Homework 6

Due **October 22 by 11:59pm via Canvas upload**
Please show all work, writing solutions/explanations clearly, or no credit will be given. You are encouraged to work together, but everyone must turn in independent solutions; do not copy from others or from any other sources.

1. Polaris (also called αUMi), currently the North Star, is actually a triple-star system made of the stars αUMi Aa, αUMi Ab, and αUMi B. The apparent magnitudes of these stars are 1.98, 9.2, and 8.7, respectively. The Polaris system has a distance from Earth of $d = 116$ pc. (Neglect any effects from interstellar dust.)

   (a) Order the stars by apparent brightness, from brightest to faintest.

   (b) If you were unable to resolve the stars individually, what would you measure for the apparent magnitude of the total Polaris system?

   (c) What are the absolute magnitudes of the brightest and faintest stars in the system?

   (d) How does the Sun compare to Polaris' stars in terms of intrinsic luminosity?

2. The stars β Aurigae A and β Aurigae B constitute a double-lined spectroscopic binary with an orbital period $P = 3.96$ days. The radial velocity curves of the two stars have amplitudes $v_{\rm A} \sin i = 108$ km s^{-1} and $v_{\rm B} \sin i = 111$ km s^{-1}. If $i = 90°$, what are the masses of the two stars?

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3. Imagine that you make observations of 2 stars, determining their V-band magnitudes to be $m_1 = 12$ and $m_2 = 14.5$, colors to be $(B-V)_1 = 0.5$ and $(B-V)_2 = -0.3$, and V-band bolometric corrections to be $BC_1 = -0.05$ and $BC_2 = -0.25$. From other measurements, you know that star 2 has a parallax $\pi'' = 0.005''$.

   (a) What are the approximate temperatures of the stars? Why is the BC of star 2 more negative than that of star 1?

   (b) Assuming these are effective temperatures, what is the radius of star 2?

   (c) If interferometric measurements limit the angular size of star 1 to be $\theta < 10^{-4}$ arcsec, place a constraint on how far away star 1 is assuming the two stars are the same physical size.

   (d) Is this distance constraint consistent with the distance estimated from its $T_{\rm eff}$ under the same assumption about their relative sizes?

4. Astronomers often use the approximation that a 1% change in brightness of a star corresponds to a change of 0.01 magnitudes. Justify this approximation.