NASSP OT1 Tutorial Assignment 2013

(Due Wed 3 April)

Provide written answers, with appropriate sketches or diagrams, to all of the following questions. Be prepared to explain your answers in the tutorial session on Wed 3 April (14:00 – 16:00). Marks are indicated in brackets out of a total of 120.

1. Basics: Coordinate Systems

a. Define which of the following are arcs of *great circles*, and why: 1.) lines of constant Right Ascension, 2.) lines of constant Hour Angle. (2)

b. What is the *sine rule* for a spherical triangle. (2)

c. What is the *cosine rule* for a spherical triangle. (2)

d. With the aid of a sketch, show the *ecliptic coordinate system*, defining (i) the fundamental plane, (ii) the poles and (iii) the origin of the system (iv) the ecliptic coordinates. (4)

2. Basics: Coordinate Systems

a. In the Equatorial system, define the following: (i) Hour Angle, (ii) Declination, (iii) Local Sidereal Time and (iv) Right Ascension. (4)

b. Describe the relative pros and cons of the Equatorial and Alt-Az Systems in designing telescope mounts. (6)

3. Basics: Positions

a. Discuss four effects that change the *apparent* coordinates of an object over timescales of 6 months or more. (4)

b. Define the *parsec* as a distance unit. (2)

c. Describe what *atmospheric dispersion* is and why and how it is corrected for. (4)

4. Basics: Time

a. Describe the *Equation of Time* and the two dominant periodic terms that it comprises. (5)

b. Define Heliocentric and Barycentric time corrections and their amplitudes. When is the latter important to consider? (5)

5. Telescopes: Optics

a. List the 4 most important attributes of a telescope and explain why they are important. (6)

b. List the first five Seidel aberrations? Draw a sketch and explain how spherical aberration leads to image quality degradation. (6)

c. Give formulae, defining all symbols you use, for: (3)

(i) The scale of a telescope at its focal plane in arc seconds per mm
(ii) The focal ratio of a telescope
(iii) The diffraction-limited resolution of a telescope

d. Draw sketches showing the focusing of light from a star in the following telescope configurations: (5)
(i) a Cassegrain telescope
(ii) a Schmidt telescope
Which of these have the largest field of view and why?

6. Telescopes: Mirrors & Mounts

a. Discuss the development of new telescope mirror technologies and what impact they have had on telescope design. (5)

b. Describe the concept of *active optics*, how it is implemented and its advantages. (5)

c. Describe segmented mirrors, how they are mounted and the concept and advantage of *phasing* such mirrors. (5)

d. Discuss the different types of mirror coatings their relative advantages and how their performance is optimized. (5)

7. Telescopes: The Atmosphere and Adaptive Optics

a. Explain the concept of Kolmogorov turbulence theory in the atmosphere and why it influences seeing and image size. (10)

b. Define the Modulation Transfer Function (MTF) and explain how Adaptive Optics (A-O) modifies it, resulting in higher resolution images. (10)

8. Telescopes: The Atmosphere and Adaptive Optics

a. What does Fried's seeing parameter, r_0, measure and how does it vary with wavelength and how does it vary with seeing? (5)

b. Describe the basic components of an A-O system (10)

c. What are "laser guide stars" and why are they used in A-O systems? (5)