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

**Problem Set 3**
**Due**: Wednesday, February 11, 2022, 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 Magnitudes [22 pts].**

   (a) Explain why an ordinary lightbulb can appear much brighter than a star, even though the lightbulb emits far less light. [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?)[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 $< 1 R_\odot$). [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 $T_{\rm eff}$.

   (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]