PRELIMINARY RESULTS FROM THE 2011-2012 MOON IMPACT FLASHES MONITORING CAMPAIGN. J.M. Madiedo[1, 2], J.L. Ortiz[3] and N. Morales[3]. [1]Depto. de Física Atómica, Molecular y Nuclear, Facultad de Física, Universidad de Sevilla, 41012 Sevilla, Spain, madiedo@uhu.es. [2]Facultad de Ciencias Experimentales, Universidad de Huelva, Avda. de las Fuerzas Armadas S/N. 21071 Huelva, Spain. [3]Instituto de Astrofísica de Andalucía, CSIC, Apt. 3004, 18080 Granada, Spain.

Introduction: The identification and analysis of flashes produced by the impact of meteoroids on the lunar surface is one of the techniques suitable for the study of the flux of interplanetary matter impacting the Earth. The first attempts to identify impact flashes produced by large meteoroids on the lunar surface by means of telescopic observations date back to 1997 [1]. Thus, impact flashes have been unambiguously detected during the maximum activity period of several major meteor showers by using this technique, and flashes of sporadic origin have been also recorded [2-9]. This method has the advantage that the area covered by one single detection instrument is much larger than the atmospheric volume monitored by meteor detectors on Earth. It can be employed when the illuminated fraction of the lunar disk varies between 10 and 60 %, i.e., during the first and last quarters. At least two telescopes must operate in parallel imaging the same area on the Moon in order to discard false detections produced by other phenomena such as, for instance, cosmic rays.

Our team is performing a monitoring of the night side of the Moon from our observatory in Sevilla. This location provides very favourable statistics of clear nights per year. We employ several telescopes equipped with high-sensitivity CCD video cameras and we have also developed our own software to identify and analyze impact flashes. Here we present a preliminary analysis of the main lunar impact flashes recorded during our 2011 and 2012 campaigns.

Instrumentation and data analysis methods: For impact flashes detection we employ an 11" and two 14" Celestron SC telescopes, all of them endowed with f/3.3 focal reducers and Watec 902H Ultimate CCD video cameras operating in PAL mode. These generate interlaced video files with a resolution of 720x576 pixels and a frame rate of 25 fps. With this configuration the limiting stellar magnitude is of about 12 and we approximately monitor about $5.8\cdot10^6$ km^2 ± 10% on the lunar surface. Large enough lunar features are easily visible in the earthshine and these can be used to determine the selenographic coordinates of impact flashes.

The images taken by the CCD video cameras are stored and digitized on multimedia hard disks as AVI video files. GPS time inserters are used to stamp time on every video frame with a precision of 0.001 seconds. These video files are analyzed with our MIDAS software (Moon Impacts Detection and Analysis Software). This is Microsoft Windows application developed under C++ computer language that automatically detects flashes produced by the impact of meteoroids on the lunar surface [10]. Detection algorithms have been recently improved in order to allow for a more efficient detection of flashes. For confirmed impacts a photometric analysis is performed and the software also establishes their likely origin by trying to link them to a given known meteoroid stream or to a sporadic source.

Figure 1. Impact flash recorded during the activity peak of the Perseid meteor shower on Aug. 13, 2012 at 3h55m07.9s UTC. Top: image taken by a C14 telescope. Bottom: image taken by a C11 telescope.

Preliminary results: The main impact flashes identified so far are listed in Table 1. Most of them have been associated to sporadic sources. However, the events recorded on February 26, 2012 and March 27, 2012 took place near of the maximum peak of the δ-Leonids (DLE) and the Virginids (VIR), respectively. In both cases the geometry was favourable and the selenographic coordinates of the flash are compatible with these radiants. Besides, both events recorded on October 20, 2012 can be clearly associated to the Orionids (ORI). On the other hand, we performed a monitoring during the activity peak of the Perseid meteor shower in 2012, although the geometry was very unfavourable for this stream. Despite of this, we could confirm a flash produced by a PER meteoroid on August 13 (Figure 1).

Date and time (UTC)	Selenographic coordinates	Dur. (s)	App. mag.	Mass (g)	Source
9/Apr/2011 20:38:08	Lat: 24.4º Lon: -64.2º	0.080	8.0	101	SPO
9/Apr/2011 20:52:44	Lat: -26.7º Lon: -45.0º	0.040	8.5	32	SPO
11/Apr/2011 0:05:06	Lat: -12.4º Lon: -55.9º	0.040	8.2	41	SPO
9/May/2011 20:13:24	-	0.080	8.1	82	SPO
30/Dec/2011 21:00:30	Lat: 12.8º Lon: -28.4º	0.040	8.5	35	SPO
26/Feb/2012 21:40:10	Lat: -23.3º Lon: -28.6º	0.040	8.8	9	DLE
28/Feb/2012 23:05:16	Lat: 31.6º Lon: -35.3º	0.040	8.1	41	SPO
27/Mar/2012 20:47:16	Lat: -24.4º Lon: -69.6º	0.060	9.8	5	VIR
26/Jul/2012 21:35:04	Lat: -7.8º Lon: -68.6º	0.160	8.7	165	SPO
13/Aug/2012 03:55:08	Lat: 26.9º Lon: 82.1º	0.040	8.2	3	PER
20/Oct/2012 20:05:03	Lat: 14.4º Lon: -77.4º	0.040	8.0	3	ORI
20/Oct/2012 20:48:28	Lat: 4.5º Lon: -21.3º	0.080	8.6	2	ORI

Table 1. Main lunar impact flashes confirmed during our 2011 and 2012 monitoring campaigns.

The apparent magnitude estimated for these events range from 8.0 to 9.8 and, as can be noticed, the flashes are short in duration (about 0.05 s in average). Impactor masses have been inferred by calculating the radiated energy for every event and then by estimating the kinetic energy of the meteoroid by using a value for the luminous efficiency of $\eta=6\cdot10^{-3}$ [1]. For sporadic flashes we have used an average value of 17 km/s for the velocity of the meteoroids [1]. For δ-Leonids, Virginids, Perseids and Orionids we have considered a velocity of 29, 30 60 and 67 km/s, respectively. According to this, the impactor mass would range between 2 and 165 g.

Conclusions: We are developing a project with the aim to detect and analyze flashes produced by meteoroids impacting on the lunar surface. During our 2011 and 2012 campaigns, flashes produced by particles belonging to different meteoroid streams and also events of sporadic origin have been confirmed. Besides, the detection algorithms employed by our MIDAS software have been significantly improved. This allows for a more efficient identification of impacts. According to the preliminary analysis of these flashes, their apparent magnitude ranged between 8.0 and 9.8, and the estimated impactor masses between 2 and 165 g.

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