EXOPLANET PATCHY CLOUD PROJECT

Cross Correlation Test and Preliminary Aperture Photometry Result

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1 SUMMARY

1. Cross Correlation method can align images with the saturated primary star centroid as precise as ~ 0.01 pixels, which is far better than the precision of IDL `cntrd.pro` or `gcntrd.pro` which is more than ~ 0.2 pixels. According to the residual image patterns, cross correlation alignment has better performance tan WCS alignment.

2. Aperture photometry for secondary object in ABPIC system is measured. The light curves are very similar to Glenn's measurement. However, the light curves for two filters, F125W and F160W agree with each other better in my measurement.

3. Considering only statistical uncertainties (counting errors) and fluctuation in the background, a rough estimate gives a result of 0.3% for relative uncertainty for one photometry measurement.

2 IMAGE ALIGNMENT

2.1 ALIGNMENT PRECISION TEST

2.2 THE MODIFICATION FOR IDL crosscorr ROUTINE

2.3 PSF SUBTRACTION RESULT

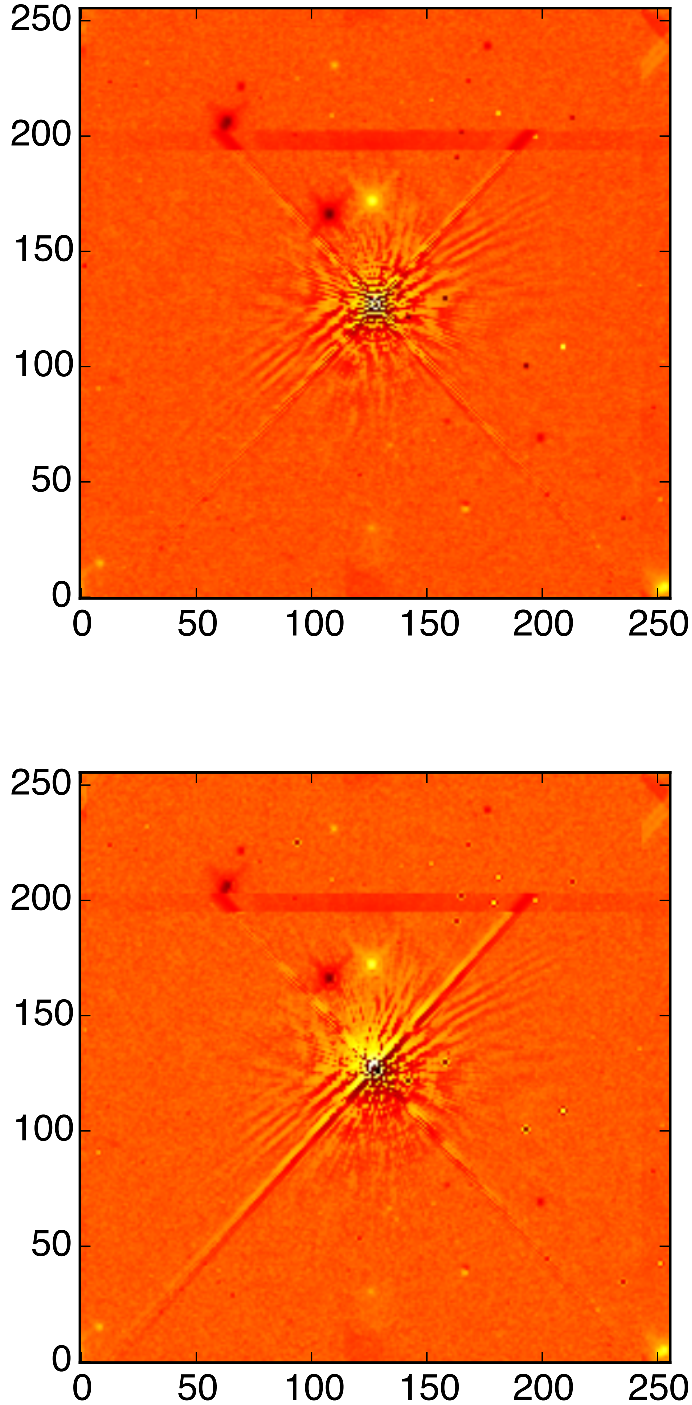

Figure 2.1: PSF subtraction comparison

3 Aperture Photometry Result

3.1 Light Curves

The light curve measurements for both absolute fluxes and relative fluxes are shown in Figure 3.1. Figure 3.2 is Glenn's preliminary measurements. The lower plot in figure 3.1 is very similar to figure 3.2. However, in figure 