AA 201: Introduction to Astronomy – Assignment

August 25, 2019 Submission Deadline: September 5, 2019

1. Castor system is composed of binary stars A and B. The star A has RA = 07h34m35.863s and DEC = +31°53'17.79'' and star B has RA = 07h34m36.100s and DEC = +31°53'18.57''. Find the angular distance between the stars in the small-angle limit. If the distance to Castor is 50.88 light-years find the separation between the two stars. Find the coordinates of star A on 2010 January 1 assuming the above coordinates are given in the J2000.0 epoch.

2. The synodic period of a planet is defined as the time for a planet to appear in the same place in the sky relative to the stars (in the same constellation). This is as seen from Earth, and involves the motion of the Earth. The sidereal period is defined as the time for a planet to go once around the Sun (with respect to the stars). This period is independent of where we are and does not depend on the motion of the Earth. Find the relationship between sidereal and synodic period for inferior (inner) planets.

3. A star, *X*, of declination DEC = 42°21′N is observed when its hour angle, *H* = 8h16m42s. If the observer's latitude, is 60°N, calculate the star's altitude, *a* and azimuth, *A*, at the time of observation. Please refer to Figure 1 given below.

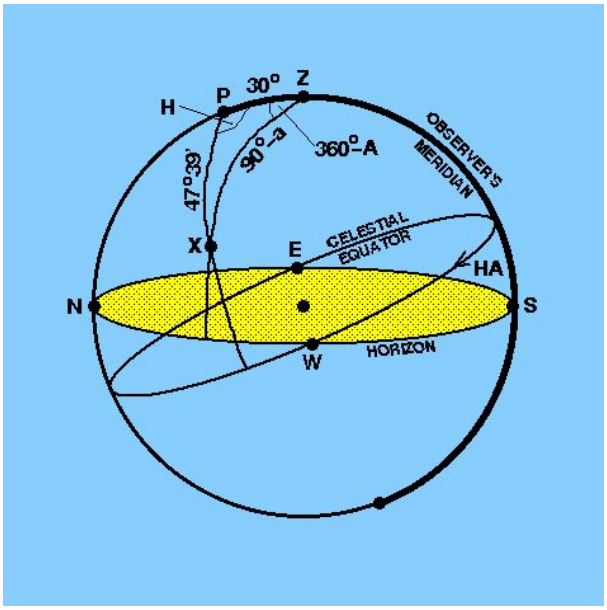

Figure 1

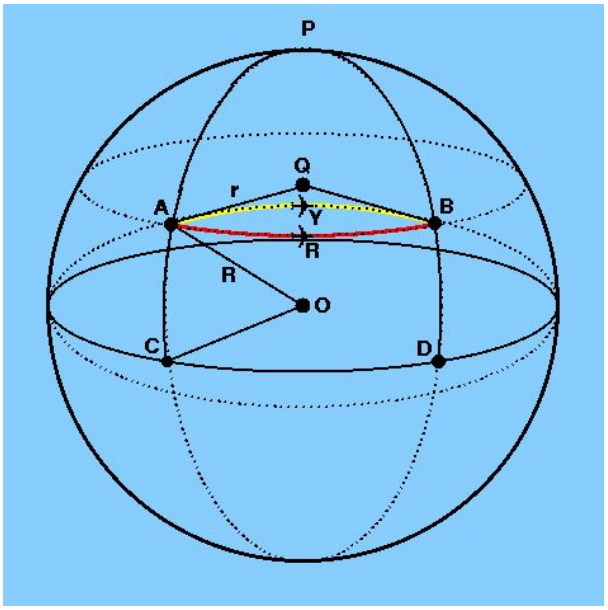

Figure 2

4. How much longer will it take to fly from Sheffield to Petropavlovsk in Russia along the parallel compared to the great circle route? Assume that Sheffield and Petropavlovsk are at the same latitude (53°23′ N), the longitude of Sheffield and Petropavlovsk are 1°28′ W and 158°42′ E, respectively, and the plane is flying at 925 km/hr. [This is an example showing on a sphere the path along the great circle corresponds to the shortest distance between two points.] Refer to Figure 2.

5. An analysis of the spectrum of an eclipsing, double-line, spectroscopic binary having a period of P=8.6 yr shows that the maximum Doppler shift of the hydrogen Balmer Hα (656.281 nm) line is λ_s = 0.072 nm for the smaller member and only λ_l = 0.0068 nm for its companion. From the sinusoidal shapes of the velocity curves, it is also apparent that the orbits are nearly circular.
a) Find the mass ratio of the two stars.

b) Find the individual masses assuming circular orbit parallel to the line of sight.
c) Find the radii of the two stars if $t_b - t_a = 11.7$ hours and $t_c - t_b = 164$ days. [Notations of time are as defined in the class]
d) If $m_{bol,0} = 6.3$, $m_{bol,p} = 9.6$ and $m_{bol,s} = 6.6$, find the ratio of the effective temperature of the two stars.
$m_{bol,0}$ = apparent bolometric magnitude when there is no eclipse [both stars are visible]
$m_{bol,p}$ = apparent bolometric magnitude during primary eclipse [hotter, smaller eclipsed]
$m_{bol,s}$ = apparent bolometric magnitude during secondary eclipse [colder, larger eclipsed]

Bonus:

1. Using Stellarium, please do the following
   A. Find the rising sun: Set your date for 09/21/16, and find the rising sun. Guess at the time, then refine your time until the sun has an altitude of 0°. Adjust the time in seconds to get as close as you can, but because you cannot adjust the time in smaller than 1 second increments, understand that you will probably not be able to obtain an altitude of precisely 0°0'0". Get as close as you can, and record the time and both azimuth and altitude coordinates.
   B. Find the setting sun: Without changing the date, advance the time to sunset. The setting sun will again have an alt = 0°. Record the time and Az/Alt coordinates.
   C. Change the date and repeat: Record the sunrise and sunset times and coordinates again on 12/21/16, 03/21/17, and 06/21/17. Fill in the following table

Date	Sunrise			Sunset		
	Time	Az	Alt	Time	Az	Alt
09/21						
12/21						
03/21						
06/21						

   Explain your results. Mention the significance of the dates. Does the sun rise due east (az = 90°) every day? Set due west (az = 270°)? On which day does the sun rise farthest to the north (smallest azimuth, or north of east)? On which day does it rise the furthest south (greatest azimuth, or south of east)?

2. Using Stellarium, please do the following.
   A. Locate the bright star Arcturus. Record the position of the star (RA, DEC, Alt, Az) at 9 PM today (23.08.2019). Increase the date at increments of 3 months and record the position at the same time.

Date	Azimuth and Altitude		Right Ascension and Declination	
	Az	Alt	RA	DE

   B. Return to the initial date and change the location to London. Repeat the above exercise and comment.
   C. The latitude of Indore is 22.7196° N and that of London is 51.5074° N. If the local sidereal time at London is 14:37:09 at 9 PM IST, calculate the altitude and azimuth of Arcturus using the equatorial coordinates from the section B. Does this match with the above observations of the coordinates (Alt, Az) in section B?