Analysis And Stellar Label Approximations of Carbon-Enhanced Metal-Poor Stars

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Abstract

A subset of the Carbon-Enhanced Metal-Poor (CEMP) stars (the CEMP-no stars) are believed to be direct descendants from the very first generation of stars to be born after the Big Bang. Determining reliable stellar atmospheric parameters (metallicity, surface gravity, and effective temperature) for low-metallicity stars in the Milky Way galaxy is an integral part in identifying candidate CEMP stars. Using a grid of synthetic stellar spectra, it has been shown that The Cannon, a new machine learning technique, can quickly and accurately determine the stellar parameters with relativity low scatter (~100 K in Temperature, 0.264 in log g, and 0.268 in [Fe/H]).

Introduction

Galactic Archaeology has roots in observing and understanding the environment from which the first stars (Population III) in the Universe were created. The focus of the study is to identify CEMP-no stars, which exhibit an overabundance of carbon and lack of heavier neutron capture elements in their atmosphere. The technique used in this work (The Cannon) has a number of direct applications, including determination of stellar parameters in large databases (~4 million) of observed stellar spectra from LAMOST, as well as the ~500,000 stellar spectra observed by SDSS/SEGUE. The derived parameters from these two datasets can be compared, and possibly averaged, which will help confidently identify additional CEMP stars for high-resolution spectroscopic follow-up.

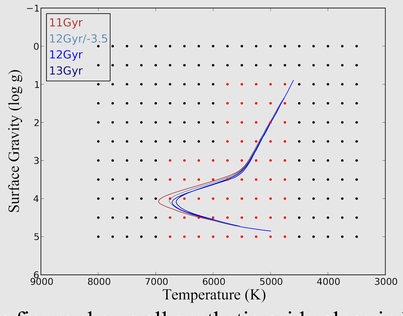

Fig. 1 : This figure shows all synthetic grid values in black dots, all candidate synthetic grid values in red dots with overlaying YY isochrones for proper candidate selection.

Stellar Label Approximations

An important part of analyzing survey spectra is to quickly identify targets that fit the characteristics for a carbon-enhanced metal-poor star. This was accomplished by using a branch of machine learning named The Cannon. The Cannon operates by taking advantage of the predictable behavior of spectral features for different stellar parameters and chemical compositions. This allows for the inference of the stellar labels for any given test set of stars.

