

Experiences in how to make precise light curves

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The better the quality of an observed light curve, the more accurately you can determine the time of minimum / maximum. Sometimes you are interested in the details of the shape of a light curve, e.g. from pulsating stars like RRL. Herewith I show you my experiences in how to get precise light curves.

The question is – what screws you have for improving the quality of your light curve?

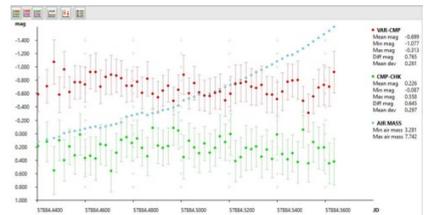
But there are target conflicts:

<i>A sufficient density of data points...</i>	<i>limits the exposure time.</i>
<i>A suitable signal-noise ratio...</i>	<i>needs a sufficient long exposure.</i>
<i>Minimizing statistical error...</i>	<i>needs a high signal-ratio.</i>
<i>Light curves in astronomical filters (J-C)</i>	<i>needs maybe different focus.</i>

What are precise light curves?

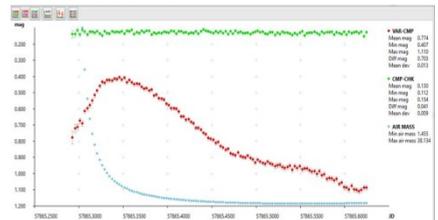
Minor precise light curve **NX Dra** ~15 mag(V) xposure 90s *)

Max value ~3000 ADU
 Sky ~2600 ADU
 difference **400 ADU**
 S/N ratio -11.3 dB / **13.5**
 FWHM 2.0 px



Precise light curve **DG Boo** 12.682(0,77) mag(V) exposure 60s

Max value ~5300 ADU
 Sky ~450 ADU
 difference **4850 ADU**
 S/N ratio -23.1 dB / **204**
 FWHM 2.0 px



*) bright sky because of almost full moon

Instrument RL 200 f/4 with G2-1600 CCD Morvian Instruments

It is obvious, that most important is an as high as possible Signal-Noise-Ratio.

According to my experiences, the following values of S/N indicates good results:

SNR >~ 23 dB (<200) for best quality light curves for RRL

SNR >~21 dB (>150) for still good light curves for RRL

SNR >~20 dB (>100) for good light curves für eclipsing binaries

What screws you have to turn for maximizing the SNR?

a) The difference between the max value of the signal and the background sky should be high enough.

a1) On a bright moon do not observe in the same hemisphere;

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a2) Increase the exposure and check the SNR until you have the right level of SNR. I use the following steps of exposures 15 – 30 – 45 – 60 – 90 – 120 – 150 – 180 individually for different astronomical (Johnson-Coussins) filters.

b) Carefully focus your optical device to ensure a good shape of the signal. My Indicator for that is the **FWHM**

FWHM 1.5 – 2.5 for precise light curves

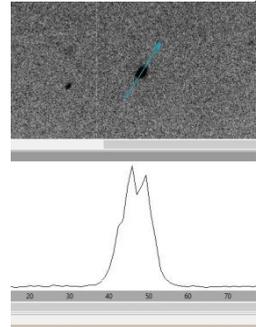
FWHM 2.5 – 4.0 for detection of minima acceptable

FWHM >4 no good light curve at all



I use a Bahinov mask for fast and reliable focusing. With my RL 200F/4 Newtonian, the difference between Blue and Infrared filter is 0.38mm in focus. If I focus in the middle of that range, I do not need to change the focus for different filters and I can keep my FWHM between 1.5-2.0 px.

bad shape



How to check the important parameters?

Before I start the observation, I use Quick Photometry Tool from MuniWin. There I can check all the key parameters of the first single shots in different filters.

The screenshot shows the MuniWin software interface. The main window displays a star field with a selected star marked by a green dot and concentric blue circles. The 'Quick photometry' panel on the right lists the following parameters:

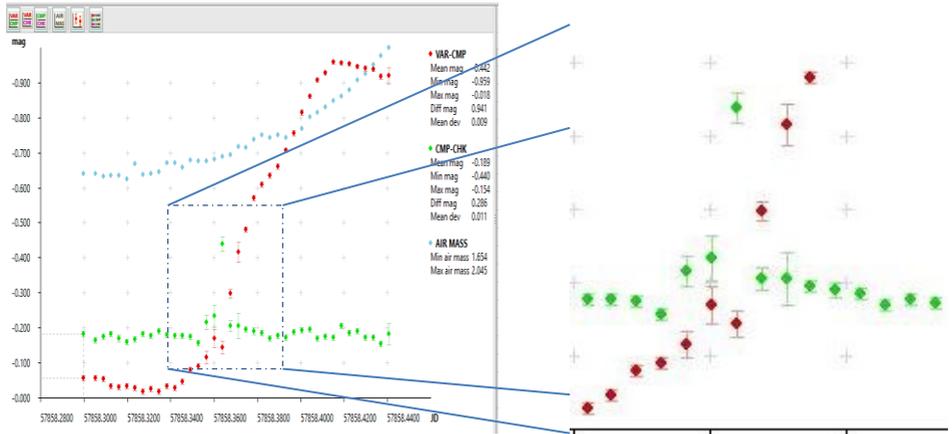
Parameter	Value
Aperture radius	2.00
Sky inner radius	20.00
Sky outer radius	30.00
Max. pixel = (387, 246)	
Max. value =	10683.0 ADU
Sky =	1000.0 ADU
Sky dev. =	16.6 ADU
FWHM(X) =	1.4 pxl
FWHM(Y) =	1.7 pxl
FWHM =	1.5 pxl
Net intensity =	27163.0 ADU
Noise =	124.4 ADU
S/N ratio =	-23.4 dB
Brightness =	13.92 mag
Error =	0.00 mag

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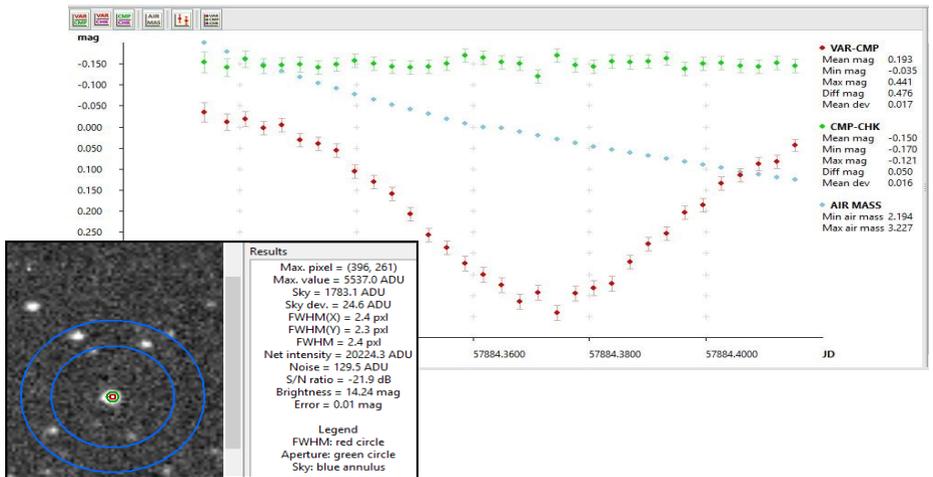
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Unfortunately one screw is fixed: GOOD SKY – GOOD LOCATION:

e.g. passage of a small cirrus cloud during observation:



Example of a good eclipsing binary light curve: LZ Dra ty EW on 2017-05-11



Using this systematical method helps you to improve your results.

Clear Sky, RFA