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Geoscientific Instrumentation Methods and Data Systems Discussions

Interactive comment on "A double-station meteor camera setup in the Canary Islands – CILBO" *by* D. Koschny et al.

Anonymous Referee #2

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This manuscript, entitled "A double-station meteor camera setup in the Canary Islands – CILBO", introduces a new, automated, double-station image-intensified video system for the observation of faint meteors. The paper is comprised of five sections: the first introduces the system and its scientific goals, the second discusses the hardware and software of the system in detail, the third describes how results are derived from observations, the fourth gives preliminary results, and the fifth summarises the paper, as well as lessons learned. The general quality of the paper is good, and it is fairly easy to read and understand. Similarly, a detailed introduction to the CILBO system is appropriate for the scope and aims of this journal. This manuscript may be improved, however, by focusing on the details of the system, instead of on the (preliminary) scientific results.

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Interactive Discussion
Discussion Paper

My principal issue is with how preliminary results are presented in section 4, “First scientific results.” The first part of the section discusses how many meteors (and meteor spectra) are captured each night. This is an important indicator of system performance. A sample of Geminid shower meteoroid orbits derived with double-station data is also given, which also shows the reader what the system is capable of (though quantitative results, such as a table giving observed orbital parameters for the meteoroids compared to the parent body, or compared to observations from other studies, would arguably be best). Conversely, the light curve analysis of Geminid meteors as an indicator of object strength (and parent body type: comet vs. asteroid) is beyond the scope of this paper.

Light curves, which give meteor brightness (magnitude) as a function of height or time, are influenced by a number of factors, including object composition (chemical and structural), grain size distribution, and possibly object strength (Borovička 2005). The F-parameter, introduced in this paper as the relative position of the peak in the light curve, is also influenced by these factors. The statement, “A late-peaked light curve (high F values) would correspond to high-strength material; an early-peaked light curve indicates a very fragile particle,” seems to oversimplify the situation. One of the most recent studies, Campbell-Brown & Koschny (2004) modelled light curves with an assortment of F-parameters, each associated with the Leonid meteoroid stream (i.e. the same parent body, and thus, similar strengths), by varying composition and grain size distribution of the meteoroid.

Similarly, the hypothesis, “If Phaethon were an asteroid (assumed to be made of high strength material compared to cometary material), more late-peaked meteors would be expected” should provide a reference, such as Trigo-Rodriguez & Llorca (2006), which discusses the relative strength of ‘pristine’ vs. ‘processed’ (i.e. asteroid) comets. Another good reference for this is Borovička 2006.

The F-parameter observations are interesting and appropriate to present, but the conclusion that Phaethon is cometary based on a wide-distribution of F-factors with mean

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$\sim$ 0.5 is premature. It requires accepting the assumption that strength is the dominant parameter influencing the F-factor. Questions of observation bias also appear: does the F-factor vary with meteoroid size, mass, or brightness? Does the F-factor vary each year? Thus, this claim is a matter best left to a subsequent paper, which can approach the topic with more detail. Omitting the claim also suits this paper, as it's meant to be a detailed overview of this new system, which is expected to produce many interesting results in the future (all of which will refer readers to this paper for specifics about the system).

Instead, quantifying the F-parameter of the observed Geminids (mean and standard deviation) and comparing it to other published values (such as Koten et al. 2004) would be more appropriate. This demonstrates the system's capabilities, and gives a sampling of results that is free of questions of assumptions or observational biases. A comparison with observed sporadics or other showers may also be informative. Additionally, presenting the data as two histograms, Geminids and sporadics (or other showers), would appear to be more effective than the scatter plot of Figure 10. Note that a sentence describing how the F-parameters are measured (i.e. were beginning and ending heights based on a threshold magnitude?) would be important to include.

Another suggestion is to add more details about the system. Specifically, give details about the field-of-view (it's roughly "20 to 30 degrees", but is this known more precisely?), the resolution (in pixels) for each camera, the frame rate, and the bit depth for each pixel in section 2.2. The last two quantities are especially important for determining the range of meteor magnitudes that the system is able to record. It would also be good to comment on the spectral sensitivity (i.e. the nominal bandpass) of the system to clarify whether the system will be biased to detect meteors with certain emission lines over others.

In section 2.4, it is stated that the MetRec software gives an estimate of the magnitude of the meteor in each frame of the video capture. How this is done should be clarified with one or two sentences – is the process automated? Is the magnitude based on

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a sum of the total brightness of the meteor in each frame, or the peak observed pixel brightness? Is there a calibration process to convert observed an observed brightness to a magnitude? What is the expected uncertainty? Similarly, how the light curve is obtained should be clarified, briefly. This is introduced in section 3. Is it based on the magnitudes measured in each frame, or on the sum image to get the "continuous light curve?" If it's the second case, the process should be briefly explained, or a reference provided, as it would be of interest for anyone with a video system who records meteor light curves.

Section 3 also discusses meteoroid flux measurements. The flux calculation should be explained briefly, as it is the third type of observation provided by CILBO, the others being trajectories (orbits), and light curves. There is an ambiguous sentence in section 5, "However, the produced flux information of meteor streams will be lost due to the way MetRec determines the limiting magnitude needed for this computation," that should also be clarified.

These were my major concerns for the paper – apologies for the delay in responding. As stated above, I believe it is a good paper that is worthy of publication, but would benefit from some changes. Some additional minor comments follow, organised by section.

Abstract:

- The first three sentences should be moved to the introduction, section 1. The abstract would sound better beginning with the sentence that starts, "This paper describes. . ."

