# Homework # 1 - Observing Stars

**Due:** Tuesday, January 31 at 2:00pm
**Reading:** Lecture Notes, Pols chap 1, BOB chap 7 & 8.

**Instructions:** Homework must be highly legible, on white paper, and with multiple pages stapled. List at the top:

- Your name.
- Collaborators (if applicable).
- Estimated time spent to complete.

Homeworks are due at the beginning of class. Late homeworks will be marked down by 50% until the assignment is graded and returned, and will receive no credit after that. Clearly outline the process for solving the problem: partial credit will be given for presenting the correct steps to solve problem, even if you do not achieve the correct numerical answer.

**Problems (3 questions, 20 total points):**

1. Parallax is critically important for understanding stellar properties. But despite its simplicity (just geometry!), most stars in the sky have been inaccessible to reliable parallax measurements - until very recently. (**8 pts total**)

   (a) Can you reliably measure parallax to any stars with your eye? (**2 pt**)

   (b) Galileo's telescope had a 3 cm aperture. How many stars could he resolve parallax for? (**2 pt**)

   (c) The *Hipparcos* satellite was a dedicated astrometry and parallax experiment that operated from 1989-1993. It had an angular resolution of 1 mas ($0.001''$). How many stars over the entire sky could have parallax measured by *Hipparcos* with at least 10% precision? (*Clearly state your assumption about the density and distribution of stars around us.*) (**2 pts**)

   (d) *Gaia* launched in 2013 and achieves an astrometric precision of 7 $\mu$as ($7 \times 10^{-6}{}''$). It is still operating, and had a major data release in April 2018. How many stars over the entire sky can *Gaia* measure parallax with at least 10% precision? (*Again, clearly state your assumptions.*) (**2 pts**)

2. Let's use an H-R diagram to age-date two star clusters. Download the files `cluster1.dat` and `cluster2.dat` from the course HuskyCT page. These are the $(B-V)$ colors and apparent $V$ magnitudes for stars in two open clusters in the Milky Way, compiled from the WEBDA database (`http://webda.physics.muni.cz`). **(8 pts total)**

   (a) Plot both in an H-R diagram of apparent $V$ magnitude versus $(B-V)$ color, labeling your axes and orienting the y-axis to be brightest at the top and faintest at the bottom. You can make two separate H-R diagrams, or color-code each cluster and plot both in the same diagram. **(4 pts)**

   (b) What is the approximate age of each cluster? **(2 pts)**

   (c) The two clusters are offset on the y-axis. Why? **(1 pt)**

(d) One of the clusters has a rather broad main sequence in the H-R diagram, almost like parallel tracks. What's going on here? **(1 pt)**

3. An eclipsing binary star system has a period of 5 days. Two absorption-line components are observed with maximum radial velocities of 50 km/s and 100 km/s. (**4 pts total**)

   (a) What is the mass of each star? (**2 pts**)

   (b) The fast star is smaller, and takes 2 hr to go from first contact to minimum in the lightcurve. Totality of the eclipse lasts for 10 hr. What is the size of each star? Which one is on the main sequence? (**2 pts**)

**Extra Question for 4710 Honors and 6710 (1 question, 5 total points):**

4. Make an H-R diagram of the 314 brightest stars in the sky (limited by apparent magnitude $m_V < 3.55$), drawn from the file `hr_nearestst ars.dat`. (You'll note that the columns represent $B - V$ and $M_V$.) Is this set representative of where most stars live on the H-R diagram? In other words, are any kinds of stars over- or under-represented in a sample limited by apparent brightness? (**5 pts**)