GU Boo: A New Low-Mass, Double-Lined, Detached Eclipsing Binary

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ABSTRACT

GU Boo is a low-mass, double-lined, detached eclipsing binary. The binary has an orbital period of 0.488728 ± 0.000002 days. Two independent sets of data were collected on the binary. The first set was collected using a 2048x2048 pixel CCD detector while the second set of observational data was collected using a photo multiplier tube.The light curves from the CCD observational data gave masses and radii for both components of GU Boo which are M_1=0.608 ± 0.005M_O, M_2=0.599 ± 0.005M_O, R_1=0.617 ± 0.001R_O, R_2=0.641 ± 0.001R_O. The analysis of the light curves from the photo multiplier tube observations gave masses and radii of M_1=0.601 ± 0.005M_O, M_2=0.595 ± 0.005M_O R_1=0.610 ± 0.001R_O, R_2=0.640 ± 0.001R_O. We have also compared our results with values obtained by (Morales & Ribas 2005) who reported physical parameters within 3% accuracy on this binary.

1. INTRODUCTION

Low-mass binary stars are very abundant in the galaxy. The problem in studying low-mass binaries is that they are very faint objects which makes them very hard to detect. In a situation were the orbital motion of the binary is in a plane edge on to an observer you get an eclipsing binary. Eclipsing binaries are very useful in that they allow us to accurately measure some of the most basic stellar parameters. In this report we present mass and radii measurements of the components of a new low-mass, double-blind, detached eclipsing binary.

2. LIGHT CURVE OBSERVATIONS AND ANALYSIS

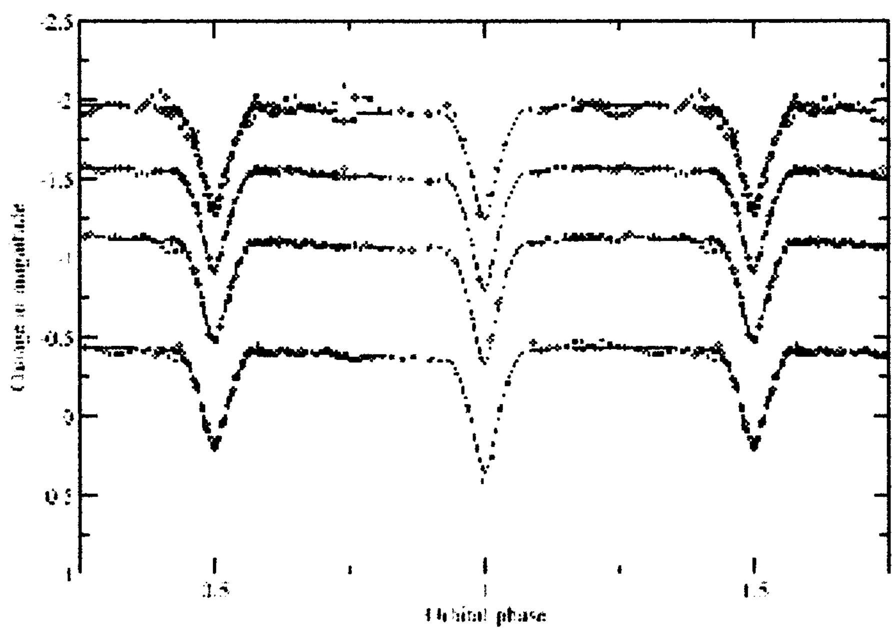
2.1 OBSERVATIONS

There were two independent sets of observational data of the binary. The first set of data was taken over four nights in the month of May using a 2048x2048 pixel CCD detector by Jerry Orosz of San Diego State University. The second set of data was taken over seven nights in the month of June using a photo multiplier tube by Paul B. Etzel San Diego State University. Both sets of observational data was collected using the 40'' telescope at Mount Laguna Observatory. The first set of data used filters V, R, and I, while the second set used filters B, V, R, and I.

