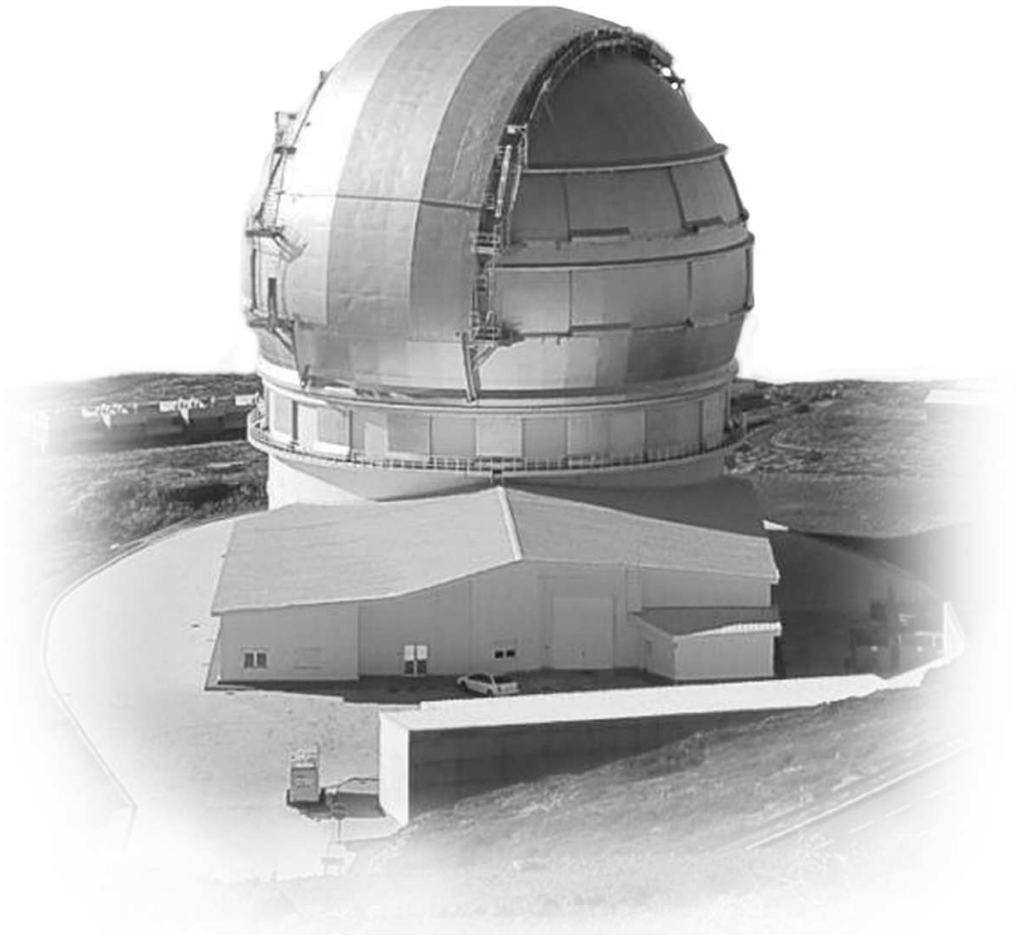
ISBN 978-2-87355-024-4

Proceedings of the International Meteor Conference

La Palma, Canary Islands, Spain

20–23 September, 2012



Published by the International Meteor Organization 2013

Edited by Marc Gyssens and Paul Roggemans

Proceedings of the International Meteor Conference
La Palma, Canary Islands, Spain, 20–23 September, 2012
International Meteor Organization
ISBN 978-2-87355-024-4

Copyright notices

Editing team and Organization

Publisher: The International Meteor Organization
Editors: Marc Gyssens and Paul Roggemans
Typesetting: LaTeX 2$_\varepsilon$ (with styles from Imolate 2.4 by Chris Trayner)

Printed in Belgium

Legal address: International Meteor Organization, Mattheessensstraat 60, 2540 Hove, Belgium

Distribution

Further copies of this publication may be ordered from the Treasurer of the International Meteor Organization, Marc Gyssens, Mattheessensstraat 60, 2540 Hove, Belgium, or through the IMO website (`http://www.imo.net`).

