Discovery of barium star candidates in galactic open clusters?

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Barium stars

- These objects display enrichment of the s-process elements. However, they are not luminous enough and too warm to be considered AGB stars having undergone a third dredge-up.
- Their overabundances of carbon and s-process elements are explained by mass-transfer in a binary system from a former AGB star (now a white dwarf).
- BS have spectral types G and K, so they are free from the strong molecular opacity from ZrO, CN and C$_2$ absorption features. This makes barium stars ideal targets to study the s-process nucleosynthesis in stellar atmospheres.
- BS are also important to constrain Carbon Enhanced Metal-Poor stars with s-elements overabundances (CEMP-s), Beers & Christlieb (2005).
- Approximately 1% of the giant field are Barium Stars (McConnell et al. 1972). Only in two open clusters they were discovered: NGC 2420 (Smith & Suntzsef 1987) and NGC 5822 (Katime Santrich et al. 2013).
High resolution spectra

Spectra for giant stars in the Open Cluster IC 4756 were obtained using FEROS (R=48000) in the 2.2mts telescope in La silla/Chile. The wavelength coverage is from (3800, 9200)Å. [S/N] > 100 for all 9 spectra.
Methodology

- $\delta A_i = A_i^\star - A_i^\odot$.

- Excitation equilibrium: $r_1 = \frac{d(\delta A_i^{FeI})}{d(\chi_{exc})} \simeq 0.00$ sets $T_{eff}$.

- $r_2 = \frac{d(\delta A_i^{FeI})}{d(\text{EW}_r)} \simeq 0.00$ sets $\xi$.

- Ionization equilibrium: $\langle A_i^{FeII} \rangle - \langle A_i^{FeI} \rangle \simeq 0.00$ sets $\log g$.

- Assigned errors by: $\Delta T_{eff}$ required for $1\sigma$ change in $r_1$; $\Delta \xi$ required for $1\sigma$ change in $r_2$ and $\Delta \log g$ required for $1\sigma$ in $\langle A_i^{FeII} \rangle - \langle A_i^{FeI} \rangle$.

- Solar model: $\langle 5777, 4.44, 1.38, 7.52 \rangle$

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Carbon abundances

Stellar atmospheric parameters in the range: $T_{\text{eff}} = [4515, 5150]$K; $\log g = [2.05, 3.15]$dex; $V_{\text{mt}} = [1.25, 2.00]$Km/s; $[\text{Fe/H}] = [-0.07, 0.05]$dex $\Delta T_{\text{eff}} = \pm 50$K; $\Delta \log g = \pm 0.06$dex; $\Delta v_{\text{mt}} = \pm 0.12$Km/s; $\Delta [\text{Fe/H}] = \pm 0.02$dex.

Green squares: Barium stars from Katime Santrich et al. (2013).
Green triangles: Barium star candidates in Open Cluster IC 4756.
Red triangles: Giant stars in IC 4756.
Blue crosses: field giant stars from Luck & Heiter (2007).
Black crosses: clump field giant stars from Mishenina et al. (2006).
s-process abundances

Uncertainties for BS candidates ±0.02dex and for another giants ±0.05dex.
Discussions

- Solar luminosities obtained: \(262\, L_{\odot}, 67\, L_{\odot}, 47\, L_{\odot} \& 74\, L_{\odot}\). Theoretical luminosity for first thermal pulse: \(1400\, L_{\odot}\) (Lattanzio 1986) and \(1800\, L_{\odot}\) (Vassiladis & Wood 1993).

- Radial velocities and membership confirmed from Mermilliod et al. (2008). HOWEVER THEY ARE NOT BINARIES? So orbits with high eccentricity?

- Contamination of the molecular cloud? High efficiency of the s-process nucleosynthesis?

- More details in Katime Santrich et al. (in prep.).