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Lunar Impact Flashes identified during the 2012 and 2013 Perseids

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Abstract

We present the results of our Moon impact flashes detection campaigns performed around the maximum activity period of the Perseid meteor shower in 2012 and 2013. Just one flash produced by a Perseid meteoroid was detected in 2012 because of very unfavourable geometric conditions, but 12 of these were confirmed in 2013. The visual magnitude of the flashes ranged between 6.6 and 9.3.

1. Introduction

Since the cross section of meteoroid streams is larger than the Earth-Moon distance, the chances for impact flashes detection is higher during the activity period of major meteor showers, such as for instance the Perseids. The first confirmed lunar impact flash produced by a meteoroid belonging to the Perseid meteoroid stream was recorded and analyzed by Yanagisawa et al. [1]. The analysis of this single event suggested that the luminous efficiency for Perseid meteoroids would be of about $2.1 \cdot 10^{-4}$, which corresponds to the lower limit found for this parameter from the observation of Leonid lunar impact flashes [2, 3]. However, the most likely value found by Bellot Rubio et al. was of about $2 \cdot 10^{-3}$, which is also the value employed by Ortiz et al. [4] to determine impact fluxes on Earth, and very close to the $1.5 \cdot 10^{-3}$ value taken by other researchers [5]. So, additional observations and analysis of Perseid impact flashes would be desirable in order to better constraint the value of this parameter for meteoroids from this stream. Here we present the results derived from the Moon impact flashes monitoring campaigns developed by our team during the maximum activity period of the Perseid meteor shower in 2012 and 2013.

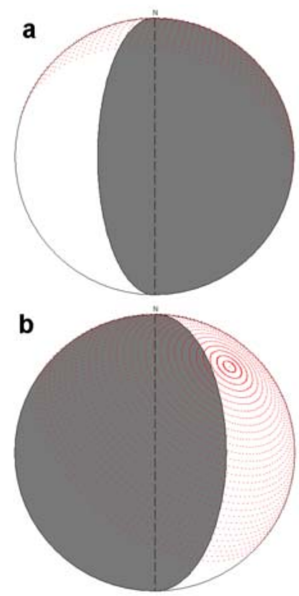

Figure 1. The lunar disk on 2012 Aug. 12 (a) and 2013 Aug. 12 (b). The white region corresponds to the area illuminated by the Sun. The gray region is the night side as seen from our planet. The dotted region delimitates the area where Perseids meteoroids could impact.

2. Instrumentation and methods

Our lunar impact flashes monitoring project is being developed from two different locations in Spain. Thus, from our observatory in Sevilla (latitude: 37.34611 ºN, longitude: 5.98055 ºW, height: 23 m above the sea level) we operate two identical 0.36 m Schmidt-Cassegrain telescopes, but also two smaller Schmidt-Cassegrain telescopes with a diameter of, respectively, 0.28 and 0.24 m are available. All of them are manufactured by Celestron. On the other hand since 2013, a 40 cm newtonian telescope is operated at La Hita Astronomical Observatory, in central Spain (latitude: 39.56833 ºN, longitude:

3.18333 ºW, height: 674 m above the sea level). Each telescope employs a high-sensitivity CCD video camera (model 902H2 Ultimate, manufactured by Watec Corporation). These devices employ a Sony ICX439ALL 1/2" monochrome CCD sensor and produce interlaced analogue imagery according to the PAL video standard. Thus, images are obtained with a resolution of 720x576 pixels and a frame rate of 25 frames per second (fps). GPS time inserters are used to stamp time information on every video frame with an accuracy of 0.01 seconds. Besides, f/3.3 focal reducers manufactured by Meade are also used in order to increase the area monitored by these devices. The telescopes are tracked at lunar rate, but they are manually recentered when necessary.

3. Preliminary results

In order to determine which area of the lunar disk should be monitored to increase the chance of detecting impact flashes produced by Perseid meteoroids, we employed the MIDAS software [6]. In 2012 the impact geometry of Perseid meteoroids was very unfavourable, since particles from this stream mainly hit the far side of the Moon (Fig. 1a). Despite this, an impact flashes observing campaign was organized during the waning crescent Moon between August 12d01h30m and August 14d05h00m UTC, with the Moon age ranging between 24.21 and 26.18 days and the disk illumination from 29 to 13 %, respectively. This corresponded to a total observing time of about 8.5 hours. The Moon was covered by clouds around 20% of this time, and bad weather did not allow us to extend the campaign before August 12 or after August 14. Thus, the effective observing window during this campaign corresponded to 6.9 hours. The total area monitored by each telescope was calculated with the MIDAS software. This area was $(4.1 \pm 0.4)\cdot 10^6$ km^2 for the 0.36 cm SC telescopes and $(7.7 \pm 0.7)\cdot 10^6$ km^2 for the 0.28 cm SC telescope. In 2013, however, the situation was far more favourable, since the observing campaign was developed under clear skies and the impact geometry was much more suitable (Fig. 1b). This time our monitoring was developed during the waxing crescent Moon from August 11d20h02m UTC to August 13d22h20m UTC (Moon age between 4.75 and 6.88 days and disk illumination between 23 and 44 %, respectively). The total observing time was of around 6.4 hours. The area monitored on the Moon by each telescope was $(5.6 \pm 0.5)\cdot 10^6$ km^2 (0.35 cm SC), $(7.4 \pm 0.7)\cdot 10^6$ km^2 (0.28 cm SC) and $(5.1 \pm 0.5)\cdot 10^6$ km^2 (40 cm newtonian).

Just one impact flash was detected and confirmed during the 2012 campaign. This event took place on 2012 August 13 at 3h55m08s UTC (Fig. 2). The selenographic coordinates of the impact were 25.2 ± 0.2 ºN, 83.4 ± 0.9 ºE. During the 2013 campaign the number of confirmed impact flashes was 12. The position of the events recorded during both campaigns is shown in Fig. 2. All of them were short in duration (between 0.02 and 0.16 seconds), with magnitudes ranging between 6.6 and 9.3. In our talk we will present the main results derived from this research in relation to the inferred value for the luminous efficiency, the mass of the impactors, and the diameter of the craters generated on the lunar surface. In addition, we will present a criterion to establish, from a statistical point of view, the likely origin of impact flashes recorded on the Moon.

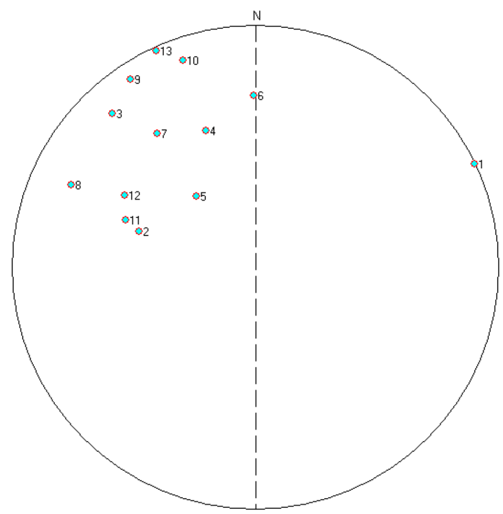

Figure 3. Position of the lunar impact flashes confirmed during the 2012-2013 Perseid campaigns.

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