Note for last two weeks

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1 Ramp effect

- In *Wilkins et. al. 2013*
  The ramp effect is neglectable when exposure level is below **30000** electrons per pixel.

- In *Deming et. al. 2013*
  They expected ramp effect to be weakly detectable in their data when their exposure level is about **40000** electrons per pixel.

In our data, the maximum exposure level at the secondary image is ~2000 e^- per pixel, which is far below 30000 e^- per pixel. Therefore the ramp effect in our case should be small enough.

2 PSF photometry

2.1 PSF Generation

Different PSFs are generated with different filter and rolling angle. Therefore totally there were 4 PSFs generated (F125W, Angle 1; F125W, Angle 2; F160W, Angle 1; F160W, Angle 2). Each PSF is the combination of all secondary object images with primary star subtracted, that were taken

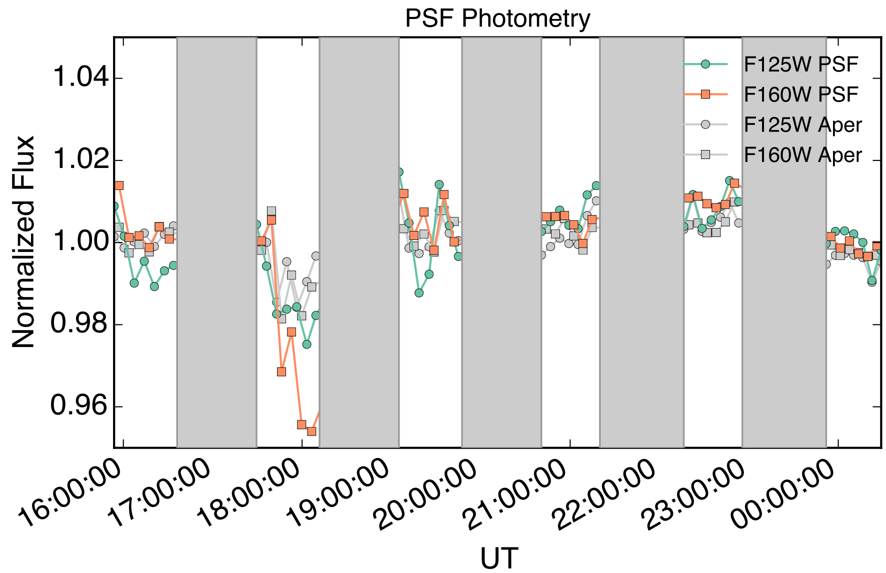

Figure 2.1: PSF fitting light curve and aperture photometry ligth curve

with same filter and rolling angle. The images were not re-aligned with the secondary object centroids (reason explained later).

2.2 Result

Preliminary PSF photometry result is presented with Figure 2.1. Colored lines are PSF photometry light curves, with aperture photometry light curves plotted in gray lines as reference. The PSF photometry results are not well correlated with aperture photometry especially in first two orbits. In last three orbits, PSF photometry seems to match better with aperture photometry.

Figure 2.2 shows the reduced χ^2 for PSF fitting. All F125W images fit terribly with PSF. However, most of F160W images have a good fit, except images taken in second orbit. Accordingly, the F160W PSF photometry light curve has the largest offset in second orbit (figure 2.1) comparing to aperture photometry.

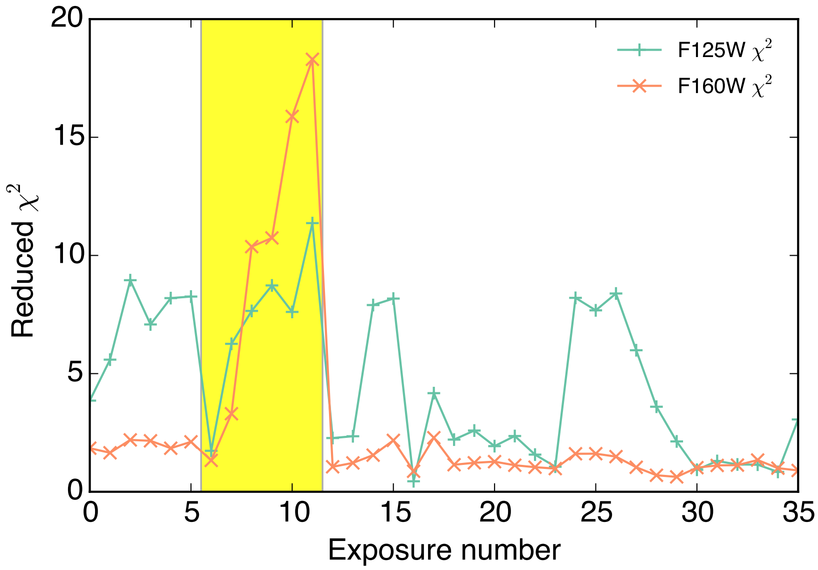

Figure 2.2: PSF fitting reduced χ^2. Yellow shaded patch indicates the 2nd orbit.

