New Tricks with the Joker: Revealing Binary Stars

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Binary Stars

- When Binary star systems are classified by the Doppler shifts on their emitted light they're called *spectroscopic binaries*.
- If one star outshines its companion, we aren't able to distinguish the two, so we call them "**Single Line**".
- "Double Line" allow us to see the individual velocities and shifts of **both** stars, giving us more information over all.



Data and Lines

- WIYN Open Cluster Survey (WOCS)
 - In the Visible
 - Older survey
- Apache Point Observatory Galactic Evolution Experiment (APOGEE)
 - Infrared
- Chosen clusters: NGC 188, NGC 6819, M67, and NGC 7789.
- Line visibility (single/double line) depends on the intensity ratio of the two stars, which is closer in the Infrared.





The Joker

The Joker is a software that uses radial velocity measurements of binary star systems to produce orbital solutions, like this one done on APOGEE data:



We are providing the Joker with WOCS data in addition to the APOGEE data that has been previously run. More data points that span a longer period of time will constrain solutions.

Preliminary Results



- Doppler Velocities of a Star.
 - WOCS data in blue.
 - APOGEE data in red.

- The Joker works to fit a possible solution to the data.
- We see WOCS is giving us more, older data points.

Preliminary Results

- Folded Phase plot
 Shows us the
 - orbital solution for this star.
- WOCS and APOGEE can be successfully combined.



Future Work

- Continue to run the Joker on all of our data for our different clusters.
- Deeper analysis with a software that analyzes Double line binaries.
- Reclassify "Single line" to "Double line" by adding APOGEE data.

The implications this work could have include the following:

Physical Characteristics

By separating the stars from each other, we open up the opportunity for others to analyze these new findings and find out more about each companion, like individual masses.

Cluster Chemistry

Since the chemistry of a star is determined by spectra, reclassification could lead to new understandings of our clusters' chemical compositions.





Fifty percent of stars in the night sky are actually binary star systems, but finding and characterizing them require significant data, time, and analysis. Studying the brighter star of the pair is fairly straightforward, but the secondary is commonly hidden. Using data from multiple Sky Surveys and a software called the Joker we will work to reveal and characterize these hidden binary stars.