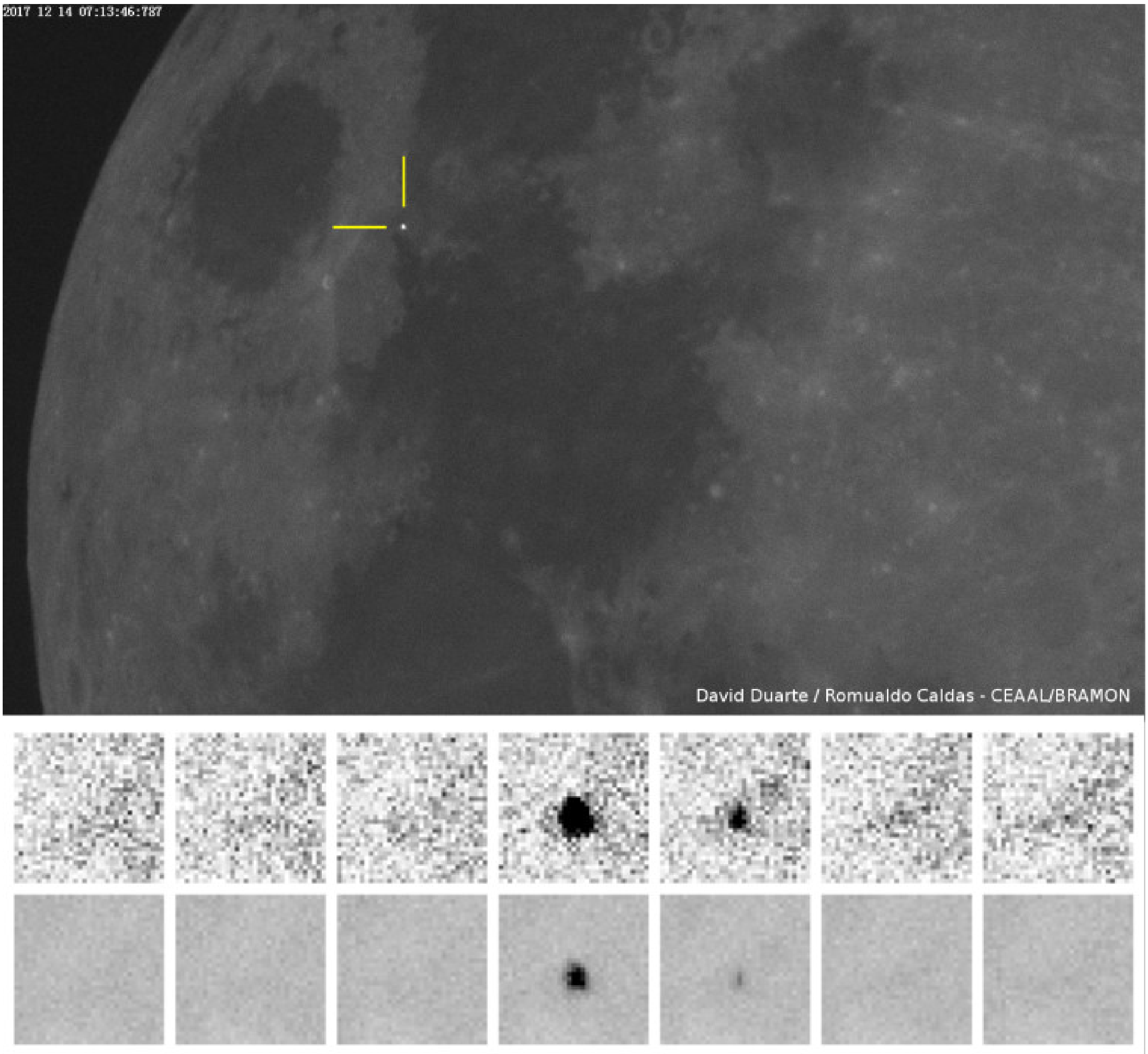

Figure 4 – Observer A: David Duarte (CEAAL) & Romualdo Caldas (CEAAL/BRAMON). Observer's Site: Maceio, AL, Brazil / Lat: -9.6205, Long: -35.7200. Instruments: Schmidt Cassegrain MEADE 8" + ASI 1600 Mono Cooled Camera.

6°27'8.28" S and 35°40'23.52" W, at a height of 185 m had recorded the flash using a 130 mm F/5 Newtonian Telescope (Skywatcher 130) with the motorrized mount Orion EQ3-2 and a modified Samsung SCB 2000 security camera (without IR filter), bearing a 1/3" CCD sensor working at 30 frames per second in 720 × 480 resolution.

A detailed analysis of impact location was made by amateur astronomer Avani Soares. The high resolution images of LRO (Lunar Reconnaissance Orbiter) available in NASA website[1] was superposed with flash image recorded by David Duarte and Romualdo Caldas resulting in location pointed in Figure 6:

Both videos was analyzed to extract light curve based in three reference stars recorded during moon monitoring session. The resulting brightness of flash was calculated to 7.1 magnitude and the light curve is shown in Figure 7.

