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MIDAS: software for automated detection and analysis of Moon impact flashes

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Abstract

One of the techniques suitable for the estimation of the flux of interplanetary matter impacting the Earth is based on the monitoring of the night side of the Moon visible from the Earth to detect flashes produced by the impact of large meteoroids on the lunar surface. Our team is performing a continuous monitoring of our natural satellite and a software package has been developed in order to automatically identify these impact flashes. The main features of this computer program and some preliminary results are presented here.

1. Introduction

The first steps to detect impact flashes produced by large meteoroids on the lunar surface date back to 1999 [1]. Thus, impact flashes have been unambiguously detected during several mayor meteor showers by using this technique and flashes of sporadic origin have been also recorded [2-9].

We are performing a continuous monitoring of the night side of our natural satellite. This can be done when the illuminated fraction of the lunar disk varies between 10 and 60 %, 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.

2. Methods

We currently monitor the Moon from Sevilla, in the south of Spain. Our observatory there employs two Celestron SC C11 telescopes and a Celestron C9.25 telescope, all of them endowed with monochrome high-sensitivity Watec 902H Ultimate CCD video cameras. GPS time inserters are used to stamp time on every video frame with a precision of 0.001 seconds. Meade 3.3 focal reducers are also used. With this configuration the limiting stellar magnitude is of about 12 and we approximately monitor about $5.8 \cdot 10^6$ 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 video cameras are stored and digitized on multimedia hard disks. Then, they are sent to a computer for further processing and analysis. A computer program is required to automatically identify impact candidates and for this purpose the MIDAS software (Moon Impacts Detection and Analysis Software) was developed [10].

3. Software description

The MIDAS software is a user-friendly Microsoft Windows application developed to automatically detect flashes produced by the impact of meteoroids on the lunar surface.

In general, the source AVI files need to be processed before performing the flashes identification procedure to address some issues that interfere with the detection process. With this aim, several video processing tools have been included in MIDAS. Thus, for instance, video noise needs to be reduced and several video filters have been implemented with this purpose. Besides, certain areas in the images must be masked to indicate that these regions must be ignored. A user-friendly mask editor has been implemented to define these areas. These include, for instance, regions containing stars, as star scintillation is a common source of false detections. Besides, the region containing information from the GPS time inserters must also be masked.

The main kernel in the software is related to the automated identification of impact flashes. To accomplish this task the software continuously evaluates the standard deviation of pixel brightness. If on any group of pixels the luminosity exceeds this deviation by a given (user-defined) value, then MIDAS considers that an event is found. A database with potential impact candidates is then created for every telescope. These databases are automatically compared to establish which events are produced by the impact of meteoroids and which of them are related to other phenomena (cosmic rays, etc.). Figure 1 shows a confirmed impact flash detected by one of our C11 telescopes from the observatory in Sevilla on April 9, 2011, at 20h52m44.658±0.001 s UT. This was identified by the MIDAS software.

MIDAS is endowed with additional tools, such as a lunar phase calendar and an interactive database containing information about meteoroid streams. This software will be freely available to researchers working in this area.

Figure 1: Impact flash detected from Sevilla on April 9, 2001 at 20h52m44.658±0.001 s UT.

4. Summary and Conclusions

We are currently performing a continuous monitoring of the night side of the Moon visible from the Earth in order to detect flashes produced during the collision of meteoroids on the lunar surface. For this purpose we have developed the MIDAS software. This is a user-friendly Microsoft Windows program that automatically identifies lunar impact flashes recorded on AVI video files. This software will be freely available to researchers working in this area.

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