Meteor detection in wide-field survey telescopes

Francisco Ocaña[1,2,3], José Daniel Ponz[2,3], and Jaime Zamorano[1]

[1] **Universidad Complutense de Madrid, Spain**
fog@astrax.fis.ucm.es

[2] **Neomenia S. L., Spain**

[3] **Isdefe, S. A., Spain**

Meteor observing requires a huge field of view (FOV) as its appearance in the sky cannot be foreseen. In the new era of the time-domain astronomy, many telescopes will cover the whole sky with a cadence of a few days. These requirements lead to fast large telescopes with wide FOVs, like the Schmidt cameras that were widely used for meteor observing in the past. We present an estimation of the number of meteors detected as a by-product of these surveys, with the detailed example of the Test-Bed Telescopes, an ESA project for NEO and space debris surveillance.

1 Introduction

This is an abstract of the poster that was presented at the 2013 IMC and the Meteoroids 2013 Conference. The complete text is published in the proceedings of the latter conference (Ocaña et al., 2014).

2 Telescopic meteors

Meteors have been widely observed with the use of telescopes (Henize et al., 1993), but in the vast majority of cases, these are serendipitous detections (Jenniskens et al.,2004; Iye et al., 2007).

Due to their nature, meteors in the range of hundredths of a micrometer are monitored using radar sensors. Most optical meteor surveys observe meteors down to magnitude +6 (millimeter range). However, smaller meteoroids have similar luminous efficiencies and are able to produce meteors as they suffer ablation down to 100 μm (Bronshten, 1983).

Therefore, these meteors are observable in the optical range with the use of silicon devices (i.e., CCDs) and the aid of optical devices for large collection areas. The performance of these systems (meteor rate) is the product of the flux of meteoroids by the atmospheric area/volume A monitored by the telescope. The flux of meteoroids in the detection range of the telescope is the integral down to the limiting magnitude (lm) of the meteor luminosity function $F(m)$:

$$\text{Meteor rate} = A \times \int_{-\,\text{inf}}^{\text{lm}} F(m)dm.$$

The sporadic meteoroid fluxes detected in the visual range (down to magnitude +6) by IMONET[1] and in the radar range for fainter meteors (Blaauw et al., 2011) served as input for this study.

[1]Monthly Reports, http://www.imonet.org.

3 Test-Bed Telescope (TBT) project

It is foreseen within the Space Situational Awareness (SSA) program of ESA to deploy several robotic telescopes to provide surveillance and tracking services for man-made as well as natural near-Earth objects (NEOs). The Test-Bed Telescope (TBT) project will procure a validation platform for an autonomous optical observing system in a realistic scenario, consisting of two telescopes located in Spain and Australia, to collect representative test data for precursor SSA services.

These small telescopes are a clear example of this new astronomical survey era. They will be 60-cm telescopes with a $2\overset{\circ}{.}5 \times 2\overset{\circ}{.}5$ field of view (FOV) taking short exposure images during clear nights all year round.

The result of this study for the TBT telescopes with a FOV of approximately 6 square degrees each is the detection of meteors in the range of a couple of them per hour. Low-noise CCD read-out, short exposures, and dark skies are essential to increase the SNR of meteors and the subsequent detection probability. Otherwise, the limiting magnitude is diminished rapidly due to the short time the meteor spends over a pixel compared to the constant sky background.

4 Meteor identification

Most meteor detection programs rely on movement detection thanks to the video rate imaging. However, still images show streaks coming from several sources: planes, satellites, and other fast-moving objects. In huge FOVs, meteors show characteristic light curves that allow unambiguous identification.

Nevertheless, identification could be an issue in wide-field telescope images. Fortunately, these telescopes usually have focal lengths long enough to show meteors (at 100 km high) out of focus (Jenniskens et al.,2004; Iye et al., 2007). Also, low-Earth orbit satellites are easily discarded taking only images when the Sun is not illu-

minating these orbits (usually within 2 hours after or before twilight).

5 Conclusions

Meteor detection rates that will be achieved with the future wide-field survey telescopes are similar to the ones for current video networks. Therefore, meteors detected as by-products in these surveys will be a free source of meteoric data. For this purpose, survey images should be analyzed by meteor scientists using survey archives or even dedicated algorithm in their processing pipelines.

References

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Francisco "Paco" Ocaña during his Friday noon presentation. (Credit Bernd Klemt.)