[1] https://lunar.gsfc.nasa.gov/

5 Next Steps

All the data collected are being analyzed to obtain more detailed information about this first recorded impact. A request was sent to NASA to get new images on impact area through LRO. From these images it will be possible to search for a probable new small crater originating from this event.

Based on the success of the first campaign, another 3 efforts were scheduled for 2018, for Lyrids on April 21 and 22, Perseids on August 13 and 14 and for the Geminids on December 14. Thus comes enhancing the technique, gathering more observers and encouraging lunar observation and TLP searching.

Figure 5 – Observer B: Marcelo Zurita (APA/ BRAMON). Observer's Site: Araruna, PB, Brazil / Lat: -6.4523°; Long: -35.6732°. Instruments: 130mm f/5 newtonian + SCB 2000 Camera.

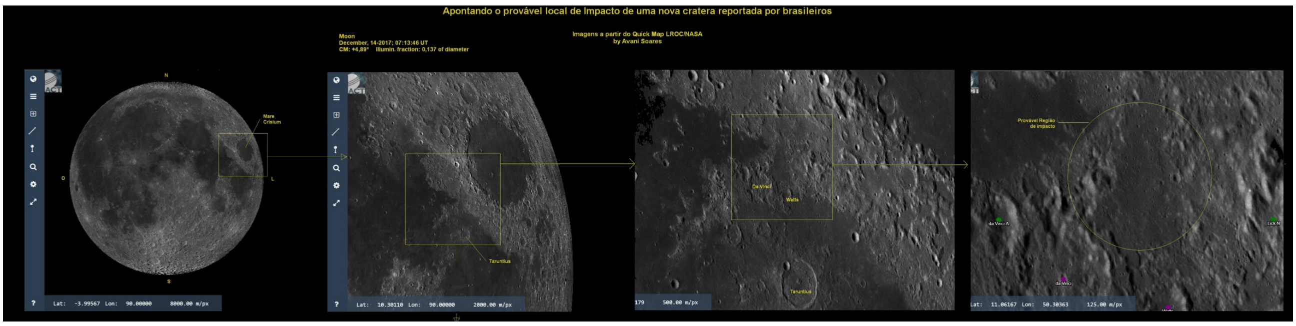

Figure 6 – Pointing the probable impact location Produced by Avani Soares, a Brazilian amateur astronomer from LRO images

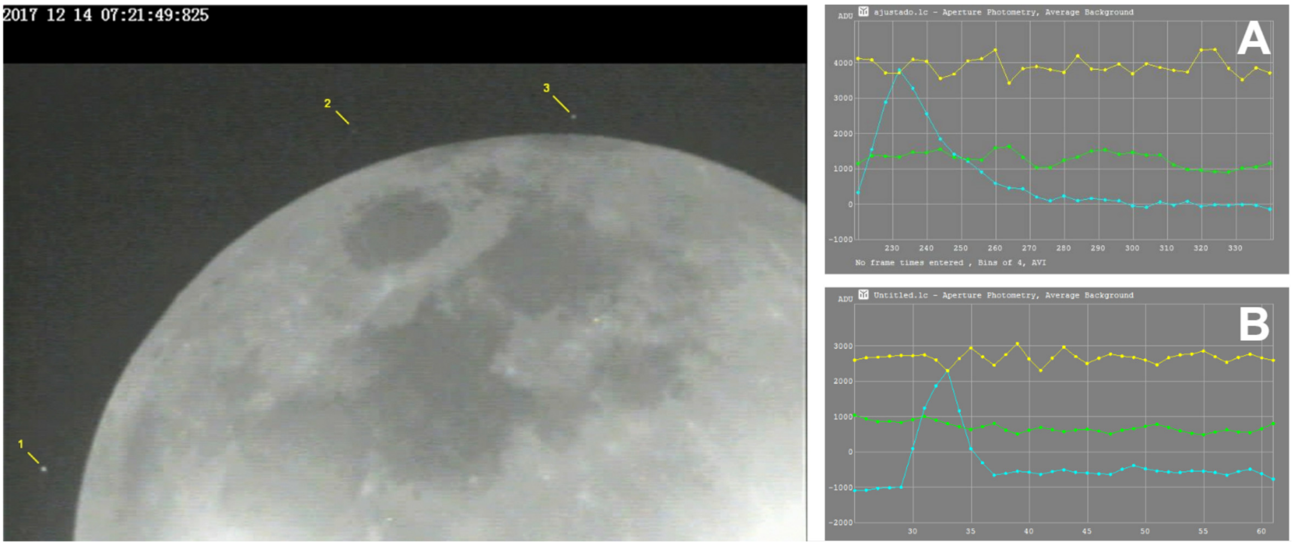

Figure 7 – Left: Reference Stars used to determination of impact flash magnitude. Right: Photometric analysis showing typical light curve of a lunar impact for both observers (A: David Duarte & Romualdo Caldas; B: Marcelo Zurita)

References

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