Kenton Greene
Professor Larry Molnar

Merging Contact Binary Stars

A binary star is a system that consists of two stars orbiting each other. A contact binary is a binary star whose component stars are so close that they share the same atmosphere. Our system of interest, KIC 9832227, is one of these contact binaries. What sets it apart is that its orbital period is decreasing faster than any other contact binary system known, and the rate of decrease is accelerating. This is of particular interest, because some speculate that all contact binaries end in a stellar merger and subsequent nova. The extreme period decay in our system may be a harbinger of such an event in the near future.

Like many binary stars, our system is an eclipsing binary, which means that as the two stars go around their orbits, they alternately pass in front of each other from our point of view. The resulting decrease in light coming from the system is one of the main methods of discovering and studying such eclipsing binary systems. Studying the amount of light coming from an object is called photometry. Another way to study such systems is through spectroscopy, that is, analyzing the light spectrum of the system. All stars have characteristic lines in their light spectra due to the presence of various elements in their atmospheres. When a star moves away from Earth, these spectral lines appear to move towards the red end of the spectrum (redshifted). When a star moves towards Earth, the opposite happens, and its spectral lines are blueshifted. Studying how the stars in our system move is a second way of studying their orbital characteristics.

The data that we have taken so far on the system include both photometric and spectroscopic data. The spectroscopic data was taken at WIRO (Wyoming InfraRed Observatory). The photometric data continues to be taken using Calvin's Rehoboth and Grand Rapids telescopes. By comparing the brightness of our system to the brightness of non-variable stars, we can find how our system's brightness changes with time, which we call its light curve. Thus far its light curve shows that it is on track to merge and explode in roughly 4 years. By studying deviations from the average light curve of our system, we have also modeled the starspot activity on the more massive star. Studying the light spectra taken at WIRO allows us to rule out the possibility of a large third body star which could confound our period measurements. To date, all systematic searches to date for binary systems other than KIC 9832227 that are likely to merge in the near future have come up empty.

We continue to process the photometric data we take on KIC 9832227. So far, our data are consistent with our previous prediction of a stellar merger approximately 4 years from now. Also, we remain hopeful in our search for other, similar stellar systems. All indications point to a merger, but a critical question remains unanswered: Why is KIC 9832227 going to merge? What characteristics make this system unique from all other binaries?

This question has been the driving motivation for our work this summer. By taking a statistical look at over five hundred eclipsing binaries also from the KIC catalog, we hope to determine the characteristics that make our system unique. This has not been a trivial task and requires a considerable amount of computational power. To help streamline this process, we are using a new software package called PHOEBE, which its a new devolopment in anaylisis software that will run on the Calvin College's Dahl supercomputer. Despite its computational potential, PHOEBE still has several bugs and glitches that need to be resolved. My work this summer has been focused on resolving these issues so that our results can be trusted.

Working on this project has been an unique privilege and opportunity. It has allowed me to develop the skills, techniques and methods necessary to conduct science research. I have learned to be more organized. I have learned to document my thoughts and methods accurately, to take tackle a huge seemingly daunting project and methodically break it down into manageable pieces. Furthermore, this summer has been time to study, in depth, a topic of stellar astronomy that I find fascinating.