

# **Astronomy 16 – Modern Astrophysics**

Fall 2014

Lab 5 - background

Wednesday, December 3, write-up due by Wednesday, December 10 at noon

Now that you've had several experiences reducing data, and also done the transit photometry on WASP-11, you'll do a complete analysis of data I took last week of an exoplanet transit candidate and try to discover an exoplanet of your own.

In this document, I'll provide some background information, which you should read before coming to lab on Wednesday night.

Note that on Wednesday night, we'll spend about 30 minutes finishing up our exoplanet lecture (and discussion!). Then we'll have some time to work with data and for you to get help from me, and to plan out the steps you'll take to complete the lab.

Of course there'll be special incentive to be the first student to get your light curve finished and analyzed to see if we might have a planet. It's a pretty exciting feeling to learn something significant about the universe and know that you're the only one of the seven billion people to know it.

In any case, here's an outline of the overall workflow:

- reduce raw data (biases, darks, flats)
- do aperture photometry on the target plus potential comp stars
- optimize the comp-star choice to produce a good light curve
- assess noise and systematic trends

- fit a transit model to your light curve to determine the exoplanet size (or place a limit on it) and several other parameters
- write up your results in a lab report that includes images and makes quantitative (if tentative) conclusions about the possible exoplanet's properties

The first few steps of the process are things you've done before. The data reduction instructions and the photometry instructions are now posted on the right side of the class website. There are several other useful data-related links collected there.

To prepare for the lab, please do the following:

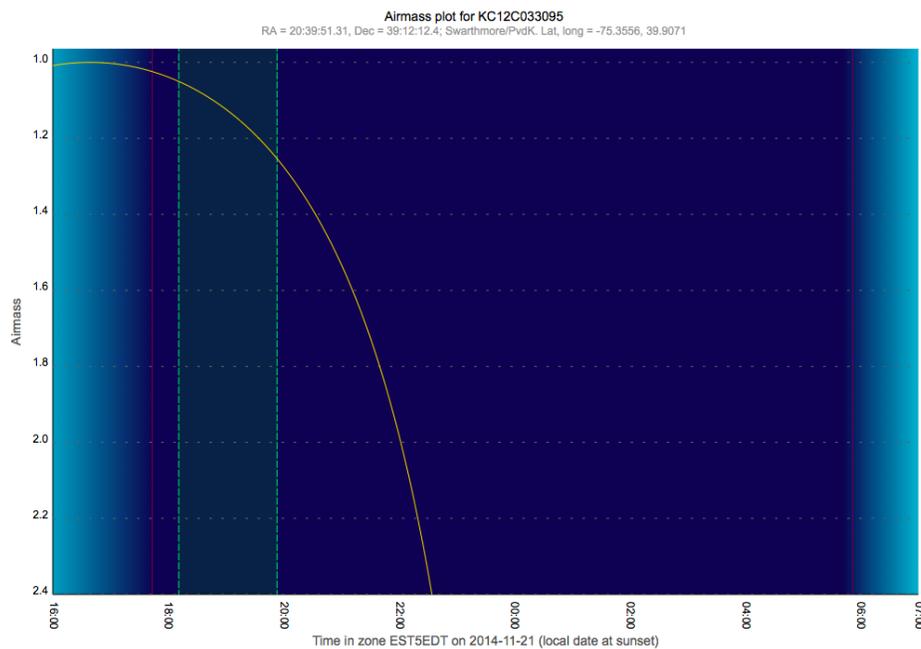
1. Review the slides from Tuesday's class (as well as your notes and the material in Ch. 12, sec. 3).
2. Go to the Observatory website's *research* page: <http://www.swarthmore.edu/peter-van-de-kamp-observatory/research> and follow the link to the KELT website. Read the short description of the *method*. Also check out the telescope link and note how small it is. What does KELT stand for? The last slide from Tuesday's class summarizes the follow-up method.
3. Go back to the Observatory site and look at the paper on KELT-2Ab. (Link to pdf is near the top left of the ADS page; ADS is the go-to source for astronomy research papers.) The paper is actually short and you can skim it (though many details will not be easy to understand). Instead, read the abstract and the first two figures and their captions. And peruse Table 2.
4. Read the following information about the target:

Here was the observation planning interface (part of Tapir, but a restricted access part that has the master list of KELT candidate host stars):

Name	V mag	Start—Mid—End	Duration	BJD <sub>TDB</sub> start-mid-end	Elev. at start, mid, end	RA & Dec (J2000)	Period (days)	Depth (mmag)	Priority
<a href="#">KC03C08665</a> Finding charts: <a href="#">Annotated</a> , <a href="#">SkyMap</a> ; Info: <a href="#">KELT page</a> , <a href="#">Simbad</a> , <a href="#">2MASS</a> ; <a href="#">Airmass plot</a> , <a href="#">ACP plan</a>	11.91	15:54—18:15—20:36	4:43	6983.371 6983.469 6983.568	08°, 30°, 55°	03:42:21.14 +40:12:59.8	10.07	30.8	10
<a href="#">KC12C033095</a> Finding charts: <a href="#">Annotated</a> , <a href="#">SkyMap</a> ; Info: <a href="#">KELT page</a> , <a href="#">Simbad</a> , <a href="#">2MASS</a> ; <a href="#">Airmass plot</a> , <a href="#">ACP plan</a>	11.23	18:11—19:02—19:53	1:42	6983.466 6983.501 6983.537	72°, 62°, 52°	20:39:51.31 +39:12:12.4	0.51	12.8	2

