Exercises for the final exam

1. What is *mean solar time* and why is it different from *apparent solar time*.

2. What is the difference between adaptive and active optics?

3. Describe a system for correcting the effects of atmospheric 'seeing'. What can be done if there is no appropriate guide star within the isoplanatic patch?

4. Describe in only a few sentences how *proportional counters* and *scintillation detectors* work.

5. An observed spectrum $O(\lambda)$ is the convolution of the true spectrum $T(\lambda)$ and the telescope response $I(\lambda - \lambda')$ such that

$$O(\lambda) = \int_0^\infty T(\lambda')I(\lambda - \lambda')d\lambda'$$

   Describe how you can recover the true spectrum if the response function is known.

6. The flux (intensity) from a source located at an angle α from the optical axis of a interferometer is given by

$$\begin{aligned} F_P(\theta) &\propto |e^{-ika(\theta-\alpha)/2} + e^{ika(\theta-\alpha)/2}|^2 \\ &\propto \cos^2\left[\frac{ka(\theta-\alpha)}{2}\right] \\ &\propto \{1 + \cos[ka(\theta-\alpha)]\} \end{aligned}$$

   where a is the distance between the two slits.

   (a) Make a sketch of the interferometer including the position of a measurement point P, the optical axis, the position of the two slits, and the angles θ and α.

   (b) Sketch the output for a single source located at an angle $\alpha = 0$.

   (c) On the same drawing sketch the output for a source located at an angle $\alpha = \alpha_1 << 1$.

   (d) Explain how an interferometer can be used to measure the distance between two equally bright sources located, say, at angles α_1 and α_2.

   (e) An interferometer at slit distance a can be shown to have a resolution given by

$$\frac{\Delta\alpha}{\alpha} = \frac{D}{2.44a}$$

   relative a telescope with diameter D. Explain how it is possible for an iterferometer to have so much better resolution even though it is collecting much less light.

7. What is the Bolometric magnitude of an object?

8. What is 'blazing'?

9. What are spectroscopic ghosts, and what can they be caused by?

10. What does an optically active material do?

11. The degree of birefringence in a material can be given by $J = \mu_e - \mu_o$, where μ_e and μ_o are the refractive indexes of the ordinary and extraordinary rays.

    (a) What are the ordinary and extraordinary rays?

    (b) If light of wavelength λ is sent through a birefrengent material with degree of birefringence J, the travel time will differ by an amount Δt when traversing a distance T of the material. Find an expression for the time delay Δt and the phase delay δ as a function of wavelength λ and thickness T.

    (c) In addition to a birefringent crystal, what other optical component(s) is(are) included in the construction of a Lyot filter?