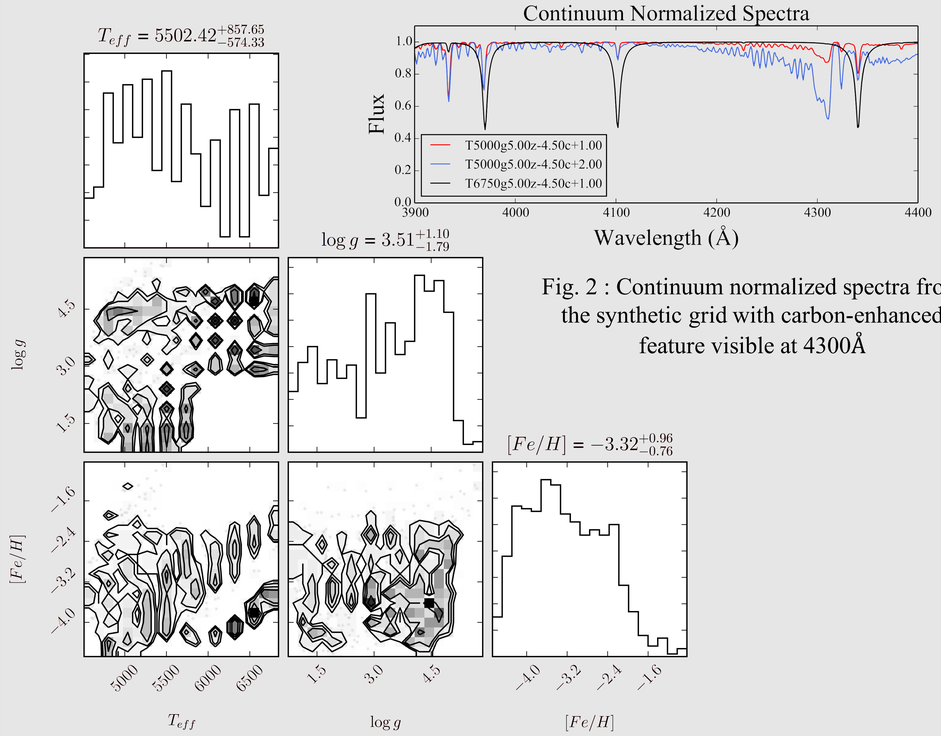

Fig. 2 : Continuum normalized spectra from the synthetic grid with carbon-enhanced feature visible at 4300Å

Fig. 3 : Density plots of the stellar labels against each other (off diagonal), and histograms of each label (on diagonal).

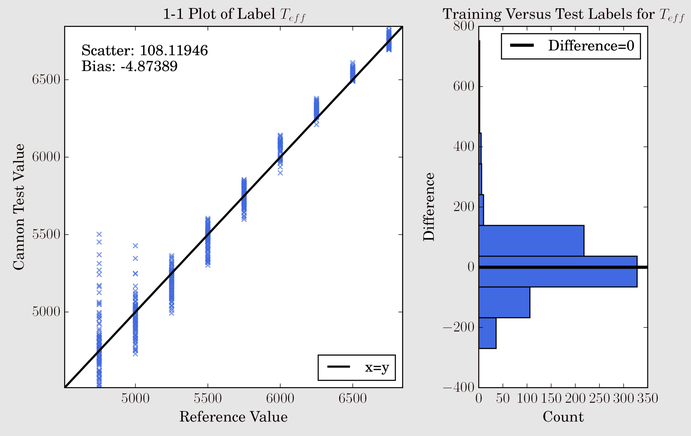

Fig. 4 : Inference of the temperature labels on the synthetic grid.

Carbon Corrections

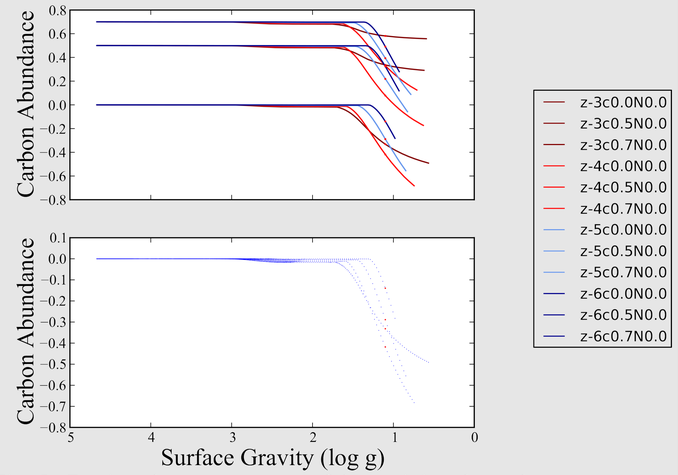

Fig. 5 : Depicts the current stage of determining the carbon corrections for a set of observed stars against stellar evolution models.

Currently, carbon corrections are being used to more accurately quantify the initial amount of carbon present when the CEMP-no stars were formed. These corrections are calculated by taking the increase of nitrogen and depletion of carbon on the stellar surface into account. The rate of this transformation has been shown to be dependent on the metallicity and surface gravity. This being said, correctly adjusting the surface carbon abundance will provide further information on the star prior to its evolution.

Conclusion

Successfully determining the stellar labels of input spectra from various stellar surveys is incredibly useful in attempts to find CEMP candidates. Proposed future work is to determine the stellar labels from LAMOST spectra. Also, from finishing the corrections in the carbon abundance will be of great use in correspondence with The Cannon.

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