2.3 Possible Reason for Bad Fit and other problem

2.3.1 fshift changes PSF

I checked the F160W second orbit images, and found that for the two images that have the worst PSF fit, their secondary object images are clearly from others' – the FWHMs for these two images are 0.2 pixel narrower than those for other images. However in the original images (without registration and primary star subtraction), the PSFs for these two images are similar to those for others.

In the mean time, I found the PSF's FWHM are enlarged by fshift, which I guess is due to bilinear interpolation. For the original F160W PSF, the FHWM is ~ 1.68 pixels. After registration and primary subtraction, it becomes ~ 1.9 pixels.

I did some test and confirmed that fshift did change the PSF. I also found over sampling the image with cubic interpolation (`congrid(,cubic=-0.5)`)first would alleviate this effect but could not eliminate it. I guess the degree that fshift enlarge the FHWM of PSF is related to the fractional part of the shift, but I have not confirmed it yet.

I think fshift could make the PSF slightly unstable and could be one of the reason for bad PSF fit. For this reason, I did not align the image again with the centroids of secondary objects when generating synthetic PSF because it calls for fshift again. Actually for the cross correlation aligned images, the maximum offset for secondary objects' positions is ~ 0.05 pixel, which could cause a ~ 0.1 pixel enlargement in synthetic PSF's FWHM. On the other hand fshift itself could enlarge the FWHM for ~ 0.1 pixel.

2.3.2 How to normalize the PSF?

To get absolute flux measurement, synthetic PSF has to be normalized. I am not sure what factor to use for the normalization.

> aperture radius vs standard deviation use aper.pro to measure photometry and uncertainty

3 Analyze light curve

> is the source varying what is the amplitude in two colors

According to aperture photometry, the peak to peak variation is about 2

> is the change periodic

At least, it is difficult to find a period by eye.

> are the changes in the filter correlated

As shown in 3.1, changes in two filters are well correlated.

> color magnitude diagram (Apai 2013)

I was confused about magnitude system when converting fluxes to magnitudes. STSCI provides three magnitude systems, ST magnitude, AB magnitude, and vega magnitude. I used both AB magnitude and vega magnitude for conversion and listed the plots in figure 3.2.

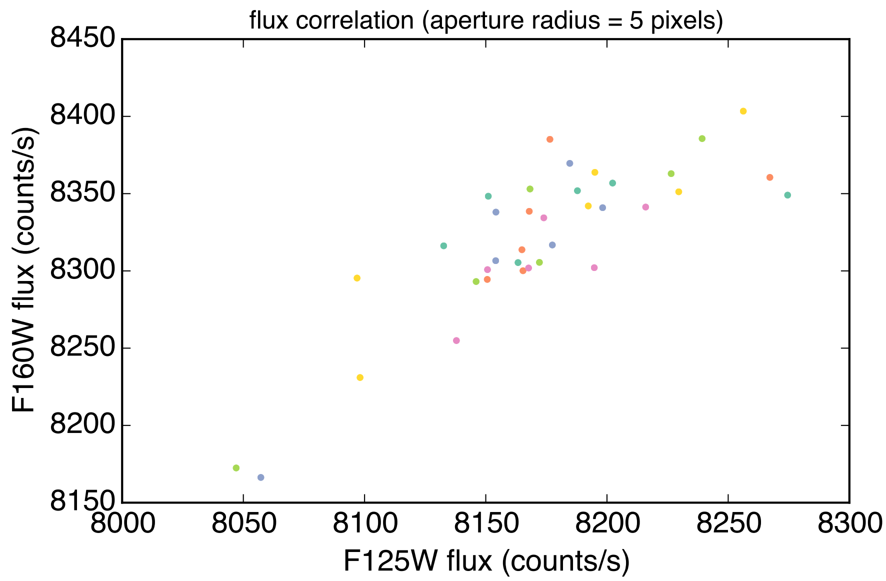

Figure 3.1: F160W flux vs. F125W flux. Different colors indicate different orbits.

