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An overview of observed lunar impact flashes

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Abstract

Detection of lunar impact flashes are started to observed last 20 years and number of attempts have been done to detect flashes. Many results of observed impact flashes, (magnitude of flashes, mass of impactor, impact energy, source of meteoroids, crater size and temperature of impact events) have been determined from observation by researchers [1,2,3,4,5,6]. An overview of lunar impact flashes and the statistics of observed lunar impact flashes are presented.

1. Introduction

Meteoroids are fragments remaining from comets and asteroids traveling through the interplanetary medium of the Solar System. Sometimes, they strike planets or the Moon. The Moon has no atmosphere like the Earth, so the falling objects do not create fireballs, yet the kinetic energy of the incoming object is converted into thermal energy which can be detected as an impact flash. Though the meteoroids can hit anywhere, flashes are easiest to detect on the night side of the lunar surface. So, most of observations are done at 5-10 or 20-25 ages of the Moon. If meteoroids are big enough, they can be detected during the Moon eclipse or even on the day side of the Moon. In the last years, with the development of CCD cameras technology and the using large telescopes, faint impact flashes are detected. Milestones of lunar impact flash are;

- Melosh et al. (1993) made a theoretical assessment of impact flash detection by using photometers [7].

- Ortiz et al. (1999) began to search for impact flashes with CCD cameras instead of photometers [1].

- Two independent groups detected an impact flash on the Moon during the 1999 Leonid meteor shower and this became the first confirmed observation of lunar impact flashes [2,8].

- Bellot Rubio et al. (2000) pointed out the luminous efficiency (the friction of kinetic energy converted into radiation) of the collision process can be determined [9].

- Chudnick ct al. (2002) reported the 1999 and 2001 Leonids impacts positions on the Moon and Ortiz et al. (2002) determined the mass distribution of 2001 Leonids impacts [10,11].

- The NASA MEO (Meteoroid Environment Office) started monitoring lunar impacts in 2006 and detected 435 candidate impact flashes during 2005-2018 (https://www.nasa.gov/centers/marshall/news/lunar/lunar_impacts.html)

- Observation of Geminid, Lyrid, Perseid and Taurid impacts have been reported [3].

- The NELIOTA project from Greece started monitoring the Moon for faint NEO impacts in 2017, with a 1.2 m telescope, two video cameras and Johnson-Cousins R and I filters (https://neliota.astro.noa.gr).

- Lunar impact flash temperatures are determined from observational data [5,6].

- Lunar impact flash has detected for the first time during the total lunar eclipse on 2019 January 21, and the first time that lunar impact flash observations in more than two wavelengths are reported [12].

2. Observed impact flashes

In between 1999 and 2019, the observed brightness of 254 lunar impact flashes are given by various researchers (exception of NASA MEO data). The observed lunar impact flashes in these years are shown in Figure 1. From 1999 to 2006, the impact flashes magnitudes are given only in visual or V band. Since 2006, R brightness is given and since 2017, I and R brightness of impact flashes are given in literature. The brightest lunar impact flash event was detected in 2013 with 2.9 magnitude in V band and 8.3 seconds duration time [13.] With the exception of last years data in Figure 1, the most points are obtained from meteor shower observations.

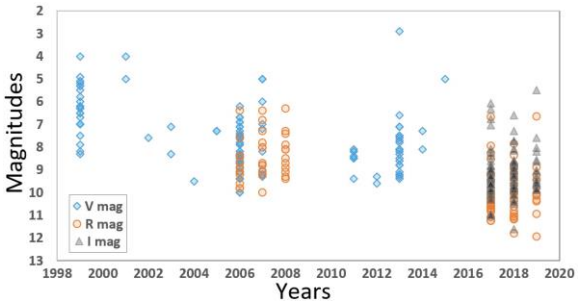

Figure 1: Brightness distribution of observed lunar impact flashes in years.

Continuous observations of the NELIOTA project, which started in 2017, also detect lunar impacts other than meteor showers. Most of the recent data on the Figure 1 is from NELIOTA observations (https://neliota.astro.noa.gr/DataAccess). Thus, small mass impactors can be determined. The faintest flash observed is given as 10.95 in the V band and 10.33 in the R band for the same event. The faintest flash observed is given as 10.95 in the V band and 10.33 in the R band for the same event. On the other hand, faintest flashes observed in R and I band are 11.94 and 10.4, respectively. In the R and I band observations of the same events, I band magnitudes are always smaller (brighter) than R band. This indicates that, the impact events occur at temperatures corresponding to the near infrared region. Observed impact temperatures are determined to be in between 600 K and 5700 K [14, 11].

3. Summary

Impact temperature and impactors mass, are obtained by observations of lunar impact flashes. In order to understand the lunar impact events, we needed to global observation campaigns.

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