The Eclipsing Binary KR Persei

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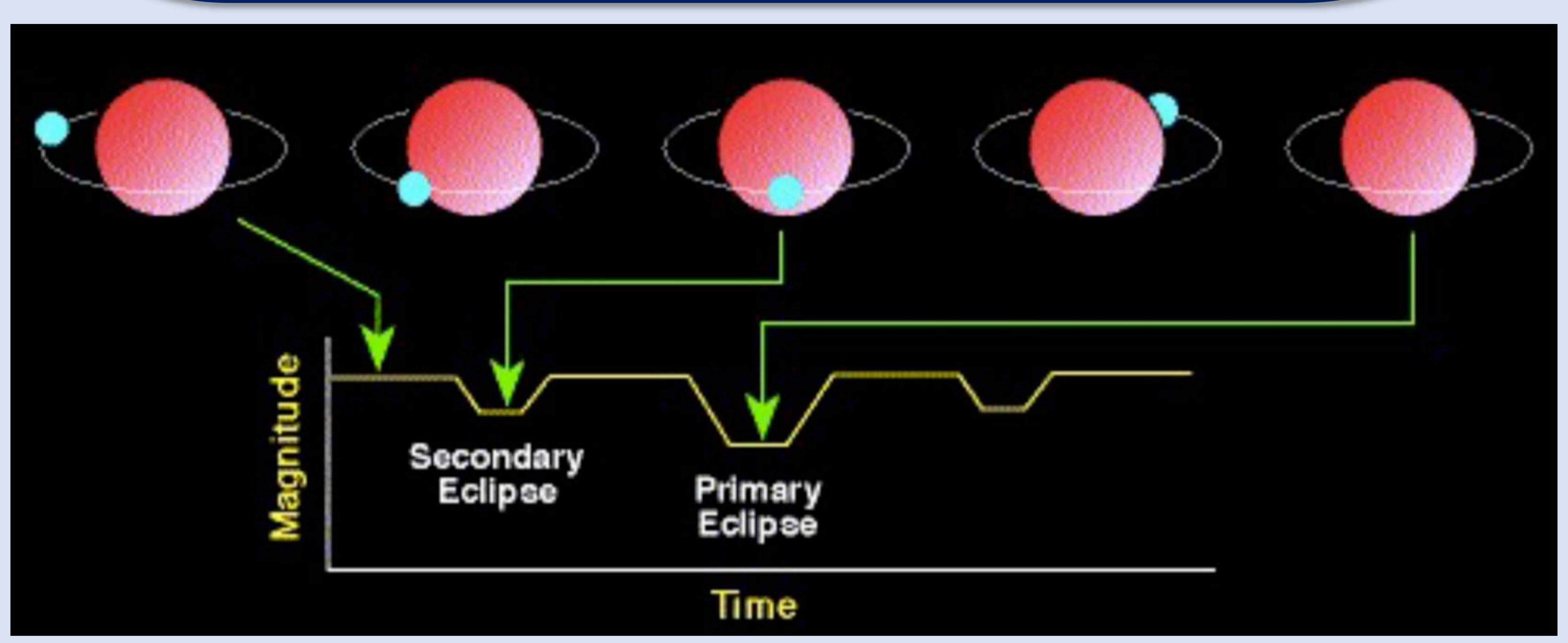
Introduction

KR Per is a bright, double-lined, short-period eclipsing binary. Photometric (UVBRI) and radial velocity (RV) data are often used to find an orbital solution to eclipsing binaries; prior work[1] used these types of data to determine the defining characteristics of this binary, such as the orbital eccentricity, semi-major axis, and each star's mass and temperature. Photometric and RV data were obtained from the Fernbank observatory (Atlanta, GA) and the Yunnan Observatory (Yunnan, China). However, the dataset used in the past was incomplete; we aimed to use a more complete set of data to refine this solution.



