## Lab 7  - Extrasolar Planets
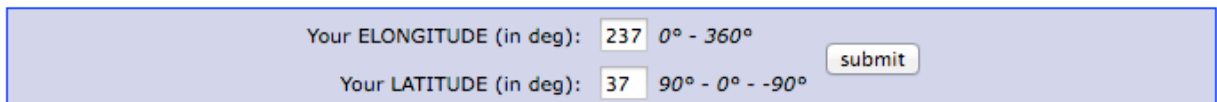
The existence of extrasolar planets; planets outside our solar system, was not confirmed until 1995. http://planetquest.jpl.nasa.gov/page/history Since then, NASA's Kepler mission alone, http://www.nasa.gov/mission_pages/kepler/main/#.VBIY7V5XZiE  has logged almost 1,000 confirmed planets, and over 4,000 planet candidates (9-14). Some of these are in the habitable zone.  http://en.wikipedia.org/wiki/Circumstellar_habitable_zone

Modern CCD cameras and processing software, with careful effort, allow students to measure and graph many of these exoplanets as they transit their host star. The parent star's brightness dips during transit, by typically ~1%.

Before exploring transiting exoplanets in detail, we will locate potential targets using Exoplanet Transit Database (ETD) website:  http://var2.astro.cz/ETD/predictions.php

Open **ETD** and go to the **Transit Predictions** page.
Enter **ELONGITUDE 237.6** (that's east longitude) and **LATITUDE 37.5** for CSM Observatory, and hit the **Submit** button.



ETD website

Under **Available Predictions**, first choose *today's **local date***. Begin, Center, and End transit times will then be listed in UT time. During imaging, it will be the next calendar day in Greenwich. For transit information in local time:

Subtract 8 hours from the UT times listed, for local Pacific Standard Time (PST).
Subtract 7 hours from the UT times listed, for local Pacific Daylight Time (PDT).
For instance:
For PST, 4:00 UT on Dec. 2, is 8:00 pm local time on Dec. 1 (4:00 am - 8 hours)

*Exact begin, middle, and end of transit, and target altitude, are critical. At least one hour setup time must be considered, to power on equipment and carry out all procedures as noted in ASTR 203 p. 26-29.*

Below is an example ETD listing of exoplanet WASP-39 b.
http://www.superwasp.org/exoplanets.htm

Here we chose exoplanet WASP-39 b with a transit on July 22. All dates/times are UT and the local date is July 21. ETD gives us the following information:

Transits predictions for ELONGITUDE: 237.67° and LATITUDE: 37.53°

| OBJECT | | BEGIN (UT/h,A) | CENTER (DD.MM. UT/h,A) | END (UT/h,A) | D (min) | V (MAG) | DEPTH (MAG) | Elements Coords |
|---|---|---|---|---|---|---|---|---|
| WASP-39 b | Vir | 3:46 48°,SW | 22.07. 5:10 37°,SW | 6:34 23°,SW | 168.2 | 12.1 | 0.0215 | 55342.9688+4.055259*E RA: 14 29 18.43 DE: -03 26 40.20 |

ETD website

**Begin transit** is 8:46 pm PDT (3:46 UT minus 7 hours) with WASP-39 b 48 degrees above the southwest horizon in Virgo.

**Center of transit** is 10:10 pm PDT (5:10 UT minus 7 hours) with our target 37 degrees above the southwest horizon. The UT date, 22.07 is also listed.

**End transit** is 11:34 pm PDT (6:34 UT minus 7 hours) with our target now 23 degrees above the southwest horizon. ETD transit times are extremely accurate, and converting to local times quickly becomes routine with practice.

We also see **duration D** of WASP-39 b transit is 168.2 minutes. **Magnitude V** (visual) of the target is 12.1, and deltaV (dimming) **DEPTH MAG** is .0215.
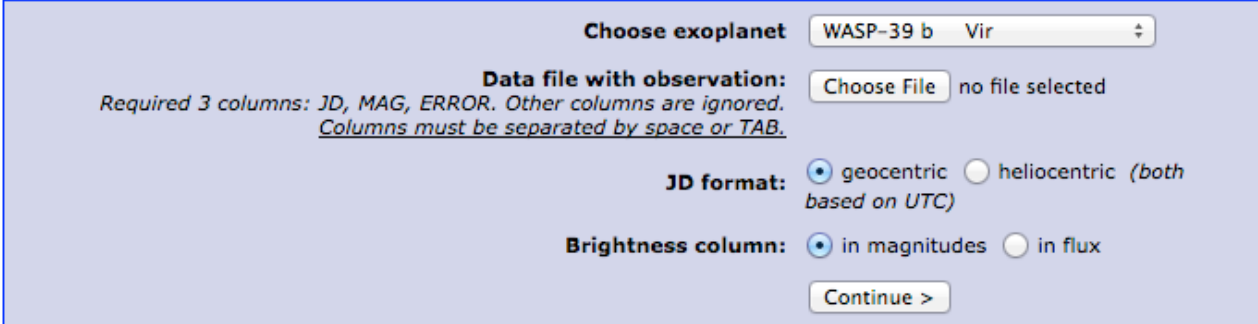
RA and DEC are also listed, though an AAVSO chart will be provided, with either an SAO or GSC star identifier, found in the Sky6 database.  SAO or GSC catalog numbers are sometimes found on Simbad. http://simbad.u-strasbg.fr/simbad/sim-fbasic

Follow extrasolar planet imaging procedures in ASTR 203, Lab 6, p.29, and photometry processing procedures in ASTR 203, Lab 8, p.31-34.

When processing exoplanet data in Maxim DL, save a .png screen shot of your target and comparison stars. Also save a **.csv** (comma seperated values) file of your data for analysis in Excel. Save a second .csv file, but first replace the commas (,) with spaces ( ), using the **"find and replace"** function in Notepad (Windows). This data file and image will be sent to ETD for publishing.

Next, we'll submit and compare our exoplanet data at ETD website database.

To contribute your data to ETD website, go to the **Model-fit your data** page at top of the website. http://var2.astro.cz/ETD/predictions.php Choose your exoplanet target from the drop down menu, then select **Choose File** and navigate to your data file.



ETD website

Follow directions to upload your data and the screen image taken earlier, and answer a few questions about your imaging procedures and equipment. Data is normally published to ETD within one week.