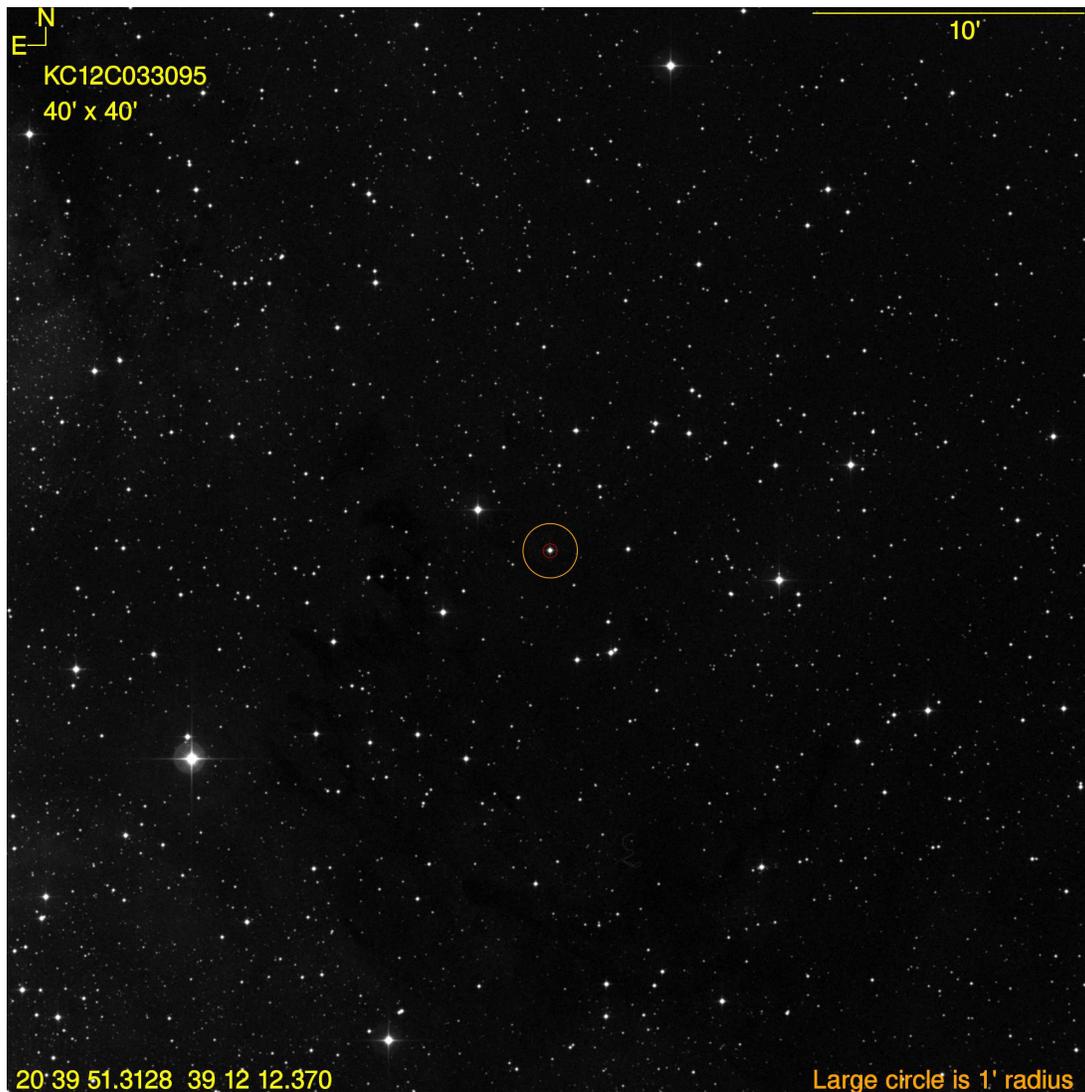
It's that second star I observed. Take a look at the information in the table.

Here's the airmass plot:



So you can see I had to observe it right after sunset. And it was going down (so the airmass and associated extinction increases throughout the observation).

Here's the annotated finding chart (compare to the real data, once you load it in AIJ):



5. You should download the data and put in on your computer prior to coming to lab. You can do as much of the data reduction and analysis as you want prior to coming to lab.

[http://astro.swarthmore.edu/astro16/labs/data/lab5\\_data.zip](http://astro.swarthmore.edu/astro16/labs/data/lab5_data.zip)

Specific information about optimizing your light curve and fitting a transit model (and interpreting the results) will be given to you later and shown to you during our lab meeting.