Automated detection and analysis of Moon impact flashes from Spain

José María Madiedo[1,2], José Luis Ortiz Moreno[3], Nicolás Francisco Morales Palomino[3] and Jesús Cabrera Caño[2]

[1] **Facultad de Ciencias Experimentales, Universidad de Huelva, E-21071 Huelva, Spain**

[2] **Facultad de Física, Universidad de Sevilla, Departamento de Física Atómica, Molecular y Nuclear, E-41012 Sevilla, Spain**
madiedo@cica.es

[3] **Instituto de Astrofísica de Andalucía, CSIC, Apt. 3004, Camino Bajo de Huetor 50, E-18080 Granada, Spain**

We are currently performing a monitoring of the night side of the Moon in order to identify flashes produced by the impact of meteoroids on the lunar surface. For this purpose, we employ several telescopes equipped with high-sensitivity CCD video cameras. Software development plays an important role in our project, and, as a result of this, our detection and analysis package has been improved. Some of the results obtained so far are presented here.

1 Introduction

One of the techniques suitable for estimating the flux of interplanetary matter impacting the Earth is based on the monitoring of the night side of the Moon to detect flashes produced by the impact of meteoroids on the lunar surface. The first steps to detect such flashes date back to 1999 (Ortiz et al., 1999). Thus, impact flashes were unambiguously detected during several major meteor showers by using this technique and flashes of sporadic origin were also recorded (Ortiz et al., 2000; 2002; 2005; Cudnik et al., 2002; Cooke et al., 2006). In this context our team has developed the MIDAS project (Moon Impacts Detection and Analysis System). Its main objective is the identification of these flashes by means of an automated system that employs small telescopes operating from different locations in Spain. The identification of these events is performed by the MIDAS software (Moon Impacts Detection and Analysis Software).

Figure 1 – Location of the Moon impact flashes detection systems.

2 Methods and preliminary results

Figure 1 shows the location of our impact flashes detection systems. We currently monitor the Moon from Sevilla (Southern Spain). Our observatory can employ several SC Celestron telescopes (two C14, one C11, and one C9.25), all of them endowed with Watec 902H Ultimate CCD video cameras. In addition, a new 40-cm telescope is being setup in Central Spain, which will be operated from La Hita Astronomical Observatory.

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, we monitor about 5.8×10^6 km^2 on the lunar surface, give or take 10%. Sufficiently large lunar features are easily visible in the earthshine, and these can be used to determine the selenographic coordinates of impact flashes. The Watec CCD cameras we employ work according to the PAL standard (25 fps), with a resolution of 720×576 pixels. The images taken by them are stored and digitized on multimedia hard disks. Then, they are sent to a computer for further processing and analysis.

The MIDAS software (Moon Impacts Detection and Analysis Software) was developed to automatically identify impact candidates (Madiedo, 2010). The main kernel in the software is related to the automated identification of impact flashes. Several algorithms are available to perform these detections, and new algorithms are currently being implemented in order to increase the efficiency of the software. During the detection process, a database with potential impact candidates is 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.). The software can also perform a photometric analysis of impact flashes in order to calculate the absolute magnitude of these events and the mass of the impactors. Figures 2 and 3 show confirmed impact flashes detected on March 27, 2012, at $20^{\rm h}47^{\rm m}16\overset{\rm s}{.}281 \pm 0\overset{\rm s}{.}001$ UT and July 26, 2012, at $21^{\rm h}35^{\rm m}04\overset{\rm s}{.}686 \pm 0\overset{\rm s}{.}001^{s}$ UT, respectively.

MIDAS is endowed with additional tools, such as video processing filters, a lunar phase calendar and a database containing information about meteoroid streams.

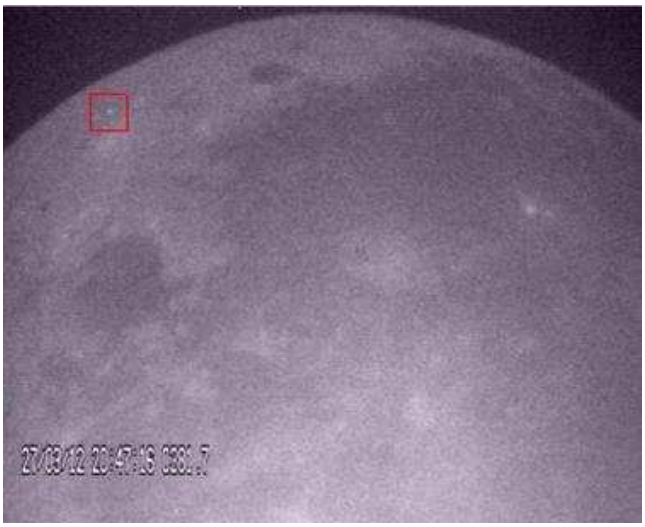


Figure 2 – Confirmed impact flash recorded from Sevilla on March 27, 2012, at $20^{\rm h}47^{\rm m}16\overset{\rm s}{.}281$ UT.

