Classification of Eclipsing Binaries using Fourier Analysis

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Automated Classification Systems

With recent advances in sky surveys and information technology, data from millions of binary star systems is being collected. The amount of data is too numerous to sift through by hand, and therefore an automated classification system is necessary. Our goal is to pattern these binary systems and train a neural network to automatically classify these systems on a mass scale.

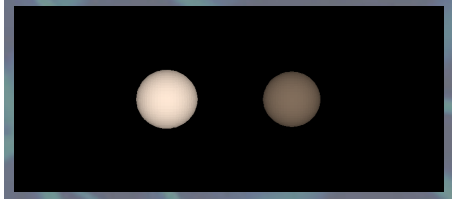
Eclipsing Binaries

These three systems are called eclipsing binaries. An eclipsing binary is a system of two stars that orbit each other and throughout their life cycle share mass. A detach system like CG Cyg is a system that orbits around a LaGrangian point but does not share mass. A semi-detach system like 44iBoo is a system that has begun to share mass but the Roche Lobes (atmospheric envelopes) have not contacted. One star pulls mass from another, grows to certain size, and then feeds mass back to the other star. A contact system like V757 is in constant contact, where the Roche Lobes have expanded on both stars to the point that they are now constantly sharing mass back and forth as they orbit.

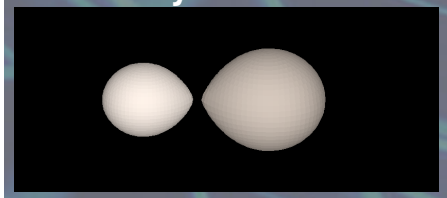
What's Next

At this point we are collecting more data on well known Binary Systems and looking for patterns in the coefficients of the Fourier aproximations. If we can find a pattern, then we will begin to use Tarleton's observatory to collect data from systems and test our process. We will test to find error in our patterns, and we will use these test to check if our classification system works with actual data instead of theoretical data. The next step will be to collect data from systems that have not been classified and use our mass scale classification system to classify those systems.

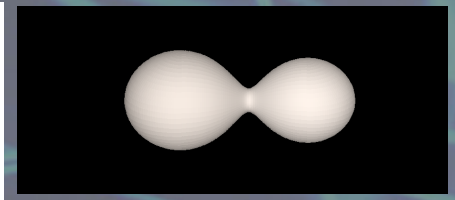
CG Cyg Detach System



44iBoo Semi-Detach System

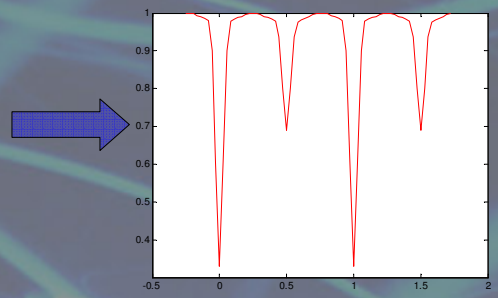


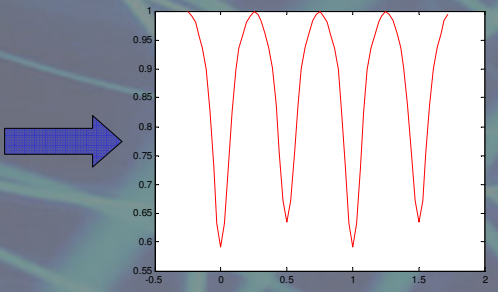
V757Contact System

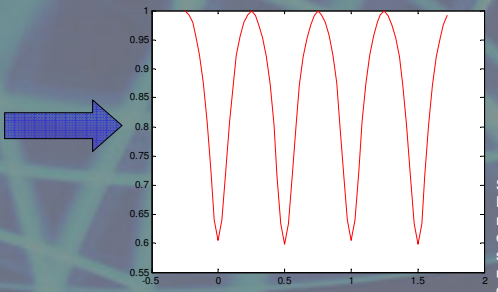


Graphics from Starlight Pro simulations.

Red Light Spectrum Light Curves







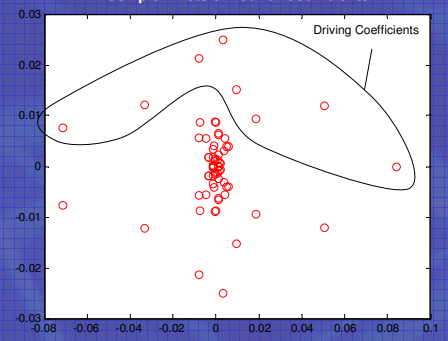
Using Matlab and Fourier Analysis, we can construct a complex plot of the Fourier coefficients. This will help us to determine what coefficients drive our Fourier approximations of the light curve.

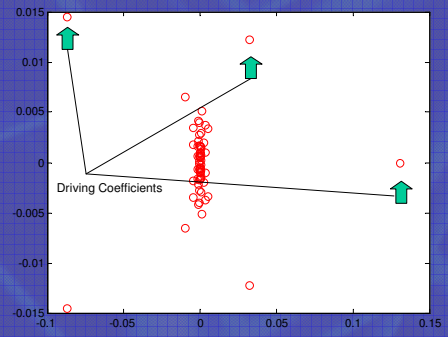
If we can determine which coefficients drive each approximation to the different types of systems, then we can look for patterns in those coefficients. For instance, if the driving coefficients of a semi-detach system are always the 4th and 7th coefficient, then we can use that pattern to classify semi-detach systems on a neural network. Additionally, if there are always the same amount of driving coefficients, we can use that pattern to classify semi-detach systems.

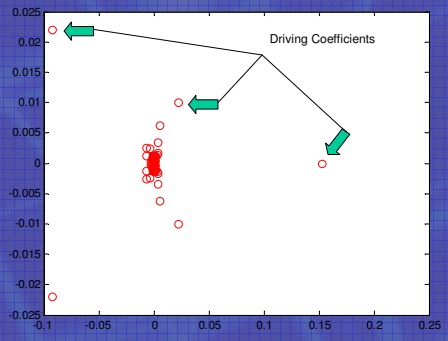
Once we find a reasonable pattern, we will be able to train a neural network to match each type of system to their respective pattern. This will allow us to feed data from millions of system into the neural network and classify these systems on a mass scale.

Since most of the stars we see are Binary Systems, the need for a mass scale classification system is evident. Classification of these systems will lead to a better understanding of the make-up of our universe. These systems also give clues as to the distances of objects near the system.

Complex Plots of Fourier Coefficients







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Abstract

In this work we are attempting to classify eclipsing binaries using Fourier analysis of light curves. We hope to identify the driving coefficients of the approximations to the light curves and use those coefficients to classify the systems as detach, semi-detach, or contact. By identifying these driving coefficients and their relation to each type of binary system we hope to avoid using geometrical representations to classify the systems. If successful, this method can be used as part of a mass scale automatic classification system.