ASTRONOMY 426

PRELIMINARY TEST

Name: ____________________________
Class: Fr So Jr Sr Grad Other

Note: This test will have NO effect on your grade or your success in this class. It will be used solely to assess the level of instruction and to optimize the experiences in this class.

1. Describe the function of a telescope. Sketch the optical system and show the focal plane.
   1. Gather more light
   2. Enable seeing greater detail
   3. Form an image
   4. Map angles on the sky to position in the focal plane

2. According to Allen's Astrophysical Quantities, \( \alpha \) Cen A is a solar-type star with spectral type G2 V and a parallax of \( 0.74212 \pm 0.00140 \) arcsec and a radius of \( 7 \times 10^5 \) km.
   a. What is the distance, \( D \), to \( \alpha \) Cen A in units of parsecs?

\[
D \ [pc] = \frac{1}{0.74212} \ [arcsec] = \frac{1}{0.74212} = 1.3475 \ pc = 277,940 \ AU
\]

\[
[6 \ [pc] = \frac{2.00140}{0.74212} = 1.99] = 4.15 \times 10^{13} \ km = 7.8 \times 10^{10} \ km
\]

b. Given that 1 parsec = \( 3.1 \times 10^{13} \) km, from trigonometry we calculate that \( \alpha \) Cen A has an apparent angular diameter (2 x R)/D of \( 3.35 \times 10^{-8} \) radian or 0.007 arcsec. When you measure the angular size of \( \alpha \) Cen A with the 2.4m Hubble Space Telescope using a filter centered at 500nm you measure its apparent angular diameter to be \( 2.54 \times 10^{-7} \) radian or 0.05 arcsec – a factor of 10 larger than your calculated angular diameter. How do you explain this?

\[
R_\odot = 6.955 \times 10^5 \ km
\]

Physical: \( \theta = \frac{(2 \times 7 \times 10^5 \ km)}{4.15 \times 10^{13} \ km} = 3.35 \times 10^{-8} \ \text{radian} \)

Optical: \( \theta_0 = \frac{1.22 \times \lambda}{D} = \frac{500 \times 10^{-9} \ \text{m}}{2.4 \ \text{m}} = 2.54 \times 10^{-7} \ \text{radian} \)

Diffraction: limited information from sampling the wave front.
c. You then measure $\alpha$ Cen A with the 10m diameter Keck telescope at a wavelength of 500nm and you measure an apparent angular diameter of $2.54 \times 10^{-6}$ radian or 0.5 arcsec – a factor of 100 larger than your calculated diameter. How in the world do you explain this??

\[
\text{Turbulent optical power in Earth’s atmosphere,}
\]
\[
\text{FWHM of the seeing profile } \Delta \theta \text{seeing } \propto \lambda / r_0
\]
\[
\frac{\lambda}{r_0} \ll \frac{\lambda}{\theta_0} \Rightarrow \Delta \theta \text{seeing } \propto \lambda / \theta_0
\]

3. A simple, thin, double convex lens has a focal length of 15 cm. Produce a simple ray trace diagram to demonstrate image formation with this lens. From your ray trace diagram, estimate where the image is formed. Please describe it. Now calculate the position of the image.

\[
\frac{1}{f} = \frac{1}{p} + \frac{1}{o}
\]
\[
\frac{1}{p} = \frac{1}{f} - \frac{1}{o} = \frac{1}{15} - \frac{1}{36} = 0.0389; I = 25.7 \text{ cm}
\]

4. You have just discovered a variable star with a light curve that appears to be absolutely sinusoidal with a period of 100 seconds. (Congratulations!) Sketch the light curve and the power spectrum of the light curve. Describe each plot: units of the x- and y-axes, placement of features, and anything else you’d like to share about your unique discovery.
5. In which operating systems (e.g. unix, MS-DOS, AIX, Windows, ...) and computer languages (e.g. FORTRAN, c, BASIC, c++, ...) are you fluent or conversant? Have you used/can you use EXCEL, Matlab, LabVIEW, IDL, iraf, or any other scientific computing packages? Please describe your computing experience.

6. List three functions of the operating system on your favorite computer.

   Resource management: memory, disk space (swap/page), CPUs, ...
   User interface: stand-alone, programming environment (vs text)
   Device handling: drivers, console, display, sound, ...
   Exception handling: error recovery
   Task handling: multitasking, priorities, interrupts

7. Why are CCDs (charge-coupled devices), as opposed to, say, photographic plates, the detectors of choice in astronomy?

   Higher QE: 90+% vs 1-5%
   Broader spectral range: 300 nm (and shorter) to 1.1 μm
   Linearity: Dynamic range > 10^6
   Digital format and output

8. Please list the physics and astronomy courses you have taken thus far.

9. What are the key elements you would like to address and learn during this course?