Astronomy 252: Short Project 3
Eclipsing Binaries: Preliminary Light Curve Analysis

Due: Friday, Feb. 12, 2010 at 3pm

Introduction:
In this project, you will get experience with the light curves of eclipsing binaries and learn the effects that the different binary star parameters have on the shape of the light curves. This will be explored using the computer program Binary Maker 3.

Background:
TO ADD (in the future).

A. Printed tutorial:
Work your way through the printed tutorial handout for Binary Maker 3. On the sheet below, answer the questions asked on the listed pages. List them here and not in the tutorial handout.

1. Step 11 (p14)
In examining this light curve, which star (larger or smaller star) was being eclipsed at the deeper (primary) eclipse? If you have forgotten or didn’t notice, simply press the Render button again and watch the stars as they orbit and note which one was behind at primary eclipse (phase 0.00).

Which star (larger or smaller) was eclipsed at the shallower (secondary) eclipse?

From these observations, which star is the hotter star, and which one is the cooler star? How do you know?

2. Step 13 (p. 16)
How does the light curve calculated at 90° differ from the original one at 86.6°? Specifically why did this change occur?
3. Step 14 (p. 16)
How does the light curve calculated at 80º differ from the original one at 86.6º? Specifically why did this change occur?

ADD. Step 15 (p. 16)
What is the minimum inclination at which eclipses occur for GZ CMa? ________

4. Step 18 (p. 18)
Carefully examine the differences between this new light curve and the original light curve as represented by the observed data points. Describe at least three differences between the two light curves.

Knowing that these changes in the shape of the light curve came about from simply increasing the size of the larger star, explain why the new light curve changed in each of the ways you described above. [Hint: Is the larger star spherical now? What difference would that make?]

5. Step 21 (p. 19)
After typing in your new temperature for star 2, press the Render button and watch the new light curve being plotted. Write down how your temperature change affected the light curve compared to the original one (the observed points) and explain why this change makes sense relative to the temperature change you made to star 2.

6. Step 22 (p. 20)
This light curve looks very different from GZ CMa! Write down some of the differences between the light curves of GZ CMa and AD Her.
7. Step 23 (p. 21)
Notice how large these stars are relative to our Sun! What can you tell about the differences of the two stars in AD Her from its light curve? Other than the fact that the stars’ temperatures are listed above, how do you know that the larger star is indeed the cooler star from the light curve?

8. Step 26 (p. 23)
GZ CMa is an example of a detached binary. In studying the Surface Outlines window of GZ CMa, why does it make sense that these two stars are both nearly spherical?

9. Step 30 (p. 24)
What can you tell about the temperatures of the two stars from the depths of CC Com’s eclipses?

Why does this make sense in light of the fact that the two stars are in contact with each other, even though they are very different in mass from each other?

10. Step 34 (p. 25-26)
Explain why the light curve of V471 Tau appears as it does. Why is there no noticeable secondary eclipse? Why does the light curve fluctuate outside of eclipse? (Hint: There are two reasons for the outside of eclipse variations…)
B. Solving the Light Curves for Unknown Binaries:

You will each be assigned two binary stars to solve. By knowing what parameters affect what properties of the light curve, you will use logical reasoning and trial and error to determine parameters that give a good fit to each light curve.

What we have done is to give you the real data for a binary star. The initial parameter input file has the correct values for $T_1$ and the limb darkening, gravity darkening, albedo, and mass ratio. The parameters that you are to solve for are the temperature of star 2 ($T_2$), the inclination ($i$), and the relative radius of each star ($r_1, r_2$). These have been set to arbitrary initial values.

1. Star 1: _____________________  $T_1 = $ ______________

Solve for the following:

$T_2 = $

$i = $

$r_1 = $

$r_2 = $

Discuss any particular difficulties or challenges in solving the light curve, including correlations between parameters. Is there an alternate set of parameters that gives a similarly good fit?

Any other comments about the light curve fitting of this star?
2. Star 2: _____________________  \( T_1 = \) _______________

Solve for the following:

\( T_2 = \)

\( i = \)

\( r_1 = \)

\( r_2 = \)

Discuss any particular difficulties or challenges in solving the light curve, including correlations between parameters. Is there an alternate set of parameters that gives a similarly good fit?

Any other comments about the light curve fitting of this star?
3. Summarize briefly what you learned from this exercise.

What do you think could have been done differently to improve the learning in this exercise?

Honor code: