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

doi:10.1017/S1743921317011590

Probing Galactic Chemical Evolution with J-PLUS Photometry

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Abstract. Narrow-band photometric surveys, such as the Javalambre Photometric Local Universe Survey (J-PLUS), provide not only a means of pre-selection for high-resolution follow-up, but open a new era of precision photometric stellar parameter determination. Using a family of machine learning algorithms known as Artificial Neural Networks (ANNs), we have obtained photometric estimates of effective temperature ($T_{\rm eff}$) and metallicity ([Fe/H]) across a wide parameter range of temperature and metallicity ($4000 < T_{\rm eff} < 7000$ K; $-3.5 <$[Fe/H]< 0.0) for a number of stars in the J-PLUS Early Data Release. With this methodology, we expect to increase the number of known Carbon-enhanced Metal-poor (CEMP; [C/Fe]$> +0.7$) stars by several orders of magnitude, as well as constrain the metallicity distribution function of the Milky Way Halo system.

Keywords. General: stellar parameters, Galaxy: halo, stars: abundances

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Chemical abundances of stars play a crucial role in understanding the assembly and evolution of the Milky Way. Obtaining elemental abundance estimates, however, is a costly endeavor, requiring pre-selection and follow-up spectroscopy for confirmation. While there are now tens of thousands of stars with well-measured metallicity below 1/100th solar ([Fe/H]< -2), the numbers decrease rapidly with declining [Fe/H], and only 25 ultra metal-poor stars ([Fe/H]< -4) have been discovered (Placco *et al.* 2015).

Using J-PLUS filters centered on key absorption features, such the Ca II H & K lines and the CH *G*-band, we will obtain narrow-band photometric measurements for millions of stars in the Milky Way. These feature-sensitive filters enable us to make *photometric* elemental-abundance determinations, in addition to estimates of stellar parameters such as effective temperature and metallicity.

By training artificial neural networks (ANN) on synthetic photometry and parameters estimates from the SEGUE Stellar Parameter Pipeline (Lee *et al.* 2008), we have produced accurate $T_{\rm eff}$ and [Fe/H] across a wide parameter range ($4000 < T_{\rm eff} < 7000$ K; $-3.5 <$ [Fe/H] < 0.0). This methodology was applied to J-PLUS Early Data Release to identify approximately 300 candidate CEMP stars.

References

Lee, Y. S., Beers, T. C., Sivarani, T., *et al.*, 2008, *AJ*, 136, 2022
Placco, V. M., Frebel, A., Lee, Y. S., *et al.*, 2014, *ApJ*, 809, 136
Starkenburg, E., Martin, N., Youakim, K., *et al.*, 2017, *MNRAS*, 471, 2587
Reidmiller, V., 2002, *Computer Standards & Interfaces*, 16, 265

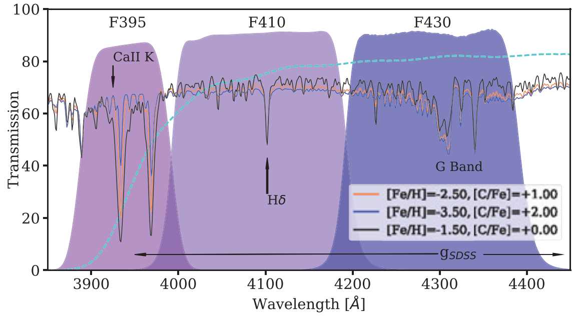

Figure 1. Three narrow-band J-PLUS filters are shown against three synthetic spectra of varying metallicity and carbon abundance. The F395 filter is ideally placed to detect the Ca II H & K lines, a proxy for metallicity, while the F410 filter captures the temperature sensitive Hδ line, and F430 captures the G-band associated with the CH molecule.

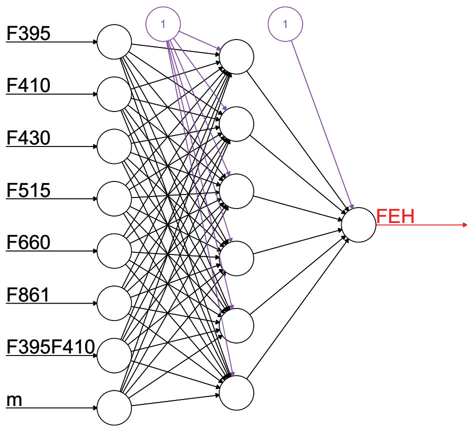

Figure 2. The ANN trained to predict metallicity consisted of single hidden layer with six neurons, six narrow-band photometric inputs, a temperature-sensitive color, (F395 − F410) and a metallicity-sensitive color, m =F395$-g - 1.5(g - i)$, analogous to the color combination employed by the Pristine survey (Starkenburg et al. 2017).

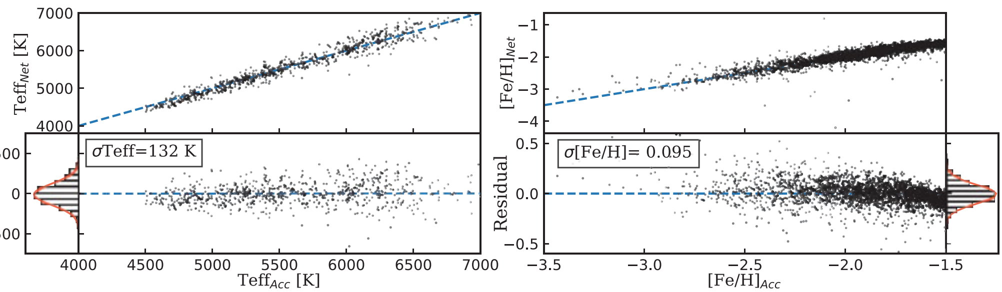

Figure 3. Left: ANN predictions for the effective temperatures of 836 stars in the J-PLUS EDR against the accepted value of T_{eff} from the SSPP. Right: ANN predictions of metallicity, using synthetic photometry for 2792 validation stars, against the accepted value of [Fe/H] from the SSPP.

https://doi.org/10.1017/S1743921317011590 Published online by Cambridge University Press