PHYS 354 — Problem Set 3

Due Jan. 14

1. 1. a) Use the Roche limit derived in class or from Chapter 19 of the book to determine at what orbital radius Io would be disrupted, ignoring oscillations and any force other than self-gravitation holding it together.

b) Now calculate how much Io would need to be flattened to be disrupted at its current orbital radius. That is, calculate equatorial radius that would yield disruption and compare its current radius.

2. Carroll & Ostlie 2.9

3. Use the following table of data for stars in the Big Dipper along with an HR diagram to deduce whether or not these stars are associated in space or simply a chance alignment of stars at very different distances.

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| --- | --- | --- |
| Star | Apparent Magnitude | Spectral Class |
| Alpha | 1.81 | F8 |
| Beta | 2.37 | A1 |
| Gamma | 2.44 | A0 |
| Delta | 3.30 | A3 |
| Epsilon | 1.79 | A0 |
| Zeta | 2.40 | A2 |
| Eta | 1.87 | B3 |
|  |  |  |

Which do you expect might be associated in space? What further measurements might you make to test your hypothesis?

4. Assume two stars are in circular orbits around a mutual center of mass and are separated by a distance a. Take the angle of inclination to be i, and the radii of the stars to be r1 and r2. Find expressions for the smallest angle of inclination that will produce a partially eclipsing binary and a fully eclipsing binary. Evaluate each expression for a = 2 AU, r1 = 10 solar radii and r2 = 1 solar radius. What fraction of all binary systems with these parameters would expect to be fully eclipsing and partially eclipsing?

5. Carroll & Ostlie 7.4

6. Calculate the average of sin3 i, where i is the angle between the orbital plane of a binary star and the plane of the sky. Astronomers usually take this average to be about 2/3. Does this agree with your calculation? Explain.

7. W Ursae Majoris stars are a class of eclipsing binary stars that have their surfaces touching. In this situation the stars share mass and thermal energy so that they eventually have identical masses and temperatures. a) Derive an expression for the orbital periods of these systems as a function of the radii of the stars. b) Determine an approximate period/luminosity or period/absolute magnitude expression for these systems. c) Suppose a W UMa system is found with an apparent magnitude of 11.6 and a period 7.93 hours. What B-V color index would you expect to measure for this system? d) What is the distance to the system in part c?