Merging contact binary stars

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KIC 9832227 is a contact binary star that Professor Molnar has been keeping eyes on since 2013. A contact binary star is two stars orbiting each other so close that their atmospheres are touching. KIC stands for Kepler Input Catalog which are the targets of the Kepler spacecraft(widely known for its discovery of 3,472 exoplanets). Soon he realized that the orbital period was getting shorter at an increasing rate. This implied that this star could potentially merge in the future causing an explosion known as a red nova. He referred to an article by astronomer Romuald Tylenda, who had studied observational archives to see how V1309 Scorpii behaved right around its explosion. Tylenda's analysis of the pre-explosion record of V1309 Scorpii is Dr. Molnar's template for his prospective red nova, KIC 9832227. In previous years, we calculated different parameters of KIC 9832227 and ruled out the possibility of a third body. Goals for this summer have been figuring out what is driving the two stars closer at a faster rate, fitting varying light curve shapes through time by using Binary Maker 3.0, which is a 3D modelling program for binary stars, to place star spots on KIC 9832227, and confirming that our calibration process is done in a correct manner.

In order to follow up the previous year's question of third star, we did spectroscopic imaging from WIRO (Wyoming Infrared Observatory) to calculate the radial velocity. This helps us to see if there is any invisible object, such as a black hole, as a third body. We also took images of KIC 9832227 throughout the year using our telescope down in Rehoboth, NM. There are three main steps when using data for experiment: taking data, processing data, and analyzing data. We remotely take data using our computer in Grand Rapids, MI to control our telescope in Rehoboth, NM. Once we get the data, we download them and calibrate the images with bias, dark, and flat calibration images. These calibration images are taken at the end of each night. Then we take the calibrated images to plot a light curve using photometry. The last step is analyzing data. From here, there are a few different things we can do. We can calculate the rate of change as the orbital period decreases, or we can try to fit the varying light curve by using Binary Maker 3.0 to visualize our target object. To get further insight on the trend of KIC 9832227, data from various archives (NSVS, ASAS, WASP, and Kepler) are used on top of our own data.

For further study, we searched through the Kepler data catalog to find stars that are similar to KIC 9832227. We followed up a published list of 31 stars found to have rapidly changing periods. We found only one star, KIC 9840412, on the list that seemed promising. So, we took two nights of data, processed, and analyzed to follow up. It turned out that this star will not be our next candidate.

This summer has been such a great experience for me. I started out this summer by going to Laramie, WY, to get some data from Wyoming Infrared Observatory (WIRO). When I first saw the 2.3-meter telescope, I was so excited. Fortunately, I did not have a hard time getting used to using their telescope because I had experience controlling Calvin College telescopes. Reflecting back, I did not realize how fortunate I am to have access to these equipment and experiences to pursue what I love. Since I got back from Wyoming, I have been reading as many scientific papers as possible to be informed about what we are studying. Beginning of this summer, I basically had no knowledge about binary stars, but now I am at a point where I can understand the data in front of me and have critical opinions about them. Overall, I believe this will definitely be a stepping stone for my future both because of the useful experience with programming and instrumentation   and because of the guidance and helpfulness of my Professor, Dr. Larry Molnar.