Astronomy 111 **Fall 2017**

Homework Assignment #3

(remember: no ragged edges; write on one side of page only to leave room for comments/corrections)

due in class Thu. 10/19

1. The primary mirror of the Gran Telescopio Canarias (GTC) on La Palma – where colleagues and I are fortunate to have observing time – consists of 36 hexagonal segments with an equivalent diameter of 10.4 m, making it the largest optical telescope in the world. The central Cassegrain hole has an equivalent diameter of 2.4 m.

a) Calculate the percentage of light that would have been collected by a full 10.4 m mirror (i.e., without a Cassegrain hole) that is lost because the hole is there. How many times more light can be detected by a telescope with a diameter equal to the GTC 2.4 m hole than can be detected with our 0.6m telescope upstairs?

b) Calculate the diameter of a full mirror (i.e., without a hole) having the equivalent LGP as the actual GTC (i.e., with a hole) has.

2. As we saw in class, the 8.4m GMT mirrors are the largest single mirrors ever made. Calculate the diameter of a single mirror with the same total light gathering power as the seven GMT mirrors.

3. For this problem you will have to do some research on the web. Include references for your sources. Go to the website for David Archer's book, *Global Warming: Understanding the Forecast*, and follow the link (http://forecast.uchicago.edu/modtran.doc.html) to run the MODTRAN code (click "run me"), which models transmission and emission of infrared radiation by the atmosphere. Leave all defaults as is, *except*:

- For **Locality** choose "1976 U.S. Standard Atmosphere."
- Choose **Wavelength (linear)** from the pull-down menu under the graph.
- Now choose a sensor **Altitude** of 0 km (i.e. on the ground) and set it to "**looking up"** to get a sense of what the atmosphere looks like from below at various wavelengths.

The model updates automatically as you click outside the "Altitude" box. The resulting plot shows atmospheric emission in blue, and compares it to blackbody curves of different temperatures.

a) In what wavelength ranges is the Earth's atmosphere (relatively) transparent? How can you tell? For this part and the parts below, print out some plots, annotate them to back up your conclusions, and turn them in with your homework paper.

b) Now change the sensor altitude to simulate an observation from the top of Mauna Kea. How does the atmosphere change? What wavelength ranges are observable now?

c) Finally, repeat the exercise for observations from SOFIA (Stratospheric Observatory for Infrared Astronomy), a Boeing 747SP aircraft carrying a 2.5-m reflecting telescope optimized for infrared observing. *(based on a problem from E.L. Jensen)*

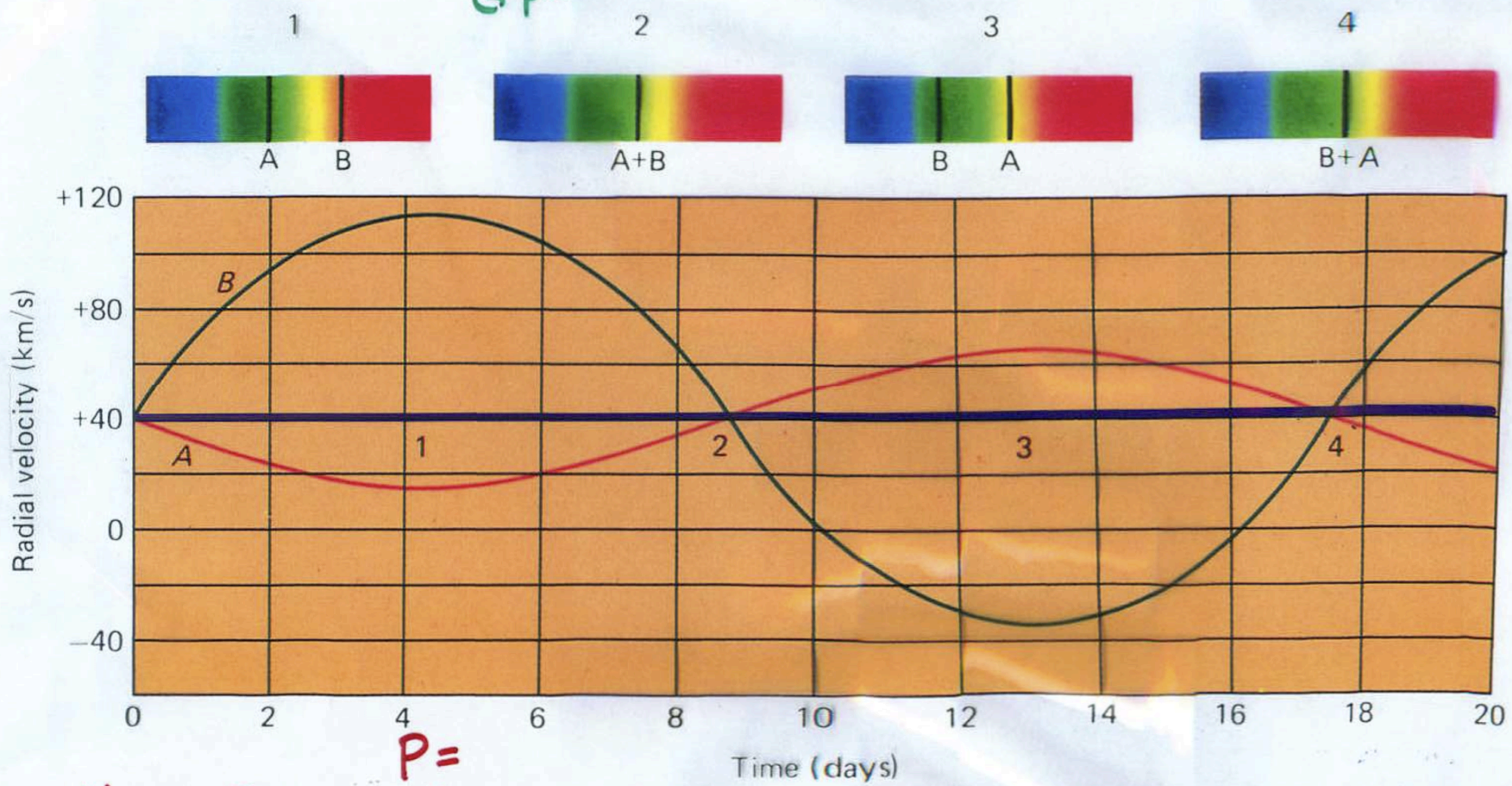
4. Solve the binary problem given on the next page for the indicated quantities, **filling in the calculated parameters as indicated under the graph.** Show all your work on a separate page. Be especially careful with units in your calculations, which should all be done in SI (meters, kilograms, seconds; G=6.67x10-11 in that system). **Express your final answers for stellar masses m_A and m_B in both kilograms and in solar masses.**

Also:

Kutner Ch. 4: Questions 3, 7; Problem 26
Ch. 5: Question 22; Problems: 15, 24
Ch. 6: Problems: 5, 14

$GMP^2 = 4\pi^2 R^3$ $G = 6.67\times10^{-11}$ $R = \frac{PV}{2\pi}$

$M = \frac{4\pi^2 R^3}{G P^2}$



$P =$

$V_{system} =$

$V_{orb} =$

$\frac{m_A}{m_B} =$

$m_A + m_B =$

$V_B =$

$R =$

113.

$V_A =$

$m_A =$

$m_B =$