HOMEWORK #4 (due start of class Jan 27)

LEARNING GOALS for this assignment:

1. To understand the concepts and implications of astronomical coordinate systems.
2. To apply this understanding in practical situations in modern astronomy.

TO RECEIVE FULL CREDIT:

1. Staple multiple pages and identify yourself by Star Name (worth 5 points!).
2. You must **show how** you derived your answer by writing all the logical steps that led you to it. Follow the format of the "Homework Example" on our Web site.
3. All sentence responses must be typewritten and in complete sentences. You may handwrite any arithmetic. Use good English grammar.
4. **If you work more than three hours on this assignment, you should stop, record your work here, and contact Dr. McCarthy or Mr. Hammer (our Teaching Assistant) for help.**

Observational Astronomy: FOV, Zenith Distance, Air Mass, Refraction

Part I. Read section 5.1 (*"The Behavior of Light"*) in our online textbook to prepare for next week's classes.

Part II. Questions

Answer the following three questions, worth ten points each.

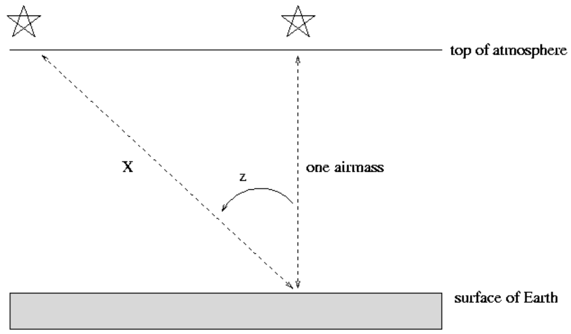
1. The westernmost belt star of Orion (Mintaka; δ Orionis) is extremely close to the Celestial Equator, at a declination of -0^o 17' 56.7". Astronomers can determine the field-of-view (FOV = (angular width) of their instrument by timing how long it takes Mintaka to move across the FOV when the tracking is disabled, due to Earth's rotation.

How long (min and sec of time) would it take Mintaka to drift through a 1-deg FOV?

More advanced option (5 extra-credit points):
How would this time duration change for the star Deneb at declination 45 degrees?

2. Light from a star traverses different thicknesses of Earth's atmosphere depending on the star's elevation angle. The "airmass" of an object in the sky is the ratio of the path length of light at the object's elevation to the path length at the zenith.

Based on the schematic diagram below, derive a formula that relates airmass (x) versus "zenith distance" (angle "z"). NOTES:
1. This diagram assumes the top of the atmosphere is "plane parallel" to the ground (i.e., we are neglecting Earth's curvature).
2. x = 1 towards the zenith.



More advanced option (5 extra-credit points):
Astronomers prefer to observe at elevations below two airmasses to avoid excessive atmospheric effects (absorption, twinkling, dispersion, etc.). For the Submillimeter Telescope (SMT) on Mount Graham at latitude = 32^d 42' 6", what is the southernmost declination of objects the SMT should observe?

3. When pointing a telescope accurately at an astronomical object, the object's coordinates must be corrected for several factors that are time-dependent, such as refraction of light through our atmosphere as shown below. Here's an approximate formula for the amount of refraction (R, in arcmin) in visible light versus an object's true altitude (ϴ, in degrees):

$$R = 1.02 \cot [\Theta + 10.3/(\Theta + 5.11)].$$

Based on this formula, what is the refractive correction required to point at an object through two airmasses?

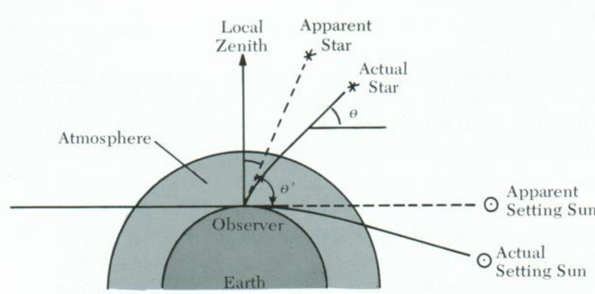


Figure 6–25. *Atmospheric Refraction.* An observer "sees" a star at altitude $\theta' > \theta$, when the star is actually at altitude θ. The refraction effect is zero at the zenith ($\theta' = \theta = 90°$), and reaches a maximum of 35′ at the horizon.