EPSC Abstracts
Vol. 13, EPSC-DPS2019-1193-3, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Automating the detection and coordinate identification of impact flashes on the Lunar surface

Raven Larson (1,2), Paul Hayne (1) and Chrysa Avdellidou (2)
(1) University of Colorado Boulder, USA, (2) Université Côte d'Azur, France (raven.larson@colorado.edu)

Abstract

Creating an automated detection and coordinate identification program of impact flashes on the Moon can result in the opportunity to directly observe the thermal emission data of a fresh lunar impact crater. High speed image data of the lunar surface can be obtained in real time and then analyzed to identify impact flashes and their respective lunar coordinates. These coordinates can then be used to attempt a direct observation of an impact crater using the Lunar Reconnaissance Orbiter.

1. Introduction

Observing the thermal data of a newly created impact crater is a rarity. A new observational campaign that will start in Nice and will later collaborate with Diviner is determined to change that. By combining the resources of the Observatoire de la Côte d'Azur and NASA's Lunar Reconnaissance Orbiter (LRO), it is possible to increase the chances of observing fresh impact craters on the lunar surface soon after their formation. In particular, thermal observations of fresh craters still retaining the heat of the impact could constrain fundamental energy partitioning in the impact physics. The key to increasing the odds of conducting thermal observations of these impact crates is in the automation of detecting these impact flashes and identifying their lunar coordinates.

Automating this process will decrease the time allocated towards manually identifying these impact flashes and instead will allow for the chance to immediately observe these impact sites using the LRO thermal emission camera, Diviner.

1.1 LRO/Diviner

The LRO went into orbit around the Moon in June of 2009. Since then it has been responsible for mapping the geological surface of the Moon, as well as the surface temperatures globally and at all local times. Using Diviner, LRO's infrared radiometer, it is possible to observe, and record detailed thermal emission measurements from an impact crater if it is detected within a few hours after the impact (similar to the thermal diffusion timescale).

At an orbital elevation of 50 - 100 km, Diviner has a mapping field of view of 3.75 km (0.02% of the lunar radius). With the impact flash detection automated, coordinates of the impact can be utilized to attempt an observation using LRO.

2. Approach

Once the impact flash is detected, it is necessary to obtain the lunar latitude and longitude of the impact to attempt an observation with LRO. Extracting these coordinates from the ground-based observational data can be automated using two methods: coordinate transformations, or geolocating.

Using the coordinate transformation approach, image coordinates are converted into their RA and Dec counterparts, and those are transformed into corresponding lunar latitude and longitudes. In contrast, geolocating takes advantage of lunar surface features having well-known locations and allows for the detection of those features in the images to calibrate the impact coordinates.

Both of these methods involve increasing errors at the lunar limbs. However, we are able to check our derived coordinates through testing the automated code against known impact coordinates using data and images from the NELIOTA project.

The NELIOTA project has been monitoring the Moon for faint impact flashes since early 2017. Thus far NELIOTA has been successful in recording 58 impact flashes in its nearly 850 days of observations.

Currently, NELIOTA collects data form the 1.2m Kryoneri telescope (located at the Kryoneri Observatory) using two fast-frame sCMOS cameras. In order to detect the impact flashes, these cameras observe the dark, night-side of the Moon so the impact flashes will stand out against the dark background. [1]

These images can be used to test the automated code and to improve the accuracy of the derived coordinates.

3. Implications

After successfully automating the detection and coordinate identification it increases the chance of directly observing the thermal emissions of a fresh lunar impact crater. From the ground-based observations, we will have the ability to obtain the mass of these impactors, and with the collaboration with LRO we will have the opportunity to observe the crates of the impacts.

The preliminary tests and results of this new automated detection method are the first step to a better understanding of impact cratering and obtaining their thermal signatures. We will produce models of the cooling behavior for impact craters as a function of impact energy, frictional and shock heating, and crater size. These models can be compared to the data obtained from Diviner to constrain the impact physics, similar to [2].

References

[1] C Avdellidou, J Vaubaillon, Temperatures of lunar impact flashes: mass and size distribution of small impactors hitting the Moon, Monthly Notices of the Royal Astronomical Society, Volume 484, Issue 4, April 2019, Pages 5212–5222, https://doi.org/10.1093/mnras/stz355

[2] Hayne, P. O., Greenhagen, B. T., Foote, M. C., Siegler, M. A., Vasavada, A. R., & Paige, D. A. (2010), Diviner lunar radiometer observations of the LCROSS impact. Science, 330(6003), 477-479.