CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

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Project Number

S1811

Project Title

Stellar Isotopic Abundances in the Milky Way: Insights into the Origin of Carbon and Neutron-Capture Elements

Abstract

Objectives/Goals

Elements heavier than iron are formed via two neutron capture processes: the rapid r-process that occurs in supernovae and the slower s-process that occurs in less massive stars. Isotope ratios in stars can reveal which process is a greater contributor to heavy metals in stars, since each of the processes creates each element at a unique isotopic ratio. The ratios produced by each process have been predicted by two competing models, the stellar and classical models. We evaluated the validity of these models by studying high-resolution spectra of twelve Milky Way stars, which were analyzed for the first time in this study.

Methods/Materials

To determine r- and s-process contribution, we measured carbon and europium isotope ratios in the stars by fitting observed spectra with synthetic model spectra. Generation of the synthetic spectra involved measuring the Doppler shift, resolution, and carbon and europium abundances. This study also presents a method to calculate the europium isotope ratio by modeling the shapes of absorption lines.

Results

Our results show that the ratio of 12C to 13C increases proportionally with [Fe/H]. The new results agree with the conclusions of Lucatello et al. (2006) and Frebel (2008), and show significant improvement in the reduced scattering of data points.

Conclusions/Discussion

Analysis of the obtained isotope ratios suggests that the carbon in most stars of the sample originated in supernovae. The range of europium isotopic ratios disputes previous theoretical predictions about the stellar and classical models of heavy element nucleosynthesis, and the work presents new insight into the origins of life in the universe.

Summary Statement

This work measured isotopic abundances using hyperfine model fitting, providing insight into star progenitor histories and relative contributions of different element creation sites in the Milky Way.

Help Received

Participant in SIP (Science Intermship Program) at UCSC under the supervision of Dr.Kirby and Prof. Guhathakurta