Deriving Properties of Stars with BASE-9 Software and the Vega Supercomputer

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Abstract

This research involves using a Bayesian Statistics software developed by Dr. Ted von Hippel and his team to determine properties of binary stars. This software, titled BASE-9, which stands for Bayesian Analysis of Stellar Evolution, can be used to derive the properties of stars and star clusters including age, metallicity, helium abundance, distance modulus, mass, binary mass ratios, and cluster membership probability. With this information, the impact of environment on the characteristics of binaries over time can be examined. This project has consisted of running thousands of stars within different clusters using the Vega Supercomputer in order to study the properties of binary systems. By using BASE-9 and Vega, these properties can be derived with much more precision and by more direct means than other commonly used methods.

Figure 1: Above is a photo of the open cluster NGC 188, which is one of the clusters currently being worked on. Taken by Ron Brecher.

BASE-9 & Binaries

Using photometry from hundreds of open clusters, BASE-9 will be used to

- Identify photometric binaries and determine their masses and mass ratios.
- Establish the cluster age, distance, reddening and metallicity.
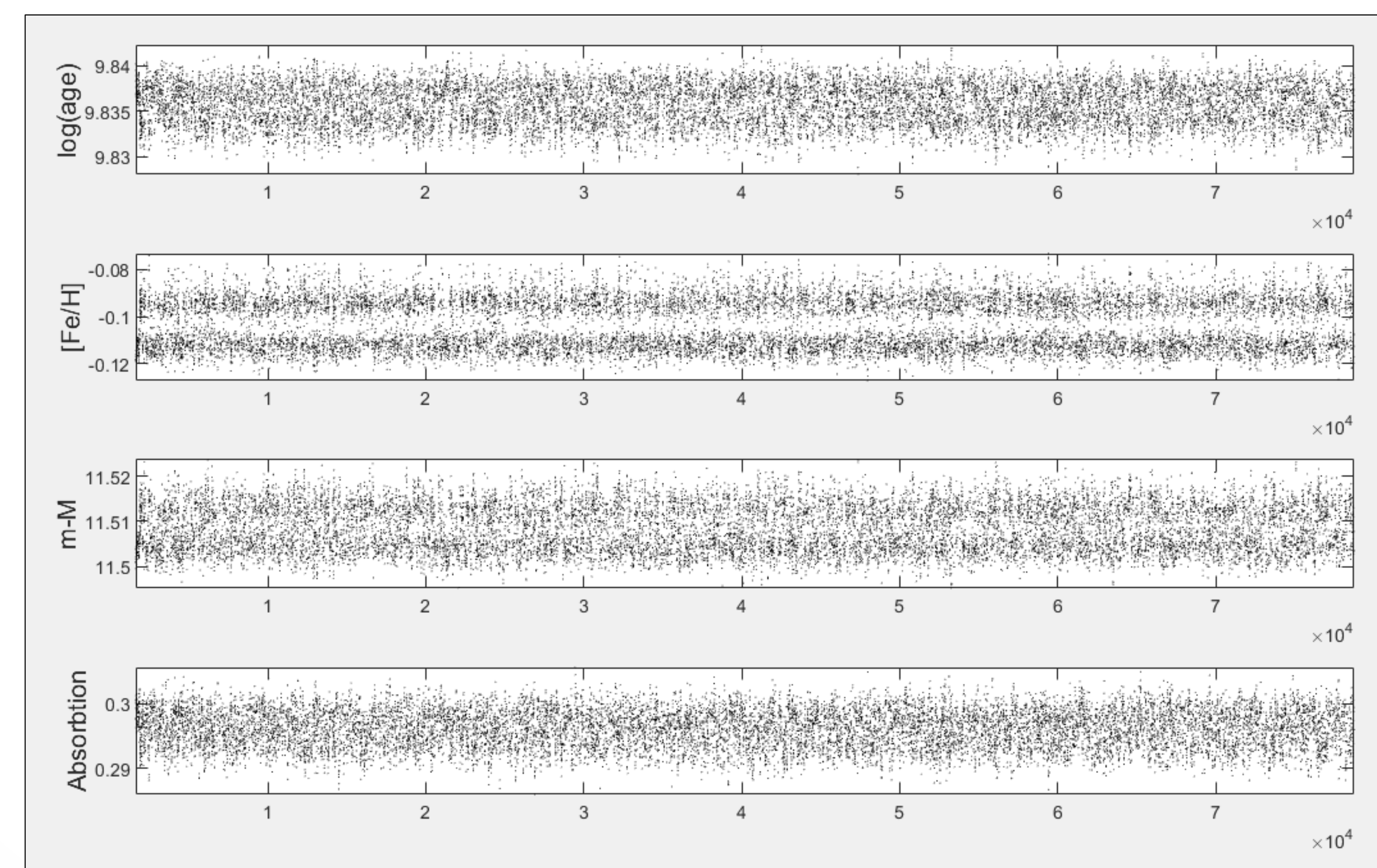- Derive star-by-star photometric membership probabilities and masses

Figure 2: Above are plots of the various properties derived by BASE-9 for the open cluster NGC 188. These properties such as log(age), metallicity, distance modulus, and absorption are displayed on the y-axis and the iteration number on the x-axis.

In figure 2, the results of running the singlePopMcmc function of BASE-9 on the open cluster NGC188 are displayed.

The precision of these results is evident when looking at the y-axis of each plot, which display a very narrow range of values.

Methods

- Embry-Riddle's supercomputer, Vega, is utilized by both faculty and students to solve complex computational problems through high performance computing.

Figure 3: A photo of the Cray supercomputer located in the Lehman College of Engineering. Taken by Daryl Labello

- For this project, Vega allows for the batch processing of stars through the BASE-9 software which greatly decreases the time it takes to retrieve results.

- For NGC 188, running the singlePopMcmc function only took 0.13 seconds per star for 10,000 iterations.

Conclusions

Although the process of running many different clusters through BASE-9 to determine the masses and mass ratios of binaries is still in process, the functions of BASE-9 have proved to be successful so far in terms of precision and timeliness with the help of Vega.

I would like to thank Dr. Ted von Hippel for his guidance throughout this ongoing research.