11th Hel.A.S Conference
Athens, 8-12 September, 2013
CONTRIBUTED POSTER

A new method for planetary transit light curve optimization

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Abstract: We present a new method for optimizing photometry of exoplanet transit events.Instead of using multiple circular or other apertures, we suggest that after the physical model has been determined with the help of classical photometry, the contribution of each pixel can be tested by constructing its own light curve. In this manner, contaminated pixels or pixels that generate false signal can be detected and deleted

1 Observations and instrumentation

For the purpose of testing our hypothesis we collected data for the transit of the planet Qatar-1b.The observations took place at the Astronomical Station on Mt. Holomon, Halkidiki. We recorded the transit of the planet at 5/1/2013 using a Schmidt-Cassegrain telescope with D = 279.4 mm, F = 2800 mm and the Fingerlakes PL6303E CCD camera.

2 Data analysis

First, we performed aperture photometry in order to define the optimum aperture and derive the best aperture optimized light curve. Next, from the former light curve the best fit was derived using Mandel and Agol transit model. Then, we constructed a light curve for each pixel. Finally by neglecting each pixel's light curve once and constructing the final light curve without it's contribution, we checked if the rms of the residuals between the current final curve and the model was minimized. If so, then the pixel was deleted from the aperture. For the case of Qatar-1b the optimum aperture for classical photometry was found to be a 14 x 14 pixel box. We tested our method for this aperture first, and also for a rectangular aperture of 28 x 28 pixels. We provided a computational network, with some basic equations that describe the previous procedure and the outcome is obvious in figures 1-2. Grey dots represent the classical photometry, while the red ones, account for the pixel to pixel routine. In both figures the residuals where displayed for a better understanding of the results.

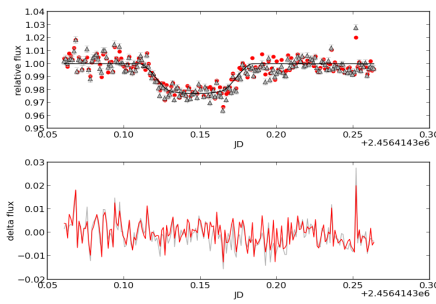

Figure 1: aperture dimensions in pixels:14 x 14

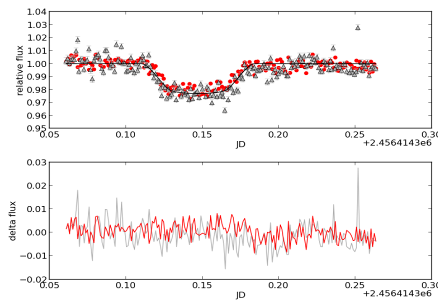

Figure 2: aperture dimensions in pixels:28 x 28

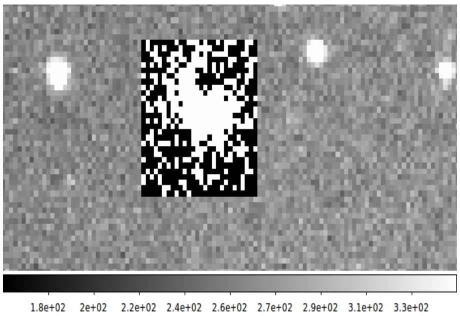

Figure 3: mossaic of optimum pixels in a 28 x 28 pixel area

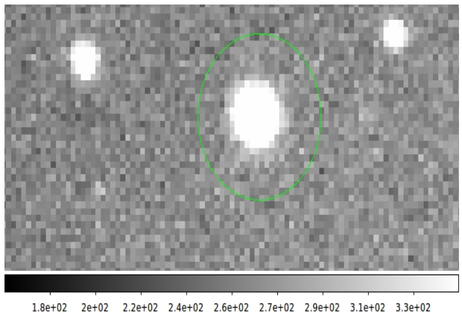

Figure 4: area of Qatar-1b

3 Results and future work

It's obvious from Figure 2 that this method optimizes the transit event light curve and thus can produce more accurate physical parameters after application of a new model.In figures 3 and 4, we can actually see the effect of our method, where all the false (according to the method) pixels are coloured black. Obviously, the white pixels construct a mossaic of optimum pixels around the target star. In future publications, we will test the hypothesis that this method can effectively erase a false signal from within the light curve since we are allowed to discard pixels that are actually inside the aperture, while classical photometry is unable to do so. It is very important to note that there must be a limit as to how big an aperture can be. As the aperture grows bigger there is a finite number of pixels that if combined correctly can either reduce the noise almost completely, or generate a false signal, which is exactly the opposite of what we want. All of these questions will be investigated and answered in future publications. The best light curve that was derived from the 28 x 28 box versus the best classical photometry light curve, is displayed in the next figure

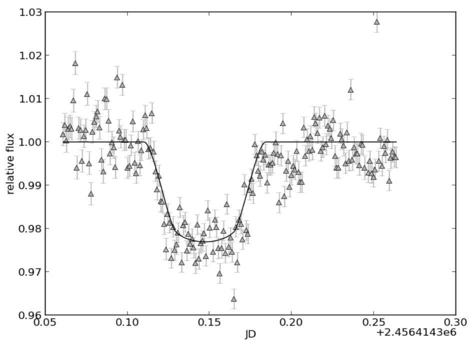

Figure 5: classical photometry

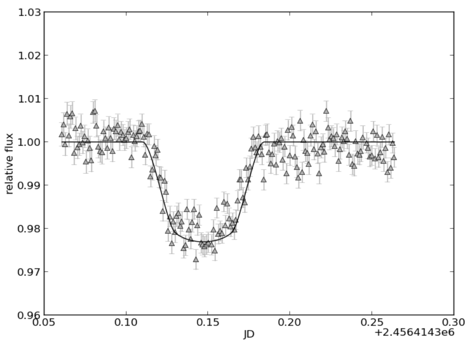

Figure 6: pixel to pixel photometry

References

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