PHYS 321: PROBLEM SET 8

Due April 23, 2018 Mon @ 11:30 am

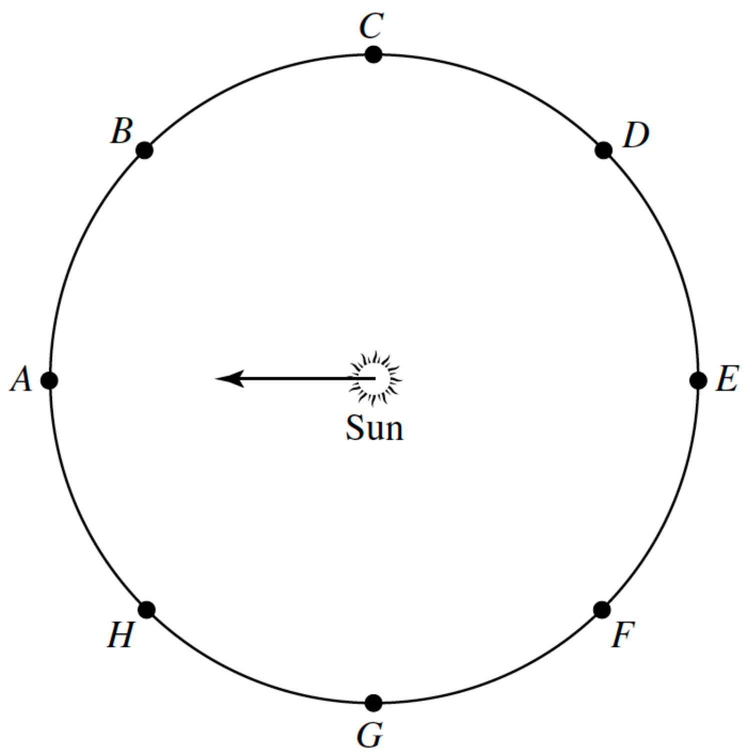
Solve the problems listed below, and ***write up your answers clearly and completely****. Do not turn in rough work – instead, make a clean copy after checking your calculations. Use English sentences and phrases to explain your solution and describe your answers step by step. Even if you did not get the correct answer, you may get partial credits for these steps!*

1. (2 credits) In 1792 the French mathematician Simon-Pierre de Laplace (1749–1827) wrote that a hypothetical star, "of the same density as Earth, and whose diameter would be two hundred and fifty times larger than the Sun, would not, in consequence of its attraction, allow any of its rays to arrive at us." Use Newtonian mechanics to calculate the escape velocity of Laplace's star and verify Laplace's statement. Can such a star actually exist? Why or why not?

2. (2 credits) Approximately how many times has the Sun circled the center of the Galaxy since the star's formation about 5 billion years ago?

3. (2 credits) Regarding rotation curve near the Galactic Center
   (a) Show that rigid-body rotation near the Galactic center is consistent with a spherically symmetric mass distribution of constant density.
   (b) Is the distribution of mass in the dark matter halo (Eq. 24.51) consistent with rigid-body rotation near the Galactic center? Why or why not?

4. (4 credits) Consider a sample of stars that lie in the Galactic plane and are distributed in a circle about the LSR, as shown in the included Figure on the next page. For the purpose of this problem, assume also that these stars are at rest with respect to the LSR (of course, this could not actually occur in such a dynamic system).
   (a) With the Sun located at the position of the LSR and the solar motion in the direction of Star A as indicated, sketch the velocity vectors associated with the apparent motion of each star, as seen from the Sun. Label the apex and antapex on your diagram.
   (b) Sketch the radial-velocity and transverse-velocity components of each star's apparent motion on the diagram used in part (a).
   (c) Describe how you might locate the apex of the solar motion given the radial-velocity data of a large sample of stars in the solar neighborhood.
   (d) How would you identify the solar apex from proper motion data of stars in the solar neighborhood?


C
B
D
A
Sun
E
H
F
G