Please review the handout “Guidelines for Homework Assignments” before starting this homework.

1. Consider the η Cas binary star system in Cassiopeia. The brighter component of the binary (η Cas A) has a spectral type of G0V and has an apparent magnitude of $m_V = 3.45$. Its companion (η Cas B) is a K7V star of magnitude $m_V = 7.51$. The system is at a distance of about 6.0 pc, and the mean separation of the stars is 71 AU.

(i) Which of these stars is most similar to the Sun? (Look up the spectral type of the Sun, for comparison.)

(ii) By what factor is the V (“visual”) band flux of η Cas A greater than the V-band flux of η Cas B?

(iii) Compute the absolute V magnitude, $M_V$, for both stars and compare them to the Sun ($M_V=4.8$).

(iv) What is the angular separation between η Cas A and η Cas B as seen from Earth? Considering your observation of Mizar A and B, would you expect to be able to resolve these two stars with unaided eyes? What about with a telescope?

2. Consider the binary star system Albireo, also known as β Cyg, and sometimes called “the eye of the swan” for its location in the constellation Cygnus. Its brighter component is a K3III star of magnitude $m_V = 3.2$. Its fainter component is about 11 times fainter than β Cyg A in the V filter and is of spectral type B0V. The two stars are about 390 ly away and are separated on the sky by 35".

(i) What is the apparent V magnitude of β Cyg B?

(ii) What are the absolute V magnitudes of β Cyg A and β Cyg B?

(iii) What is the (minimum) physical separation between the two components of β Cyg?
(iv) To the unaided eye, β Cyg looks like a single star. By what factor is the combined flux of the two stars greater than the flux of β Cyg A alone? Using this result, compute the combined \( V \) magnitude of the β Cyg binary system, i.e. how bright this star appears to the unaided eye.

3. With Hubble Space Telescope it is possible to observe stars with \( V \) magnitudes of 27 in a matter of minutes. The star Vega has an apparent \( V \) magnitude of 0.0. How does the flux from a \( m_V = 27 \) star compare to the flux from Vega?

4. Flux at Earth from the Sun and stars

(i) Given the luminosity of the Sun and its distance from Earth, compute the flux at Earth from the Sun.

(ii) The average U.S. household uses about 1600 Watts averaged over 24 hours. Assuming that solar panels have an efficiency of 10\% (convert 10\% of the available energy from the Sun into useful power) and run 12 hours/day every day, how many square meters of solar panels would the average household need?

5. Saturn is low in the west this month, not far from the star Antares. Saturn’s magnitude is about \( V = +0.5 \); Antares’ magnitude is about \( V = +1.0 \)

(i) Which object appears brighter, and by what factor?

(ii) Aside from their relative brightness, what other distinguishing features can help you know which object is Saturn and which is Antares? Try to think of at least three things.