2.2 ANALYSIS

The data was calibrated and reduced using software packages in iraf. Both a master flat and master bias were created using flat combine and zero combine tasks in iraf. We performed photometry on the program star as well as eight other stars in the image. The light curves used in our analysis *figure 1* contains observations in filters B, V, R, and I. The smaller dip in the light curves corresponds to the secondary eclipse while the larger dip corresponds to the primary eclipse. The lack of data during the primary eclipse of the binary is due to the fact that the observations were taken within a few weeks of each other. From modeling the eclipses on these light curves we were able to obtain values for the components mass and radii see *Table 1*. The variations in the data between the eclipses on the light curves is due to spots on the surface of the stars. Young low-mass stars are known to be very active because of their fast rotations.

Figure 1: Light -curves of GU Boo observed with filters B, V, R, & I



3. RADIAL VELOCITY CURVE OBSERVATIONS AND ANALYSIS

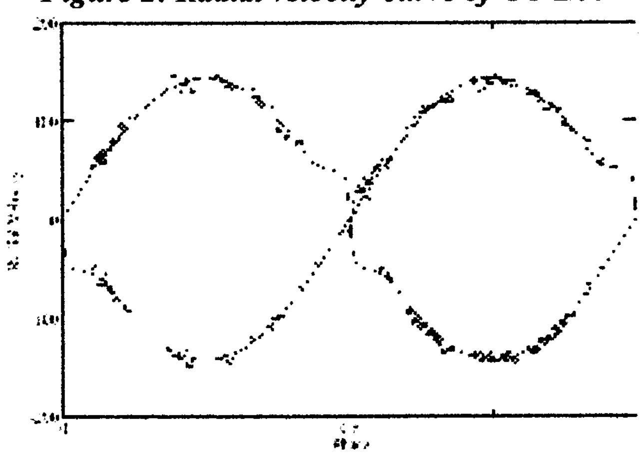
3.1 OBSERVATIONS

The data obtained from the spectra of GU Boo was collected by (Morales & Ribas 2005) covering the entire orbital phase in two nights using the echelle spectrograph at the 4-m Mayall telescope at Kitt Peak. The spectra of the binary from the first night covered a wavelength range of 310-860 nm per frame while the second night covered a wavelength range of 310-1010 nm. A total of 103 spectra was collected over the two nights.

3.2 ANALYSIS

The radial velocity curve of GU Boo is in *figure 2*. In this figure the triangles correspond to the velocity of the primary star, while the circles correspond to the velocity of the secondary. The wave in the model on this velocity curve is what you would expect to see due to the rotational velocities of the components. However the observational data does not agree with the model and I had to eliminate those data points from the velocity curve. The reasoning behind the disagreement in the model and the observational data is still unknown. The rotational velocities of the components are as follows about 65 km per second for the primary and 58 km per second for the secondary (Morales & Ribas 2005). By looking at the velocity curve you might assume the system to have a circular orbit and indeed this is the case in that the eccentricity is about 0.001.

Figure 2: Radial velocity-curve of GU Boo



5. SUMMARY & CONCLUSION

In this report on the newly discovered double-lined, detached eclipsing binary composed of two M-type stars we have obtained light curves of the binary and modeled the light curves to determine basic stellar parameters see *Table 1* for final results. Both sets of observational data extracted different values for mass and radii but in all considerations these values were in good agreement with those obtained by (Morales & Ribas 2005). The light curves that Morales & Ribas obtained look very different than the ones from our observational data but the mass and radii values are in somewhat of a agreement. Current models of stellar evolution still underestimate the radii of low-mass stars by 20% (Torres & Ribas 2002).

Table 1: Physical parameters of components of GU Boo

Source of observational data	1st set (Downum & Orosz)	2nd set (Downum, Orosz & Etzel)	(Morales & Ribas 2005)
$Mass_1 (M_O)$	0.608±0.005	0.601±0.005	0.610±0.007
$Mass_2 (M_O)$	0.599±0.005	0.595±0.005	0.599±0.006
$Radius_1 (R_O)$	0.617±0.001	0.610±0.001	0.623±0.016
$Radius_2 (R_O)$	0.641±0.001	0.640±0.001	0.620±0.020

6. ACKNOWLEDGMENTS

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7. REFERENCES

Lopez-Morales, Mercedes & Ribas, Ignasi. 2005, ApJ, 0505001, v1, 29
Torres, Guillermo & Ribas, Ignasi. 2002, ApJ, 567, 1140