As one component of an eclipsing binary star system passes in front of the other, the light observed from Earth is decreased. This produces a light curve like the one observed above, yielding useful information such as the period of orbit and the temperature of each star. Source: [2]

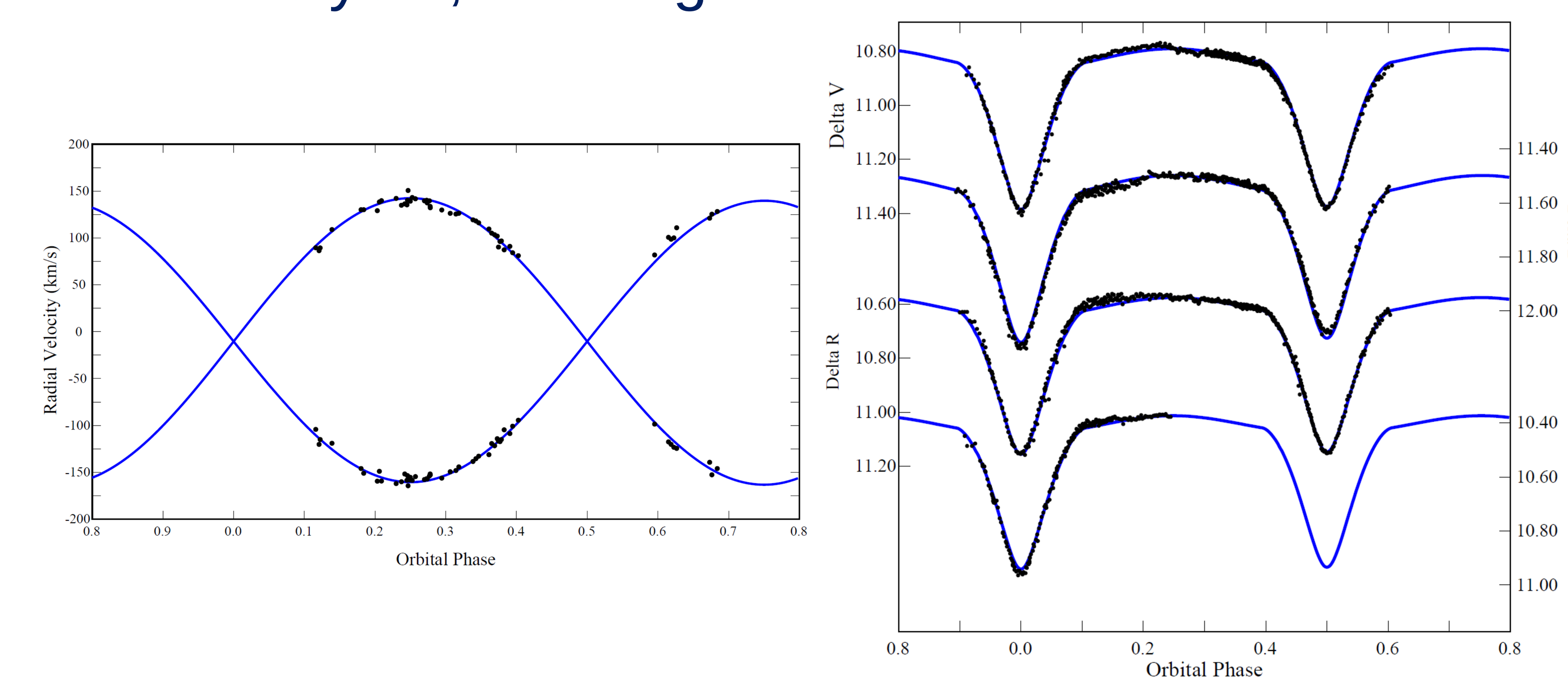
Method

The Wilson-Devinney program uses differential corrections to find nonlinear least squares solutions to the light curves of binary systems[3]. Radial velocity and photometric data are used as an input; the program iteratively attempts to converge upon a solution that minimizes deviations between the data and the theoretical curve, referred to as the "inverse problem". By adjusting the system's orbital parameters, one is able to find a well fitting solution. We used this program in conjunction with parameter estimates found in prior work; with newly acquired high precision radial velocity data from the Fairborn Observatory (AZ), we were able to further refine these parameters and find an orbital solution. We have additionally included data obtained by the Emory University Observatory (Atlanta, GA), allowing for photometric data spanning nearly the entire period.

