CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

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Project Number

36844

Project Title

The Effect of Dynamics on the Mass Functions of Globular Clusters

Preliminary

Abstract

Objectives/Goals

All star formation regions follow an initial mass function (IMF). For many years, it was assumed that there exists an universal IMF from one star forming region to the next. The objective of this project is to introduce a novel, unambiguous verification of IMF variation within a star region. We exploit the presence of multiple populations and mass segregation (dynamical evolution) in globular clusters and justify through N-body simulations.

Methods/Materials

Used series of N-body simulations through the Starlab software environment and kira integrator to model the 12 Gyr dynamical evolution of two star generations in multiple globular clusters over a range of various mass function slopes. Models reproduced the distribution of present day stellar masses of generations in the globular cluster. Used data obtained by Keck Telescope I to gain insight on chemical distribution of generations in GC 47 Tucanae.

Results

I created 5 different globular cluster models, each with 2 generations, with a specified input IMF for each generation. After evolving each model for a specific amount of time, I recorded the final mass function (PDMF) of each generation for each model. I found that the slope of each star generation's mass function evolves similarly to one another; the Generation 1 and Generation 2 of the GC experience the same dynamical evolution. If the slope of G1 < slope of G2 at t=0, then the slope of G1 < slope of G2 at the end of the evolution time, by nearly the same difference.

Conclusions/Discussion

I created five different globular cluster models to analyze the effects of dynamical evolution and mass segregation on the mass function slopes of two generations in globular clusters. Through the results, I conclude that the two generations of the globular cluster experience the same dynamical evolution. Evidence in the Globular Cluster 47 Tucanae suggests the existence of two different generations of different chemical abundances. This suggests that they have different Present Day Mass Functions. Through the model results, if the two generations differ in the PDMF, they would also differ in the IMF, thus allowing us to find the clearest evidence to date for IMF variation in the most extreme star formation environments.

Summary Statement

I analyzed the effects of dynamical evolution on the mass functions of generations in globular clusters through a series of N-body simulations to introduce a novel, unambiguous verification of IMF variation.

Help Received

I developed and ran the simulations and analyzed the results on my own personal laptop. I consulted Dr. Evan Kirby from the California Institute of Technology, who gave me insight on the development of my project. Dr. Sverre Aarseth from the University of Cambridge helped me understand the Nbody code for