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20 years of ground-based lunar impact flash observations

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1. Inrtoduction

The lunar surface is beeing monitored the last 20 years for the detection of the impact events by small meteoroids [1,2,3,4,5]. During an impact event a light flash is produced which is actually the molten ejected impact fragments. On the lunar surface this corresponds to the glowing molten regolith. Early modelling has predicted the range of temperatures at which the lunar regolith melts and vaporises during impact events [6]. During 70s laboratory experiments [7,8] have shown the dependece of the flash temperature to the impacting material density.

2. The surveys

Several teams from different countries have been involved in observational campaigns focusing mostly at observations during large meteoroid streams. In addition there are other 2 observational campaigns that observe at daily mode capturing both parented and background population meteoroids. Here will be presented the main results from these teams focusing mostly at the newest, ESA-funded, campaign operated by the National Observatory of Athens [9].

3. The science

In general, when impacts occur the kinetic energy of the projectile is partitioned: a fraction of said energy is consumed for the excavation of the impact crater and compaction of the target medium, another fraction is used to heat the materials, while the remaining fraction is converted into the kinetic energy of the ejecta. In the case when the impact is energetic enough, the materials of impactor and target are vaporised and plasma can be generated. That depends on the impact speed and the mass of the impacting body in combination with the type of the materials. Understanding the energy partition problem is essential to convert the measured brightness of a flash to the impacting energy and possibly to the mass of the projectile. Typically, a black body radiator with luminous energy E_lum is assumed, which is a fraction η (luminous efficiency) of the kinetic energy of the impactor, KE,

$$E_{lum} = \eta \times KE \qquad (1)$$

where E_{lum} the luminous energy of the events and η the luminous efficiency. Some previous studies, in order to perform the colour correction to their flash data and derive the E_{lum}, assumed an average flash temperature of 2,800 K adopted from the study of Nemtchinov et al. (1998).

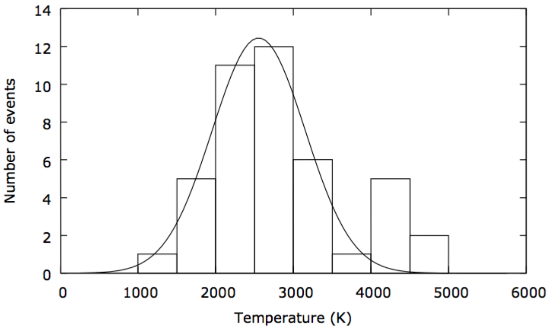

Figure 1: Temperature frequency distribution from NELIOTA survey [10].

The advantage of having temperature measurements at several stages of the long-lasting flashes (the cooling of the flash) can give insight to the thermal evolution of an expanding cloud of droplets. This may reveal information for the size of the melted droplets feeding the studies of lunar regolith where melt-droplet spheroids have been found [10].

Apart from the information that we get for the impact event itself, lunar flashes are used to derive the masses of the impacting meteoroids. The link of a meteoroid to a possible parent meteor stream would define its impact speed on the Moon V, leaving the mass the main unknown. However, a trustowrthy value for η is still needed and is a matter of debate [11,12].

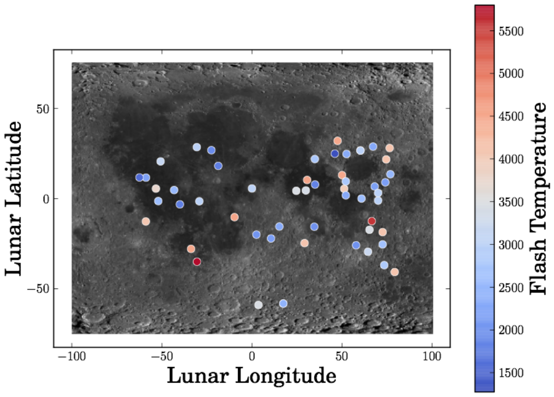

Figure 2: The location of NELIOTA impact flashes on the lunar surface [10].

4. Implications

A direct implication of studying lunar impact flashes in the understanding of the mechanisms that produce the light. In addition it enables us to construct the size frequency distribution of objects in the near Earth space at very small scales. A future application is to use systematically the lunar impact flashes for the detection of the fresh craters on them Moon and link a mass/size of an impactor with a crater size.

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