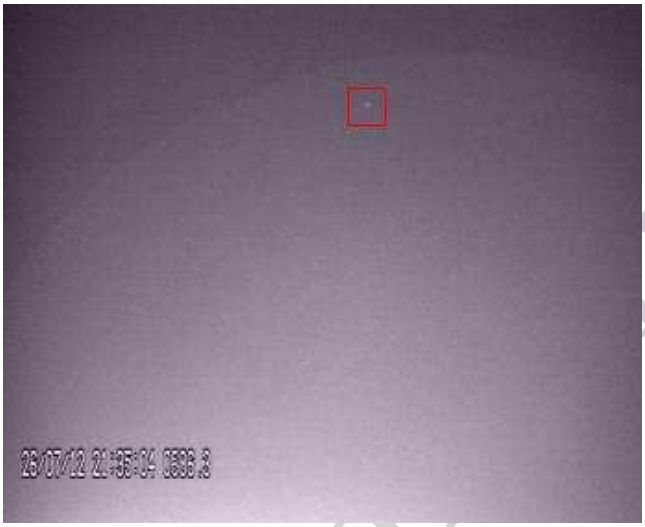


Figure 3 – Confirmed impact flash recorded from Sevilla on July 26, 2012, at $21^{\rm h}35^{\rm m}04\overset{\rm s}{.}686$ UT.

3 Conclusions and future work

We are operating a system that monitors the night side of the Moon in order to detect flashes produced by the collision of meteoroids on the lunar surface. A software package (MIDAS) has been developed to automatically identify and analyze these flashes. Our detection network will be expanded in a near future, as we are currently setting up a new telescope in Central Spain. On the other hand, new detection algorithms are currently being implemented in the MIDAS software. As a result of this we expect to identify impact flashes more efficiently.

Acknowledgements

We thank the Fundación AstroHita for its support in the establishment of the lunar impacts observing facilities located at La Hita Astronomical Observatory. We also acknowledge support from the Spanish Ministry of Science and Innovation (project AYA2009-13227) and the Junta de Andalucía (project P09-FQM-4555).

References

Cooke W. J., Suggs R. M., and Swift W. R. (2006). "A probable Taurid impact on the Moon". In *Proceedings 37th Annual Lunar and Planetary Science Conference*, March 13–17, 2006, League City, Texas, abstract no. 1731.

Cudnik B. M., Dunham D. W., Palmer D. M., Cook A. C., Venable R. J., and Gural P. S . (2002). "Ground-based observations of high velocity impacts on the Moon's surface". In *Proceedings 33rd Annual Lunar and Planetary Science Conference*, March 11–15, 2002, Houston, Texas, abstract no. 1329.

Madiedo J. M., Trigo-Rodríguez J. M., Ortiz J. L., and Morales J. (2010). "Robotic systems for meteor observing and Moon impact flashes detection in Spain". *Advances in Astronomy*, **2010**, 1–5. Article ID 167494.

Ortiz J. L., Aceituno F. J., and Aceituno J. (1999). "A search for meteoritic flashes on the Moon". *Astron. Astrophys.*, **343**, L57–L60.

Ortiz J. L., Aceituno F. J., Santos-Sanz P., and Quesada J. A. (2005). "A study of Leonid impact flashes on the Moon in 2004". *Bulletin of the American Astronomical*, **37**, 649 (American Astronomical Society, DPS meeting #37, #17.05).

Ortiz J. L., Quesada J. A., Aceituno J., Aceituno F. J., and Bellot Rubio L. R. (2002). "Observation and interpretation of Leonid impact flashes on the Moon in 2001". *Astrophys. J.*, **576**, 567–573.

Ortiz J. L., Sada P. V., Bellot Rubio L. R., Aceituno F. J., Aceituno J., Gutiérrez P. J., and Thiele U. (2000). "Optical detection of meteoroidal impacts on the Moon". *Nature*, **405**, 921–923.