FROM PHOTOGRAPHY TO PHOTOMETRY

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Abstract.
Modern astrophotography has become more and more democatrised, allowing amateur astronomers to produce images of a great quality. Raw individual astrophotographic images are also a great source of photometric information, yet unexplored. The Pro-Am program "Photography to Photometry"(P2P) aims at exploring and extracting the scientific potential of such images. As a first step, we focus our efforts on the domain of eclipsing binaries which are numerous targets whose photometric variations are easy to detect. The results of the first campaign of data collecting around the star forming region IC1805 shows the great potential of amateur data. The P2P program will continue to focus on eclisping binaries follow up in astrophotographic data and will explore others domains in variables stars studies.

Keywords: Astrophotography, Eclipsing binaries, Photometry, Citizen Science

1 Astrophotography as a source of artistic and scientific data

The practice of modern astrophotography involves the use of various equipments. The astronomical setups of amateur astronomers depend mostly on their artistic interests and on the cost of such equipments. A modern setup is usualy composed of a small optical tube (refractive or reflective telescope, from 7 to 25cm in diameter) equipped with an astronomical camera (CMOS devices are now more common than CCDs). Depending uppon the target, different filters can be used (Luminance, Red, Green, Blue, Hα, OIII, dual bands...), whether the camera is color or monochrome.

One of the astrophotographic practices is the acquisition of large field of views (more than a degree in diameter) around star forming regions, using small refractive telescopes. The presence of these regions in the galactic plane implies a large count of stars and a potentially large number of variable stars of interest detected, even with small diameters instruments. See Sect. 2.2 for an example of detection. A large amount of good quality data already exist and will continue to be produced every night by hundreds of observers.

The program *Photography to Photometry* (P2P) aims to extract all the available information and make it useful to the community. The challenge we face is to produce a protocol of data collection and a data reduction pipeline which can be applied to all types of amateur equipments.

2 First P2P test in real conditions

2.1 Why eclipsing binaries

Since the publication of the first Gaia catalog of eclipsing binary canditates by Mowlavi et al. (2023), we know 2.1 millions of systems which can show high amplitude variations (more than 1 magnitude for some of them) and a high frequency of variation (up to 5 periods per day). There are now 78 905 known targets up to the 14th magnitude (well detectable by small telescopes) from the Gaia DR3 catalog only, to which we should add all the targets not detected by Gaia. Only a few thousands of them are well studied. The measurment of the precise date of unrecorded yet eclipses allows to follow more precisely the long term evolution of the period of all binary systems. Eclipsing binaries are numerous and luminous targets, well suited to start with in this project.

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2.2 Application on the IC 1805 field of view

Every year, social media are filled with wonderful images of star forming regions. One of the most acquired is IC 1805, the Heart nebula. With 52 targets up to the 14th magnitude, it is a great target to start with. 13 French amateurs have accepted to share their data with P2P. They all have different equipment, between 7 cm and 20cm in diameter, most of them using Hα and [OIII] filters. Even with such restrictive filters, they all have well detected several targets of interests. Among these targets is V 1337 Cas, with mag$_V$=10.5 and a period of 0.4101 day. All setups managed to obtain a signal-to-noise ratio higher than 100, allowing a good detection of the eclipses and a precise time measurment. Using the tools developped internally for the analysis of the LABSCAN * archive that will be described in a forthcoming paper (Foschino in prep.a), all the collected datasets were reduced focused on this particular target.

Seven ecplipses, unrecorded before, were obtained and their time of minimum measured and compared to the known epoch of this target. Fig. 1 shows the O-C diagram produced, compared to the known data on this system from the O-C Gateway database (Paschke & Brat 2006), showing a great compatibility. The case of V1337 Cas is just a first test, all the data will be published in a forthcoming study (Foschino in prep.b) in which the observers will be more involved and better credited.

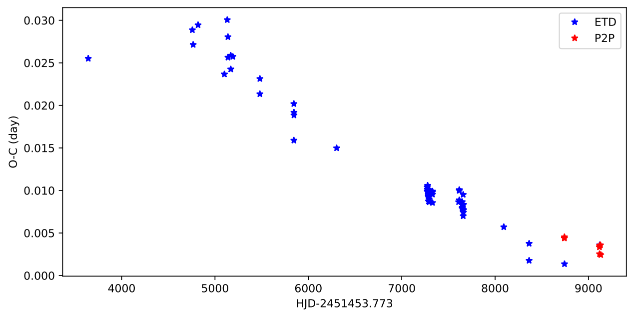

Fig. 1. O-C diagram for the binary system V1337 Cas

This test was also the occasion to fix the protocol of participation to our program, requiring the less involvment possible. The participants must register their equipment and observing location by contacting us. Then, they only have to gather or acquire all their raw data (lights and calibration images) on a specific deep sky object, compress them and send them to P2P via an upload link. The data reduction is made automatically and will be shortly published in a future database.

3 Conclusions

This test objectives were to assess the scientific potential of amateur astrophotographic and already existing images and to develop a protocol of participation the less constraining possible. These two goals have been succesfully completed and encourage us to pursue the developpement of the program and the study all the other well detected eclipsing binary systems in IC 1805. We emphase the fact that P2P aims to analyse data which were not obtained with the primary goal to be scientifically studied.

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References

Foschino, S. in prep.a

Foschino, S. in prep.b

Mowlavi, N., Holl, B., Lecoeur-Taïbi, I., et al. 2023, Astronomy & Astrophysics, 674, A16

Paschke, A. & Brat, L. 2006, Open European Journal on Variable Stars, 23, 13

*https://www.obs-bp.net/recherche