Rediscovering our Galaxy
Proceedings IAU Symposium No. 334, 2017
C. Chiappini, I. Minchev, E. Starkenburg
& M. Valentini, eds.

doi:10.1017/S1743921317007001

Measurement of [Fe/H] and [C/Fe] for Metal-Poor Stars from the RAVE Survey

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Abstract. The RAVE survey obtains moderate-resolution (R ∼ 7500) spectroscopy of relatively bright stars in the region of the Ca triplet, and derives estimates of stellar atmospheric parameters (Teff, log g, and [Fe/H]) and abundance estimates for a limited number of elements. The RAVE sample is selected on apparent magnitude, effectively removing the biases typically associated with searches for metal-poor stars such as metallicity, evolutionary status, or Galactic population membership. For the past several years, we have been obtaining medium-resolution (R ∼ 1800) spectroscopy over a much wider wavelength range, from 3700 Å to 5500 Å, for RAVE stars with estimated metallicities from the RAVE pipeline of [Fe/H] < −1.8.

Based on these observations, we use the well-tested n-SSPP pipeline to obtain atmospheric parameter estimates, as well as measurements of [C/Fe], for over 1,700 metal-poor star candidates. We present an analysis of the distribution of carbon-enhancement in the relatively local volume of the Galaxy as a function of metallicity, location, and kinematics. Our results are useful to test the RAVE parameter estimates, and add to the growing number of known carbon-enhanced metal-poor (CEMP) stars for future high-resolution follow-up.

Keywords. Galaxy: halo, Galaxy: kinematics and dynamics, Galaxy: stellar content, stars: abundances

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The Radial Velocity Experiment (RAVE), which is currently on its 5th data release, covers 20,000 degrees of the sky and contains medium-resolution spectroscopy of 457,588 stars. (Kunder *et al.* 2017). Distances, proper motions, and Galactic population have been determined or matched, and carbon has been determined with the non-SEGUE Stellar Parameter Pipeline (n-SSPP; Beers *et al.* 2014). Within the sample, 819 stars are Very Metal Poor (VMP; [Fe/H] < −2.0), and 127, after evolutionary corrections (Placco *et al.* 2014) are carbon-enhanced ([C/Fe] > +0.70).

Plotted in A(C) - [Fe/H] space, the sample appears to be almost entirely composed of the lower-A(C) (A(C) < 7.1), low-[Fe/H] CEMP-no stars which make up Groups II and III in Yoon *et al.* (2016), which found evidence for multiple types of progenitors of the two groups. Encouragingly, in this sample, ∼ 25 stars appear to belong to the under-populated Group III, which contains the lowest metallicity stars yet discovered and is crucial to understanding first-star nucleosynthesis.

As anticipated, the cumulative CEMP fraction rises with decreasing metallicity, increasing from 16% at [Fe/H] < −2.0 to 40% at [Fe/H] < −3.75.

Future work in this area will compare the stellar parameters derived with the RAVE pipeline to those derived with the n-SSPP. In addition, the stars in this sample provide us with candidates for our on-going program at the du Pont 2.5m Telescope to identify and study metal-poor r-process-enhanced stars.

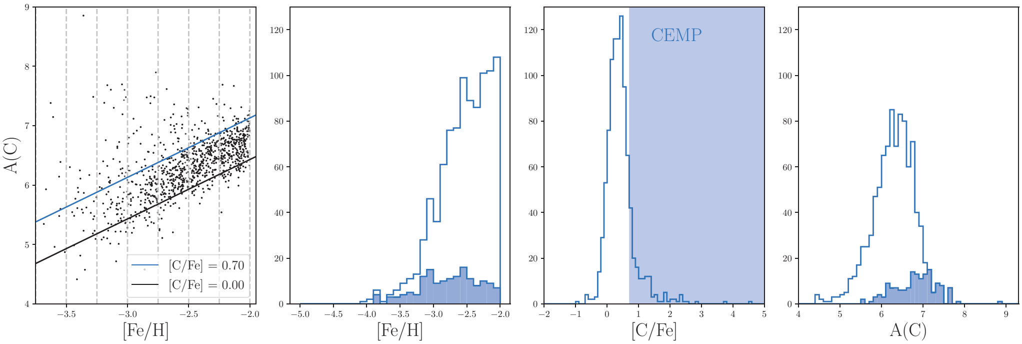

Figure 1. Far left: The sample in A(C) - [Fe/H] space. The blue line represents the [C/Fe] > +0.7 cutoff for CEMP stars. **Center, Right:** The distribution of the sample with respect to [Fe/H], [C/Fe], and A(C). The CEMP population in all three histograms is shaded in blue.

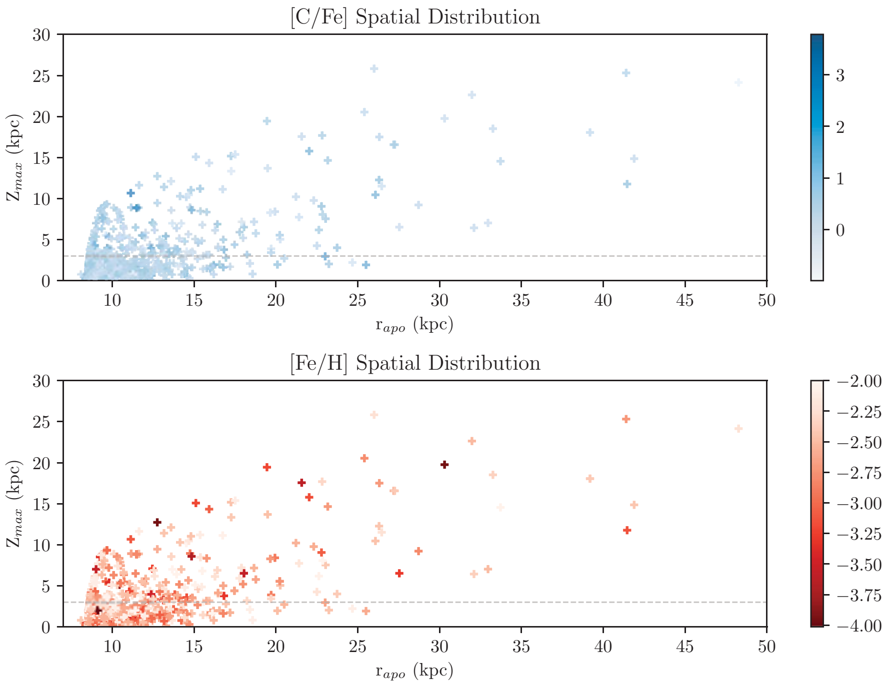

Figure 2. The spatial distribution (Z_{max} vs. r_{apo}) is shaded according to carbonicity (top) and metallicity (bottom), revealing that the most carbon-rich and lowest-metallicity stars are indeed to be found at the largest Z_{max}, within the dual halo populations (Z_{max} > 3.0 kpc; Lee *et al.* 2017).

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https://doi.org/10.1017/S1743921317007001 Published online by Cambridge University Press