

We have developed a new algorithm for differential photometry. It solves the problem of identifying proper comparison stars without prior detailed study of the field of view. The variability of the comparison stars is determined in a self-consistent way and a weighted average of them is used as a reference level. A simple error model is applied to the data giving reliable error bars for all measurements. By comparing derived errors with observed variation of the comparison stars (CS), badly behaved comparison stars can be rejected.

Differential Photometry Algorithm

After reading in the instrumental magnitudes and errors of all objects (science object and CS 1 through N), the instrumental errors are corrected according to the error model with two parameters (formula see fig. 1).

The algorithm proceeds by looping over the following two steps until convergence is reached:

- 1) calculate new weights for all CS
- 2) use weights to calculate differential magnitudes for the science object and all CS

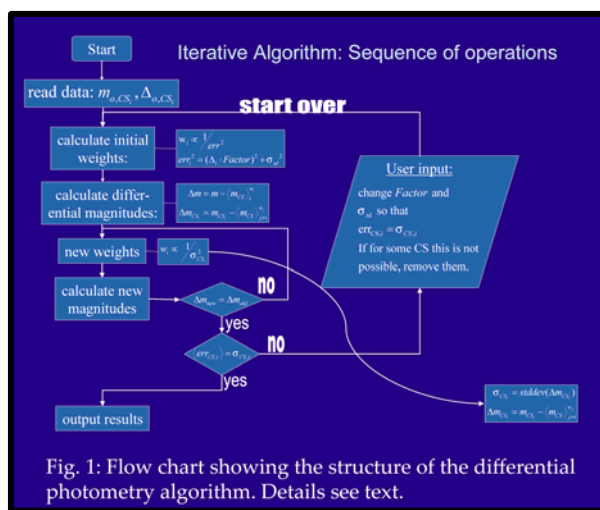


Fig. 1: Flow chart showing the structure of the differential photometry algorithm. Details see text.

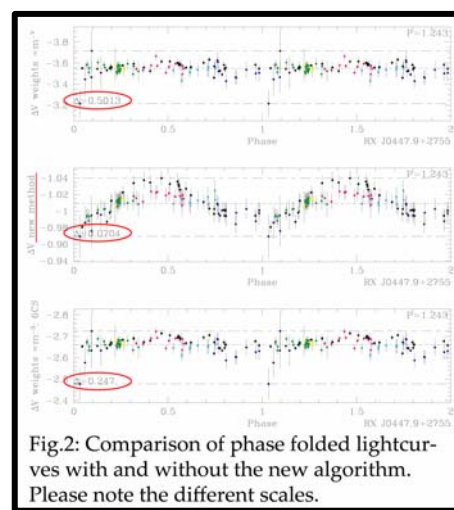


Fig.2: Comparison of phase folded lightcurves with and without the new algorithm. Please note the different scales.

Details of step 1):

- use estimator for the standard deviation s to calculate weights: $w \sim 1/s^2$
 - 1st run: $s = \text{arithmetic mean of modified instrumental errors}$
 - later: $s = \text{standard deviation of differential magnitudes of the CS}$
- weights are then: $w \sim 1/s^2$

Details of step 2):

- the weighed mean magnitude of all CS is subtracted from the object to get the differential magnitude for each exposure
- for each CS the same is done ignoring itself. The remaining weights are rescaled to a sum of one

Principle

- The variability and thus quality of each CS is automatically determined statistically
- This variability is used to calculate the best mean CS

Results

- automatic detection of good / bad CS
- averaged CS has lowest possible variation
- reliable error bars for all measurements

If statistical errors dominate, the algorithm is superior to all predefined weighting schemes. Phase-folded light curves of an example object are shown in figure 2: Using the new method, a variation can be clearly detected, whereas this is not possible for alternative weighting schemes that weight by brightness power-laws.

Conclusion

The new algorithm leads to a significantly improved accuracy. This is especially so when the FOV is a priori unknown and all field stars are candidate comparison stars. When the precision gets high, all CS are subject to show small intrinsic variability. This is best taken into account using this algorithm (see broeg et. al submitted to AN 2004).