First-year Astrophysics PhD reading group

Hand-in problems 2025/26 *Coordinator: Trent Dupuy*

(Week 1) Hand-in to Andy Lawrence by Wednesday 4 February.

(a) An astronomer wishes to observe Star A, which is located at RA $= 05^h 32^m 15.54^s$ and Dec $= +56°13'19.2''$. What time of year is best to observe this object from the ground? Can it be seen from Australia?

(b) An R-band image is taken at prime focus on a telescope where the plate scale is $27.0 \, \text{arcsec} \, \text{mm}^{-1}$, and the CCD has $15 \, \mu\text{m}$ pixels. A faint smudge can be seen at roughly the right place, but it is not clear if this is Star A. The much brighter Star B, at RA $= 05^h 32^m 16.23^s$ and Dec $= +56°12'57.4''$, is clearly seen. How many pixels should Star B be from Star A, on the North-South axis, and on the East-West axis? Draw a sketch to indicate the arrangement of the two stars on the CCD image, marking N-S and E-W directions.

(c) From the R-band CCD image, we measure Star A to have $R = 18.03 \, \text{mag}$. Star A is expected to be of spectral type A0, like Vega. What does this imply about the intrinsic optical colours of the star? Given that we know that Vega has absolute V-band magnitude $M_V = +0.6 \, \text{mag}$, estimate the distance to Star A in parsecs.

(d) At this magnitude, Gaia should be able to measure positions to an accuracy of $10^{-4} \, \text{arcsec}$. Will it be able to measure the parallax of Star A?

(e) The integrated (bolometric) flux of Vega is known to be about $2.5 \times 10^{-8} \, \text{W} \, \text{m}^{-2}$. What is the bolometric flux of Star A? What is the luminosity of Star A, in solar luminosities?

(f) Assuming a surface temperature of $10{,}000 \, \text{K}$, estimate the radius of Star A in solar units.

[$L_\odot = 3.85 \times 10^{26} \, \text{W}, R_\odot = 6.96 \times 10^8 \, \text{m}, \sigma_{\text{SB}} = 5.67 \times 10^{-8} \, \text{W} \, \text{m}^{-2} \, \text{K}^{-4}$]