CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)

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Project Number

S1806

Project Title

The Distribution of [C/Fe] Ratios in Milky Way Dwarf Spheroidal Satellites from Medium-Resolution Spectroscopy

Abstract

Objectives/Goals

The main objective of this project is to measure carbon abundances, using the medium-resolution spectroscopy (MRS) technique, for stars in the Milky Way#s dwarf satellites. The carbon abundances for these stars have not yet been reliably measured before, and this is the first time anyone has calculated carbon abundances with the MRS technique for such a large sample of stars. The direct results of this project will be used to determine if the MRS technique is better than the more commonly used high-resolution spectroscopy (HRS) technique in terms of precision and accuracy. To further examine the role of dwarf galaxies in building the halo, the degrees of carbon enhancement will be compared to the dwarf spheroidal galaxies (dSph) and the halo field population

Methods/Materials

A grid of high-resolution synthetic spectra for hypothetical stars of specific effective temperature, surface gravity, metallicity, alpha element abundance, and carbon abundance was generated for comparison with medium-resolution observed spectra of dSph stars of unmeasured [C/Fe] but otherwise known properties. After smoothing, rebinning, and normalizing the two data sets, carbon abundance was varied to find the best carbon abundance by determining the synthetic spectrum that gave the minimal deviation.

Results

A lower Carbon-Enhanced Metal-Poor (CEMP) fraction was found: 1%±1% in the dSph galaxies compared to the 21% ± 2% in the halo. In particular, Sculptor did not have any CEMP stars. The [C/Fe] values calculated for stars 598482 and 604526 in Draco are -0.08±0.08 and -0.67 ±0.22, respectively. The corresponding HRS measurements were found to be -0.48 ±0.26 (star 598482) and -0.57 ±0.30 (star 604526).

Conclusions/Discussion

A lower margin of error was discovered in the MRS measurements than in those from HRS, which shows that using the MRS technique to calculating abundances is in fact more precise than measurements through HRS. The difference in CEMP frequencies between the dSphs and the halo suggests that the dwarf galaxies have evolved over time. The lack of CEMP stars in Sculptor suggests that other galaxies similar to Sculptor in mass were not dominant contributors of the halo field population. The variation in carbon abundances supports prior knowledge of dSph stars and provides a deeper understanding of the formation of stars such as those of the Milky Way halo.

Summary Statement

By using MRS, calculating 600+ carbon abundances proves MRS is more precise and more widely applicable than the traditional HRS, ushering a new era of data analysis for distant galaxies that were previously difficult to measure.

Help Received

Dr. Evan Kirby (UCI) provided guidance for our project. Dr. PuragraGuhathakurta (UCSC) provided the facility at UCSC for conducting our research project.