**KELT Pipeline Processes**

**Opening Full Image Files**

Before using the main portion of this pipeline you will need to load a stack of fits

image files, cut out selections of target star images within the stack, and save these

cutouts as text files. The first step is to specify the path of the directory that contains

the fits image files. You will need to also create a folder to store your target star cutouts

and then specify the path of the file names would you like to give to these cutouts. The

pipeline will then sort the fits files in alphanumeric order and then open them. Next, you

will need to specify the first and last file in the file range you would like to get image

data (individual pixel flux values) from and the pipeline will retrieve this data. It is best

to load the data in smaller chunks instead of all at once so that your memory is not

exceeded.

**Creating Image Cutouts**

Once all the data has been retrieved you can then cut out your target star

images from the fits file image stack by specifying the y and x pixel range for your

target. The cutouts should include 1-5 comparison stars with the target at the center.

Generally, an image size between 80 by 80 and 120 by 120 pixels should be large

enough to include an adequate number of comparison stars, but larger images may be

needed if there are very few stars surrounding the target. The pipeline will then save the

image data from the cutouts as text files. Once a set of target images has been saved

for a particular star there is no need to run this part of the pipeline again if you need to

close the notebook or restart the kernel.

**Producing a Light Curve and Phase Curve**

This main portion of the pipeline allows you to create a light curve and phase

plot for the target star by using a background flux annulus and the comparison stars in

your target image. The first cell will retrieve the data from the target image cutouts that

was saved in the previous section. In the beginning of the next cell, the pipeline will

create a close up image of the target (labeled “Target Star Image”) so that the target

aperture and annulus for the background flux can be positioned properly. You will first

need to specify the image file number and x by x pixel size you would like to display a

close up image for. The pipeline then creates an array of the flux values in the image.

Next, the pipeline asks you to specify pixel sizes and positions for the target aperture

and background annulus, and the pipeline will then create an image of the target with

this aperture and annulus. A larger image of the target star with the comparison stars

(labeled “Comparison Stars Image”) will be created using the target aperture and

background annulus properties previously specified. Once you specify the properties of

the apertures for the comparison stars, the pipeline will create the comparison stars

image.

Next, you want to specify the first and last image file you would like to perform

photometry on for the creation of the target star light curve. These numbers can be

adjusted later to get rid of unwanted flux values (see Examining Abnormal Flux Values section). The median of the flux values contained in the background annulus will then

be calculated by the pipeline. Photometry on the target aperture will be performed by

summing up the flux values contained in the aperture and subtracting out the

background flux within the aperture. Zero flux values will be disregarded and the

pipeline will create a target flux vs. time plot with flux normalized to the highest flux

value. The same photometry process will then be completed using the comparison star

apertures to obtain the total flux from all the comparison stars and a comparison flux

vs. time plot with be created using flux normalized to the highest value. The pipeline

then subtracts the target flux from the total comparison flux and creates a flux vs. time

light curve for the target star. Since subtracting these values will sometimes result in

negative flux, the flux is normalized to the difference between the highest and lowest

flux value.

The Lomb-Scargle Periodogram is used to calculate power values for a

specified period range for the target star with the target light curve flux and time values

as inputs. LombScargle will produce frequency and power values as outputs and the

pipeline creates a period vs. power periodogram for the target. The highest power

value indicates the most likely period for the target. The pipeline calculates the phase

of the target star by folding the target light curve at the most likely period for two

cycles. A phase curve with flux vs. phase is then created for the target and the pipeline

will print out the target’s most likely period with its corresponding power value.

**Diagnostic Tests**

**Creating Flux Histogram**

This diagnostic tool allows you to create a histogram of flux values within a

specified target aperture. The target image properties including the file number, x by x

pixel size, and target aperture and background annulus geometry are specified and an

image of target star is created similar to the Producing a Light Curve and Phase Plot

section. The pipeline then creates an array of flux values within the target aperture.

Once a bin size has been specified, a histogram of the flux values within the aperture

will be created. Creating this histogram with different aperture positions and sizes will

allow you to get a sense of the distribution of flux values for the target star.

**Examining Abnormal Flux Values**

This diagnostic application allows you to examine abnormally high and low flux

values on an individual basis. The first step for this section is to cut out an image from

your fits file image stack that includes the large surrounding area of the target star and

save these cutout images using the methods described in the Creating Image Cutouts

section. An image cutout of around 400 by 400 pixels should be sufficient. Once these

cutout images have been saved you can use the first cell in this section to specify the

file names of the cutouts and the pipeline will load the images and retrieve their flux

data.

In the beginning of the second cell, the target image properties described in the

Producing a Light Curve and Phase Plot section are specified, and an image of the

target star is created. The surrounding area image will be created using the target

aperture and background annulus properties previously specified. Photometry on the

target aperture will be performed by summing up the flux values contained in the

aperture similar to the Producing a Light Curve and Phase Plot section, but the zero

flux values will not be discarded. The pipeline will then produce a target flux vs. time

plot containing both zero and non-zero flux values. You can then specify upper and

lower flux limits and the pipeline will print all flux values that fall above and below these

limits with their corresponding image file number. You can then pick a particular

abnormal flux value and change the image file number at the top of the cell to the

abnormal flux’s file number. This will allow you to view the target image and large

surrounding area of the target for this flux value and determine what is causing the

value to be significantly high or low.