

Astronomical Observations (Fall 2004) Final Exam

11 January, 2005 Tuesday 18:00~20:00

1. Two stars in a binary system have apparent magnitudes $V_A=8.0$ and $V_B=10.5$ respectively.
(a) What is the flux ratio between the two stars f_A/f_B ? (b) It turns out that star A itself later is resolved into a close binary with a flux ratio of 2. What is the respective apparent magnitude of A_1 and A_2 ? (Note: $\log 2 \approx 0.30$; $\log 3 \approx 0.48$) (10 pts)
2. Compare with a photomultiplier and a photographic plate, what are the advantages and disadvantages of a charge-coupled device (CCD) used as a photon detector? (10 pts)
3. The telescope we have used during our trip to Lulin Observatory has a primary mirror diameter of 1 m and the Cassegrain optical system has a focal ratio of $f/8$. (a) The PI VersArray 1300B CCD camera used to take images has effectively 1300 times 1300 pixels with 20 micron pixels. Calculate the field of view, in unit of arcminute, of the imager. (b) What is the theoretical diffraction limit, in unit of arcsecond, of the telescope? (10 pts)
4. What is the “*Nyquist sampling theorem*”? Suppose we want to measure the waveform of the 60-Hertz AC household power supply, how fast should one sample the output current in order to fully construct the waveform? (10 pts)
5. A photon-counting detector is used to measure a faint source against a background whose count rate is 16 s^{-1} . Assuming that the noise is random and that equal time is spent observing on and off the source, find the total integration time needed to detect a source whose strength is 1% of the background if the criterion for detection is that the signal-to-noise ratio is 3. (10 pts)
6. The atmospheric ‘seeing’ causes a distortion of stellar images. In a typical observatory site, a star, which should have appeared almost as a point source, would have an image of 1’ in diameter. Discuss two special techniques that can be utilized to overcome the seeing effects. (10 pts)
7. There is a saying among astronomers that “*A picture is worth a thousand words, but a spectrum is worth a thousand pictures!*”, signifying the wealth of information a spectroscopic observation carries. Describe the extra information a spectroscopic measurement gains in comparison to a typical broad-band photometric measurement. (10 pts)
8. Briefly explain the following terms (a) Zeeman effect, (b) antiblooming, (c) flat fielding, (d) Doppler effect, (e) aperture synthesis, (f) grazing-incidence optics (30 pts)