1. For an observer at Cambridge, Massachusetts (latitude 42°22′, longitude 71°10′ W), calculate the hour angle of the Sun at sunset on the day of the summer solstice, if refraction by the Earth’s atmosphere is ignored. For how many hours is the Sun above that observer’s horizon on that date?

   This is problem 4 from Homework 1. If you received full credit for that problem with no comments, just state that fact on your homework paper and you will receive full credit this time also. If you received full credit but with a request for a different method, please resubmit the solution with the requested method. If you did not receive full credit, please submit a new solution.

2. The right ascension and declination of the star Sirius (epoch 1987.5) are 6h45m and −16°43′ respectively. The longitude and latitude of Toledo are 83°37′ west and 41°39′ N, respectively.

   (a) How many hours and minutes of sidereal time elapse between meridian crossings of Sirius in Toledo and in Greenwich, UK?

   (b) At 0h UT on 1 December 1987, the local sidereal time in Greenwich was 4h37m (Source: *The Astronomical Almanac 1987*). At that instant, what was the local sidereal time in Toledo?

   (c) What was the local hour angle of Sirius in Toledo?

   (d) Approximately what was the local sidereal time at Greenwich on 1 January 1988?

3. Given the radii of the planets’ orbits (assumed circular) in astronomical units (AU), show that the maximum elongation of Venus as seen from the Earth is about 46°.

4. For an inferior planet, derive the relationship between the sidereal and synodic periods.

5. Using the information that was known to Copernicus — angles and timings of planetary configurations — and assuming circular orbits, devise a method of calculating the radii of the planets’ orbits in terms of the radius of the Earth’s orbit as a unit. You will need different methods for the inferior planets and the superior planets.

Required for grad students, extra credit for undergrads:

6. Prove that the celestial coordinates of the Sun \((\alpha_\odot, \delta_\odot)\) satisfy

   \[
   \tan \delta_\odot = \sin \alpha_\odot \tan \varepsilon,
   \]

   where \(\varepsilon\) is the obliquity of the ecliptic, 23°5.