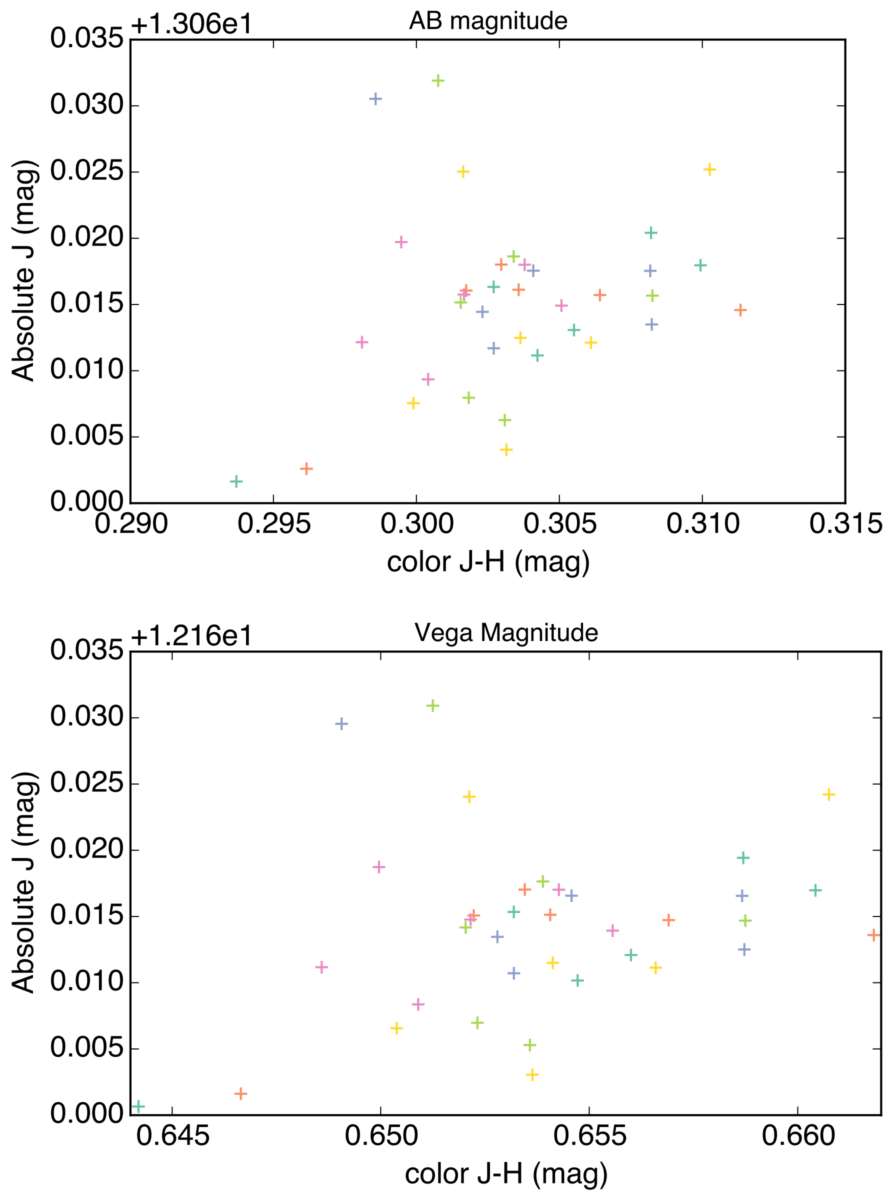

Figure 3.2: color magnitude diagram, different colors indicate different orbits

4 Optimization of Aperture Size

Optimum aperture size is related to the estimation of background fluctuation. A difference of 1 count/pixel difference in background fluctuation could lead to 0.5 pixel change in optimum aperture radius. Aper.pro routine provides 2 ways to define sky fluctuation:

1. directly input sky level and fluctuation when calling the program. The sky value and sigma should be calculated before hand.

2. input annulus radii of the sky region and let the program calculate it. The sky region here must be an annulus around the secondary object in this case.

I choose to calculate the sky fluctuation separately rather than let aper.pro calculate.

1. if the annulus is too close to the secondary object, the flux of the secondary image could contaminate the sky and end up with a higher estimation of sky level and an inaccurate estimate of sky fluctuation.

2. The annulus radii cannot be large too. Because the slight change of PSF, the image of the primary cannot be removed completely. The residual of the primary image fluctuate largest at the center region as well as the diffraction spikes region. When the annulus radii get slightly larger, the annulus would include these region. If the annulus radii get even larger to avoid these region, it would cause an under-estimate of the sky fluctuation because the area of this annulus is not affected by psf subtraction.

The optimum aperture radius turned out to be very small, it ranges from 2.8 to 3.5 pixels. which is only 1 pixel larger than fwhm of the image, which is 1.8 pixels.