

**UNIVERSITY OF KANSAS**  
Department of Physics and Astronomy  
Physical Astronomy (ASTR 391) — Prof. Crossfield — Spring 2022

**Problem Set 3**

**Due:** Wednesday, February 7, 2024, by the start of class  
This problem set is worth **42 points**.

As always, be sure to: show your work, circle your final answer, and use the appropriate number of significant figures.

**1. Angles, Distance, and Brightness [22 pts].**

- (a) Explain why an ordinary lightbulb can appear much brighter than a star, even though the lightbulb emits far less light (i.e., the lightbulb has a much lower luminosity). [3 pts]
- (b) Astronomers have measured the parallax to the stars Polaris and  $\gamma$  Vel (“gamma Vel,” a young, hot, massive star) to be about 7.5 mas (milli-arcsec) and 2.9 mas, respectively. Estimate the distance to each star. [3 pts]
- (c) In the old (pre-*Gaia*) Hipparcos astrometric catalog, the uncertainty on measured parallax was about  $\pm 0.5$  mas; roughly what distance uncertainty does this translate into for Polaris and  $\gamma$  Vel? (I.e.: if the parallax to Polaris is  $7.5 \pm 0.5$  mas, what is the uncertainty range on the inferred distance?). Think carefully about this one. [4 pts]
- (d) Describe how you might estimate the distance to a star whose parallax is too small to measure. [6 pts]
- (e) Explain why most of the stars you can see with your own eyes in the night sky are giants and supergiants (10s to 100s of  $R_{\odot}$ ), even though these stars account for only  $\sim 1\%$  of all stars (most stars are  $< 1R_{\odot}$ ). [6 pts]

**2. Order-of-Magnitude Estimation [20 pts].**

- (a) You observe a giant star that is twice the size of the Sun but has the same effective temperature. Estimate the star’s luminosity in  $L_{\odot}$ .
- (b) You observe a star that is half the size of the Sun but just 2% as luminous. Estimate the star’s approximate  $T_{\text{eff}}$ .
- (c) You observe a hot star that is just as luminous as the Sun but  $10\times$  hotter. Estimate the star’s approximate size in  $R_{\odot}$  and in  $R_{\oplus}$ .
- (d) Estimate the wavelengths at which each of the three of the stars above emit most of their light. [4 pts]