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Resurrecting Bobrovnikoff to produce crowd-sourced cometary light curves using DSLR photometry

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Abstract

One of the aims of cometary observation is putting together the light curve. As well as recording the measurements of magnitude made by observers over a period of time, it feeds the anticipation of professionals and amateurs alike in answering the question "How bright will it be?".

This developmental paper acknowledges the accepted wide variety of historic magnitude estimation methods and notes that the stringent rules of modern CCD photometry render it inaccessible to many amateur observers. The paper proposes a method which uses quantity, rather than quality, of individual observations to eliminate inaccuracy. It draws on principles of crowd sourcing already used with great success at the interface between professional and amateur astronomers.

1. Introduction

The concept of magnitude, *when applied to comets*, can be obscure. So easy to understand in cataloguing the visibility of stars, it falls short when called upon to describe an object that is spread beyond a single point of light. A comet of given magnitude might be visible or might not, depending on the concentration or diffuseness of its coma and tail. As astronomers, we tend to use "magnitude" as a shorthand for visibility. Perhaps we demand too much of this complex term, which historically has proved difficult to pin down.

1.1 Historic estimation

The history of comet magnitude-measuring methodology reveals it to be fraught with inaccuracy and guesswork. Green [1] describes at length the history of several techniques which involve observing a star of known magnitude, then spreading its light by viewing it out of focus in order to mimic the appearance of the observed comet. Comparing the result of this spreading with the visual spread of the cometary coma, enables magnitude to be estimated.

Green suggests that Bobrovnikoff's "Out-Out" method defocuses everything visible in the eyepiece, including the comet. Bobrivnikoff asserts that once out of focus, the stars and the comet will have broadly similar appearance and can therefore be compared for magnitude as they cover a visibly similar surface area.

1.2 Modern CCD photometry

Modern methods of CCD comet photometry, according to the ICQ [2], lay down stringent requirements for most parameters such as use of filters, frame calibration, pixel scale, telescope focal length and of course the CCD itself.

2. My own experience

I took several DSLR frames of C/2012 K1 deliberately out of focus, to examine using Bobrovnikoff's "Out-Out" method above. Captured simultaneously, the stars and the comet are subject to identical systemic anomalies and can therefore be justifiably compared.

2.1 Method for individual estimate

The method uses simple on-screen inspection of the pixel values of the de-focused stars, as follows.

1. Select a frame that shows out-of-focus stars approximately the same size as the observed comet coma. Extract the luminance and stretch the data to be clearly visible on screen. (Figure 1).

2. Identify stars both above and below the comet's magnitude and tabulate their visible magnitudes. Inspect each blurred star on screen and tabulate its on-screen pixel value.

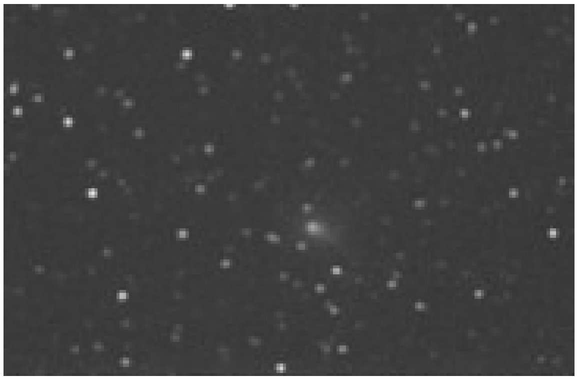

Figure 1: C/2012 K1 and stars out of focus

3. Plot the magnitudes against the pixel values and find the line of best fit (Figure 2).

4. Use that line to determine the comet's magnitude from its inspected on-screen pixel value.

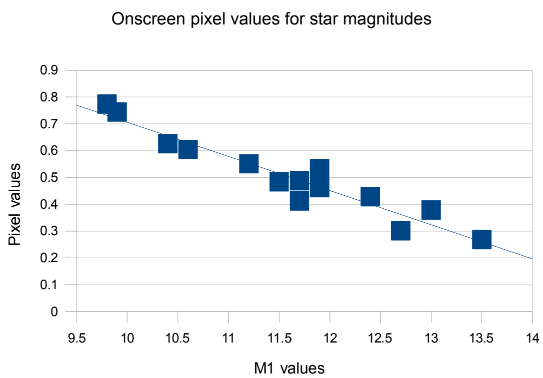

Figure 2: magnitude plot

From the graph it can be read that the magnitude of C/2012 K1 on 27 April 2014, with pixel value 0.64, was 10.5.

2.2 Collective crowd-sourced data

At first glance, this solitary piece of data has very little to commend it beyond amusement value. However, the collective data of multiple observations by amateurs should, under the principles of crowd-sourcing, eliminate inaccuracies and, in aggregate, produce robust estimates leading to a light curve.

Crowd-sourcing follows the principle that the estimates of a large number of observers, each measuring roughly according to their abilities, will on average produce an accurate result. It is the proposition of this paper to invite amateur observers to follow a routine similar to that described above, finding their own line of best fit each night and pooling their comet magnitude estimates. Each observer would use equipment and techniques of his or her own standard, in the same way as the historic estimates were gathered as reported by Green [1]. It is expected that the collective crowd-sourced readings will produce the same light curve as those rendered by professional observatories.

3. Summary and Conclusions

The purpose of gathering multiple observations is to eliminate error. It follows that amateur observers, using a wide range of equipment and sharing their measurements, should collectively be able to produce the statistically same line of best fit.

The coordination of such an exercise would fall within the ethos of the Pro-Am collabration espoused by PACA, for example. I am already a moderator of social media for CIOC and would be pleased to receive observations for tabulation once a suitable target has been identified.

Acknowledgements

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References

[1] Green, D. W. E.: On the History of Total-Visual-Magnitude Estimation Methods, International Comet Quarterly, Vol. 100, pp. 186-205, 1996.

[2] Green, D. W. E. *et al*: Guide to Observing Comets, Section 5.1, CCD Photometry of Comets [online] Available at http://www.icq.eps.harvard.edu/CCDmags.html
[Accessed 19 May 2014]