- When CILBO is first mentioned in the abstract, the first detail is that it makes use of automated roofs. While this is very novel (and difficult to get working right), it seems equally important to note that the cameras are image intensified, to give the reader an impression of the size range of meteoroids being studied.

- "For bright meteors. . ." put an example magnitude (brighter than 0 is mentioned later

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in the paper).

1. Introduction and scientific rationale:

- This is a well-written section. It introduces the basics of meteoroids, and observation of meteors, as well as why that's important. Also, it makes a point that intensified video is a good way to connect traditional video, and radar observations of meteors. Good job.

- "The light can be recorded with optical means. . ." – why not specify that light would be recorded with a camera?

- Remove "the" from ". . .and allows the observation by. . ."

- It would be good to provide a sample study or reference when stating that the "global meteoroid complex was observed mainly by radar systems." Perhaps Baggaley et al. 1994 would be appropriate?

2.1. Overview

- Change "was supposed to fulfill" to "fulfills" (as the system is operational and presumably fulfills the given conditions).

- Consider adding a length scale bar for figure 1.

2.2. The cameras

- Good clarification on the difference between stellar and meteor limiting magnitudes.

- The sentence that contains, ". . .to a CCD which is read out via a camera Toshiba Teli CS8310Bi PAL video camera," appears to repeat the word camera.

2.3. The housing

- Since the spectral camera has already been introduced (in 2.1), you can specify "spectral camera" instead of "a second camera with an objective grating."

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2.4. Electronic setup and software

- The material that goes after “The following paragraphs describe. . .” should be put at the beginning of the section, as it goes into the details of system operations (i.e. when the system starts, what defines ‘ok’ conditions, what is a meteor detection, etc.) better than the material at the beginning.

- “MetRec is reading the real-time. . .” should read, “MetRec reads the real-time. . .”

- Switch to lowercase letters for “Signal-to-Noise?”

- It’s stated that false detections occur more commonly when the sky is bright, close to a full moon. Does the system run when it’s that bright (i.e. the full moon is present or above a certain elevation)? Is there a risk for damaging the intensifiers? It may be good to clarify this with one sentence.

- Describe (one sentence or so) how the camera pointing position is found to sub-pixel accuracy using RefStars. Does it require user intervention, or is it automated?

- “On Tenerife, a second camera with an objective grating. . .” – this sentence can be omitted, as the spectral camera has been introduced a few times by now.

- I really like the details of how you managed to get MetRec to signal the spectral camera to start using a serial port. Very inventive, and it’s a good idea to describe how you solved the problem.

- “Sky temperature” = wind temperature?

- “In the morning the control software will start shutting down the system. . .” – I’d say “In the morning, the control software shuts down the system. . .” instead.

- “. . .allows the trailed user to judge whether everything went ok” sounds a bit colloquial, it might be better to say something like, “. . .allows the trained user to judge whether the system functioned correctly that night.”

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- For part b., it would be good to briefly remind the reader that the NuDAM voltage controller controls the cameras.

3. Data processing:

- "For each detected meteor, the right ascension and declination of the photometric centre of the meteor will be measured and stored." – is the position obtained for each frame?

- Also, "will be measured and stored. . ." should be "is measured and stored."

4. First scientific results:

- Good clarification of the number of meteors captured, and the fraction that are double station.

- "To give a first impression of the science this setup is capable to produce. . ." – better to say, "To give a first impression of the science this setup is capable of producing. . ."

- The reference (Fleming, 1993) is missing from the references list. I suppose it's Fleming, Hawkes & Jones, 1993, in Stohl and Williams (eds.), Meteoroids and their parent bodies, Bratislava, p. 261.

- An alternate reference to consider for the F-parameter is Beech & Murray, 2003, MNRAS, 345, 696. It seems more easily available than the Fleming et al. paper.

- As noted previously, consider showing orbital parameters for a sample of the Geminids observed, as well as a mean value, and a comparison to a published value, such as in Kero, Szasz & Nakamura, 2013, Ann. Geophys., 31, 439 (note that this is based on radar observations, however). By quantifying the mean parameters, as well as their standard deviation (a measure of uncertainty), you give the reader an impression of how precise the system is, how it compares to radar and non-intensified video, and how these observations may be used to constrain future models.

- The figure showing Geminid meteoroid orbits (Fig. 9) is certainly interesting, however,

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and should probably be kept.

- Also noted previously, the segment of this section discussing the observed Geminid F-parameters should be significantly revised. Remove the tenuous conclusion that mid-peaked light curves of Geminids indicate cometary composition for Phaethon. Instead, report the observed Geminid F-parameters (mean and standard deviation), compare it to published values. Consider presenting a histogram of Geminid F-parameters vs. the others observed (sporadics, showers) to give the reader a better impression of the distribution of values. This can replace Figure 10.

5. Summary and lessons learned

- The system has been operational for about two years now.

- "...first scientific results were presented" should be changed to "...some preliminary results indicating the capabilities of the system have been presented"

- For a., put the lesson first, something like, "The reliability of the setup could still be improved. The setup is working well, but there are times when the opening and/or closing..."

- As a side note, it is impressive that the automated roofs and system work that well in the extreme conditions stated.

- "A strain relieve for the cables could solve this issue" – change to, "relieving strain on the cables could solve this issue."

- Consider summarising the preliminary results of this paper: the mean value and spread of the observed Geminid orbital parameters (or radiants), and how they compare with other studies, and the mean and spread of the observed F-parameters, and how they compare with other studies (or the sporadics/other meteors observed)

- All of the references seem to be used in the article, and placed in the references section (except for the missing Fleming, Hawkes & Jones 1993 paper)

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Some references

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