Results: Key Properties of KR Per	Primary	Secondary
Mass	1.49 $M_\odot$	1.46 $M_\odot$
Radius	1.92 $R_\odot$	1.80 $R_\odot$
Temperature	6500 K	6478 K
Orbital Inclination	82.02°	
Semi-major Axis	6.02 $R_\odot$	
Eccentricity	0.00	
Period	0.996 days	

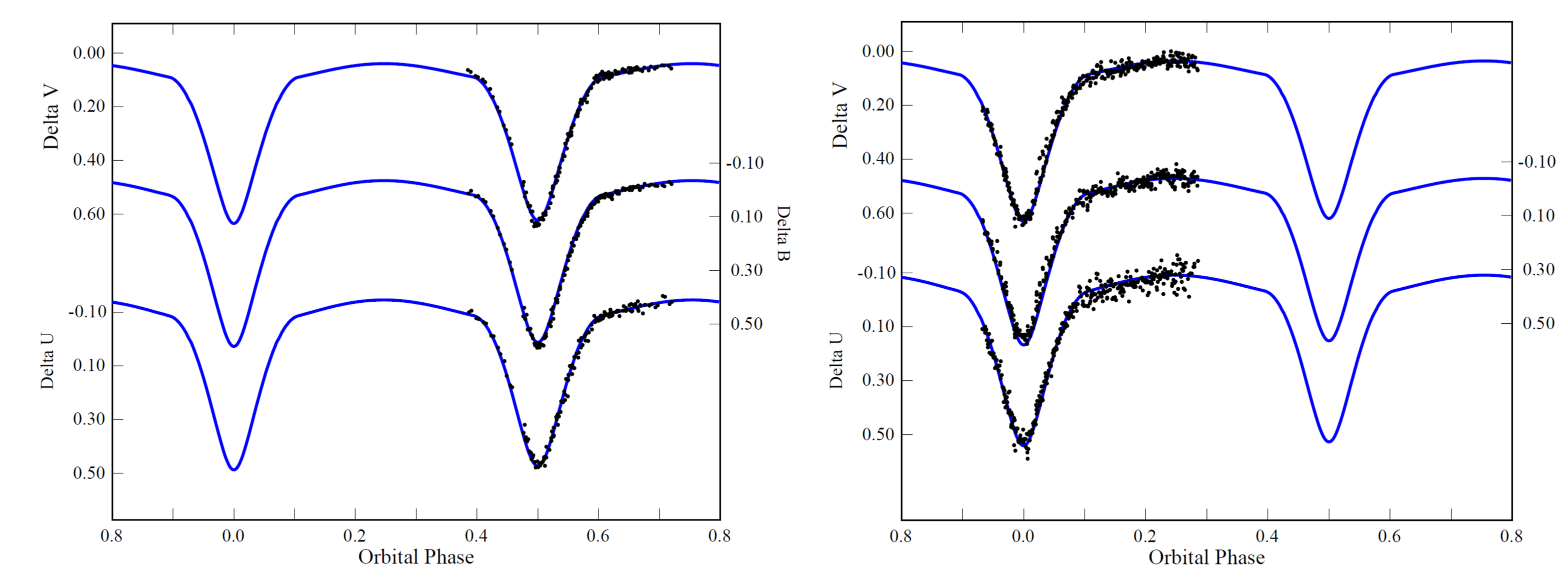
Results

We found that the two stars have comparable masses, radii, and temperatures. Both components have non-spherical shapes, and the orbital period is slightly lengthening. The orbit is circular with a period of 0.996 days. Additional spectroscopic observations will be made this year, allowing for further refinement.



Left: Radial velocity data with the solution curve

Right: Emory University photometric data, overlaid with the light curve solution; the VBR band passes cover nearly the entire period



Left: Fernbank Observatory photometric data with solution curve

Right: Yunnan Observatory photometric data, overlaid with the light curve solution; the data has greater spread but covers key portions of the light curve.

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References

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[2] Rolf Kudritzki, http://www.ifa.hawaii.edu/users/kud/teaching_15/6_DEB.pdf
[3] Josef Kallrath *et al.*, The Astrophysical Journal 508, 1 (1998)