3.2, the light curves for F125W and F160W show considerable discrepancies in 5th and 6th orbits. However in my measurement, the two curves agree better. Apart from this, the most prominent features are shown in both light curves, e.g. the light curves are lower in 2nd orbit and the discrepancy at start of the 3rd orbit.

3.2 Error Estimation

Considering statistical uncertainty and fluctuation of background sky, the relative error for one aperture photometry measurement is below 0.3% according to my estimation. The error estimation procedure is explained as following.

Statistical uncertainty:

$$\sigma_{\text{stat}}^2 = f\, t_{\text{expo}} \tag{3.1}$$

Background fluctuation:

$$\sigma_{\text{sky}}^2 = N\sigma_{\text{sky},0}^2\, t_{expo} \tag{3.2}$$

Total error are the combination of these two parts:

$$\sigma^2 = \sigma_{\text{stat}}^2 + \sigma_{\text{sky}}^2 = f\, t_{\text{expo}} + N\sigma_{\text{sky},0}^2\, t_{expo} \tag{3.3}$$

Relative uncertainty:

$$\frac{\sigma}{\text{Flux}} = \frac{\sqrt{f\, t_{\text{expo}} + N\sigma_{\text{sky},0}^2\, t_{expo}}}{f\, t_{\text{expo}}} \tag{3.4}$$

The exposure time are 30s for F125W images and 15s for F160W images. Here I adopt 15s for a upper limit estimation. The flux intensity for the exoplanet is ~ 8000 counts per second. The standard deviation for background is ~ 1 counts per second. Plugin those numbers, I estimated a relative uncertainty for 0.3%.

