**Profile Fitting Photometry Project**

The goal of this project is to recover the magnitude of asteroid TEA in the infrared. As you remember, TEA was accidentally saturated in the infrared images taken a few years ago. We need to recover this magnitude to place the final piece in a longish project that we’ve been working on for over two years.

Tea images [here](https://drive.google.com/drive/#folders/0B44FvvLeyjLKemlFRlRqRWVXMXc/0B44FvvLeyjLKfmUwbmt5TXN1WERuR0RNS3F0bVlQQkNwQUM0Z2FybjhLNXBWb3gzeDZkMXc/0B44FvvLeyjLKfk9DdUJnVFZLSHFyWm5Yd2FqdHAyX0dZTW1wQTQySGNtRWk5MVY4VWJrNUU), along with some other files that might give you a sense of Tea’s location in the images.

You are going to need to use a program called APT to do the profile fitting. You can download it from [here](http://www.aperturephotometry.org).

APT tutorials [here](https://www.google.com/search?client=safari&rls=en&q=using+APT+rebull+youtube&ie=UTF-8&oe=UTF-8). The best one is about 30 minutes long (third or so on the list).

The generic description of how profile fitting Photometry is done in wise is here:

<http://wise2.ipac.caltech.edu/docs/release/allsky/expsup/sec4_4c.html#wpro>

in includes in the next sub-section stuff about how they defined an ideal psf.

If you go down even further in this section, there is a section on "Extended wings of PSFs", which is what we were talking about -- that is, fitting a PSF to the point source, but only fitting the wings, not the peak (which is saturated).

Here are two papers describing the APT software, developed by a fellow named Russ Laher. We have had some correspondence with him (below), and I think he will help us once we have a general sense of what we’re doing.

<http://adsabs.harvard.edu/abs/2012PASP..124..737L>

<http://adsabs.harvard.edu/abs/2012PASP..124..764L>

This is a useful email chain...

On May 23, 2014, at 4:04 PM, Luisa Rebull <rebull@ipac.caltech.edu> wrote:

The images didn't come along with the reply, but coordinate systems are a bear. It depends exactly how the coordinates were calculated when they were attached to the images. From where are you getting these images? The real essence of the question is where the coordinates are coming from that are attached to the images? Are you doing the WCS solution? Or is someone else's pipeline? Are you sure that the coordinates that are getting attached are, in fact, correct?

cheers,

Luisa

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On May 23, 2014, at 10:00 AM, Russ Laher wrote:

Hi Caroline,

Sorry for the delayed response. This might be a better question for Luisa since I am not familiar with the data with which you are working. The position of the big star in the upper left corner of a0134.fits, according to APT, is

RA=153.419815 degrees,

Dec=566160 degrees

and this is in excellent agreement with the FK5 position given by SAO DS9. Perhaps your list of star coordinates are given in a different celestial reference frame.

Regards,

Russ

P.S. FYI, APT uses the FITS header keywords listed below to compute the equatorial coordinates for the tangent projection:

CTYPE1 = 'RA---TAN' / Coordinate Type

CRPIX1 = +5.280000E+002 / Pixel coordinate of x-reference

CRVAL1 = +1.535812545E+002 / Coordinate at x-referene

CDELT1 = -3.310163E-004 / Image scale on x-axis, deg per pixel

CTYPE2 = 'DEC--TAN' / Coordinate Type

CRPIX2 = +5.120000E+002 / Pixel coordinate of y-reference

CRVAL2 = +1.540857886E+001 / Coordinate of y-reference

CDELT2 = -3.310163E-004 / Image scale on y-axis, deg per pixel

CROTA2 = +1.803388E+002 / Rotation of XY coordinate system

At (CRPIX1, CRPIX2) in the image (in pixels), the sky position is (CRVAL1, CRVAL2), which is (RA, Dec) in degrees.

On May 20, 2014, at 6:03 AM, Caroline E Odden wrote:

Hi Russ,

Thanks for these instructions. James has a list of stars with coordinates and catalogue magnitudes. The trouble is that the coordinates appear to be off in APT. In other words, we think we know the coordinates of various stars in our images, but APT disagrees. How does APT determine the coordinates? Is that in the fits header? We could go back in and match the stars in the images visually with the star chart and pattern matching, but now we are curious to understand why the coordinates appear to be incorrect in APT.

I am attaching the three images we’re working with, just in case you would like to see them.

Thanks so much,

Caroline Odden (James copied)

On Mar 27, 2014, at 1:24 PM, Russ Laher <laher@ipac.caltech.edu> wrote:

Hi Caroline and James,

Luisa asked me to contact you about your APT question. I do not have a tutorial on using APT's source-list tool at this time. However, this may lead to such a tutorial, after I learn about the difficult issues that need addressing.

Regarding the goal of finding the magnitude zero point of an image, I think the steps are to:

1. Identify a number of calibrator stars in your image. These must be isolated (no neighboring stars that are really close by), relatively bright, but unsaturated. The more the better. Calibrator stars have known absolute apparent magnitudes in the band pass of the filter used to acquire the image you are photometrically calibrating. You typically consult a reference catalog to look up their absolute apparent magnitudes.

2. Perform aperture photometry on the cal ibrator stars in your image. This will give you an instrumental magnitude for each calibrator star. Instrumental magnitude is a relative or uncalibrated apparent magnitude:

<http://en.wikipedia.org/wiki/Instrumental_magnitude>

3. The magnitude zero point may be found simply computing the average of the differences between the absolute apparent magnitude and the corresponding instrumental magnitude. A refinement to this method is to exclude any calibrator star that deviates from the average by more than, say, 0.1 magnitudes (this is called "outlier rejection").

I am attaching an Excel spreadsheet that has an example calculation for 15 calibrator stars, in which the instrumental magnitudes are simulated by subtracting off the true zero point (27) from the absolute apparent magnitude and adding +/-0.2 magnitudes of random noise. Cell D20 gives the estimated magnitude zero point by the method I have described above. You can use function key f9 to draw another random sample of instrumental magnitudes.

It would help if you could send me your image. I will then be able to guide you better on how to use APT's source-list tool.

Best regards,

Russ

The excel spreadsheet referred to in the email above is [here](https://drive.google.com/drive/folders/0B44FvvLeyjLKemlFRlRqRWVXMXc/0B44FvvLeyjLKfmUwbmt5TXN1WERuR0RNS3F0bVlQQkNwQUM0Z2FybjhLNXBWb3gzeDZkMXc).