

## Section II -Photometry

### Procedure

On close inspection, many stars exhibit distinct brightening and dimming over specific periods. In photometry, we observe and measure these changes in apparent magnitude, [http://en.wikipedia.org/wiki/Apparent\\_magnitude](http://en.wikipedia.org/wiki/Apparent_magnitude) resulting from various events:

**Eclipsing Binaries**, where both components eclipse each other within our line of sight. <http://www.physics.sfasu.edu/astro/ebstar/ebstar.html> Contact binaries, where both components are touching, can have fast periods on the order of hours. Algol-type, binaries may have similar periods, but are not touching.

**Transiting Exoplanets**, which are planets orbiting other stars in our line of sight. <http://en.wikipedia.org/wiki/Exoplanet> The exciting discovery of exoplanets is fairly new in astronomy. We will determine the beginning, middle, and end transit times of chosen, known exoplanets. Student exoplanet data is submitted to ETD (Exoplanet Transit Database) website <http://var2.astro.cz/ETD/predictions.php> and posted to CSM Student Projects page.

**Pulsating Variables** [http://en.wikipedia.org/wiki/Variable\\_star#Pulsating\\_variable\\_stars](http://en.wikipedia.org/wiki/Variable_star#Pulsating_variable_stars) and **Supernovae** <http://en.wikipedia.org/wiki/Supernova> also exhibit distinct brightness changes over periods of hours, days, and weeks. Any observable super nova occurring during the semester will be imaged collectively by students and posted on our website along with other student data. <http://collegeofsanmateo.edu/astronomy/>

The American Association of Variable Star Observers (AAVSO) is an excellent source for additional information on variable star types. <http://www.aavso.org/types-variables>

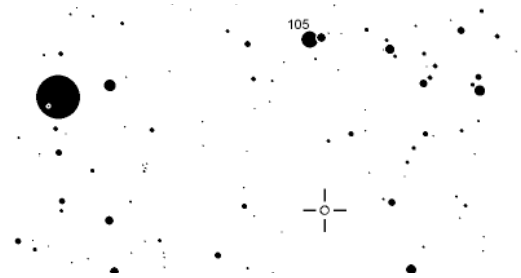
Taking photometric data in labs 5 thru 7 involves startup procedures covered in **Section I** including focus and autoguider calibration. Data gathering procedures are the same for binaries, exoplanets, and other variables.

Times for all events are calculated in JD time [http://en.wikipedia.org/wiki/Julian\\_day](http://en.wikipedia.org/wiki/Julian_day) and converted to UT time <http://ssd.jpl.nasa.gov/tc.cgi>. This includes Time of Minimum (ToM), or mid-eclipse of binaries, and the transit times of exoplanets.

AAVSO Variable Star Plotter (VSP) charts <http://www.aavso.org/vsp> of specific target fields will be provided. These charts are used for star identification and later photometry measurements in Lab 8.

*These procedures begin one hour before imaging.*

Review the AAVSO star chart provided, to see the target star (with crosshair) in the field. The target is pre-chosen based on availability and altitude during class time. Any numbered stars in the chart will later be used to calculate magnitudes in Lab 8.



AAVSO chart

**On the telescope computer**, confirm **TheSky6** and **CCDSOft** software are started correctly, and all outside equipment is powered on and ready to image, using procedures learned in **Section I**. This includes CCD temperature, telescope sync, focus, and autoguider calibration.

Locate and acquire your (provided) target star from **TheSky6** library: Choose **Finder\_Stellar** and enter the GCVS (General Catalog of Variable Stars) number to locate and slew to your star. In Focus Tools, on the imaging chip, take a 5 second confirmation image to identify the field of view and target star, using the **AAVSO** chart provided.

Position your target star using Motion Controls (**NSEW** buttons), to include 2 or 3 comparison stars in the field of view, as possible. Comparison stars (non-variables) are the numbered stars on the **AAVSO** chart, and are later used to calculate brightness changes in your target.



Motion Controls TheSky6

After carefully positioning your FOV on the imaging chip, switch to the guide chip, locate a guide star, initiate autoguiding, and confirm good autoguider numbers below 1.0 average error on both axes. Autoguiding now continues until all data is gathered.

With the autoguider running, on the imaging chip take a **subframed exposure** (left click drag) cropped close to the target star. Determine the exposure time and binning needed for a signal of about 25,000 – 45,000 ADU (Analog-Digital Unit), a measure of pixel value. The necessary exposure and binning will depend on the target's magnitude. Also see **AAVSO CCD Observing Manual**. <http://www.aavso.org/ccd-observing-manual>

To determine the exposure, start with a 30 second bin 1x1 image, check the peak value of your target (subframe) in **CCDSOft**, and adjust the exposure and binning until the desired ADU count is achieved on your target star. 30-60 second exposures, binned 1x1 or 2x2 are common. You are now ready to begin taking photometry data.