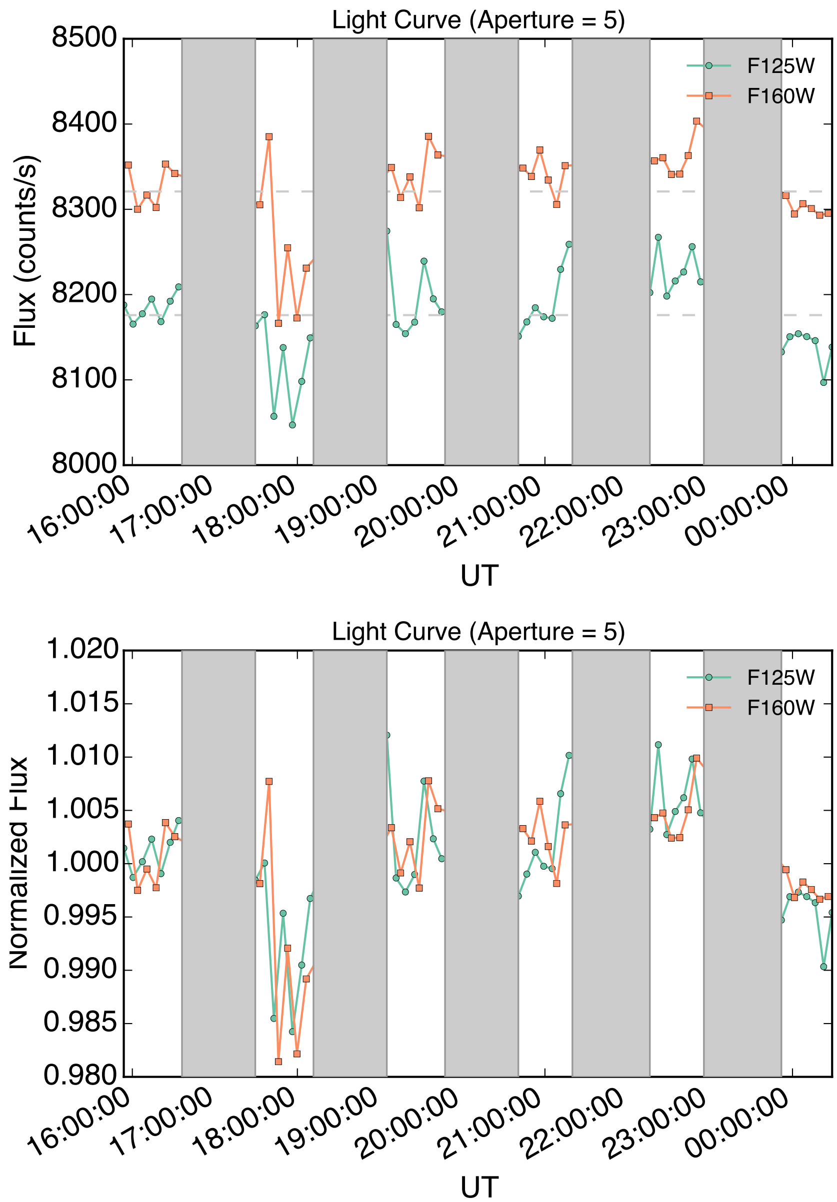

Figure 3.1: Filter F125W and F160W light curves. Upper images shows the curve for absolute flux (count per second) changing with time. The mean values for both light curves are plotted with gray dashed lines. In the lower image, two light curves are normalized with the mean value of itself.

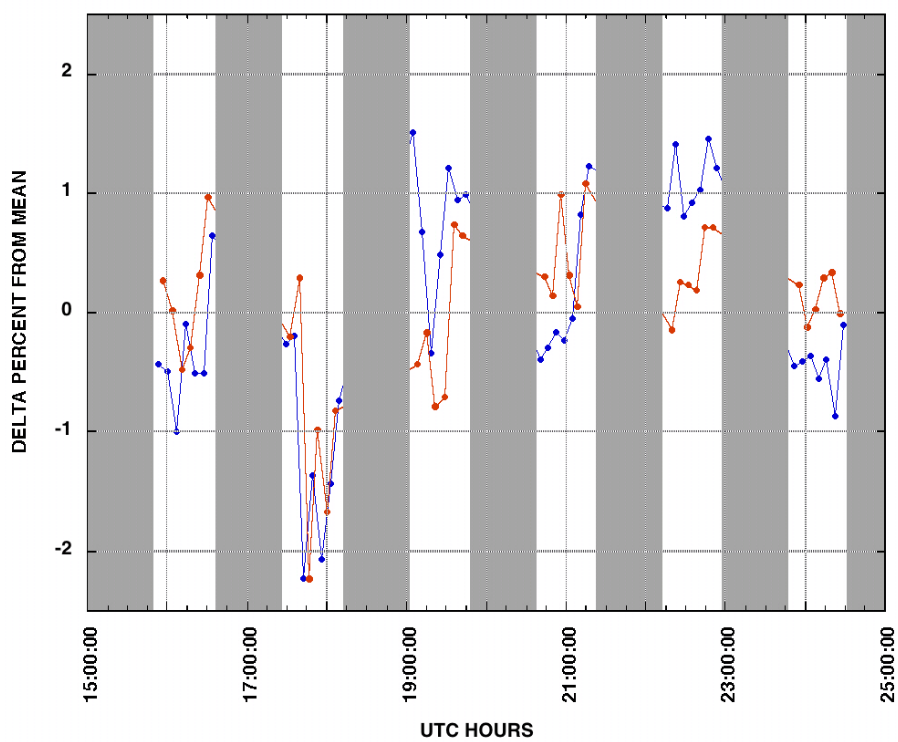

Figure 3.2: Glenn's preliminary measurement