Unveiling Extragalactic Globular Clusters: Insights from X-Shooter Spectra and NIR Abundances

Emílio Zanatta, T. Moura, B. Barbuy, M. Villegas-Pérez, M. Trevisan

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Why are Extragalactic GCs important?



Studying Extragalactic GCs



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SSP Models and Extragalactic GCs: A Struggle



To the center of M87



SSP Models and Extragalactic GCs: A Struggle





Where can we improve?



Improve Abundance Predictions

Extragalactic GC stellar populations are expected to not be well described by **solar-scaled models**, due to their horizontal branch morphology (He abundances), Na and Alpha enhancement, to name a few.

Where can we improve?



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Improve Abundance Predictions

Extragalactic GC stellar populations are expected to not be well described by **solar-scaled models**, due to their horizontal branch morphology (He abundances), Na and Alpha enhancement, to name a few.

Study Stellar Spectra Outside the Sun's Vicinity and in Nearby Galaxies

Stellar spectra from MW regions such as the **bulge** and **halo**, as well as GC integrated spectra for objects in **nearby galaxies**.

Where can we improve?



Improve Abundance Predictions

Extragalactic GC stellar populations are expected to not be well described by solar-scaled models, due to their horizontal branch morphology (He abundances), Na and Alpha enhancement, to name a few.

Study Stellar Spectra Outside the Sun's Vicinity and in Nearby Galaxies

Stellar spectra from MW regions such as the bulge and halo, as well as GC



Explore the Near-Infrared (NIR) Soften or resolve optical limitations (dust not) 'c); Molecular and Soften or resolve optical limitations (dust reddening, age/metallicity degeneracy, etc); Molecular and Atomic features, and make use of data from NIR telescopes such as the JWST, Euclid and the Nancy Grace Roman Space Telescope.



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Current Work In Progress!

Goal:

- Increase the amount of precise abundance estimates in the NIR for old and metal-poor stars beyond the Sun neighborhood.
- Test SSPs with custom abundances with
 Extragalactic GC
 Photometric and
 Spectroscopic data.

Current Work In Progress!

Goal:

- Increase the amount of precise abundance estimates in the NIR for old and metal-poor stars beyond the Sun neighborhood.
- 2. Test SSPs with custom abundances with Extragalactic GC Photometric and Spectroscopic data.

X-Shooter

(Verro+2022) XShooter Spectral Library 350–2480 nm R = 10000 -2.5 < [Fe/H] < 0.5 (Barbuy, Trevisan, de Almeida+2018) Abundance fitting of individual elements

with a Python API

SynSSP

(Moura+2019)

Create SSPs with PFANT synthetic models and custom abundances

Extragalactic GC Data

Photometric, Spectroscopic

X-Shooter Spectral Library

Data

- XSL DR3 683 Stars
- 350-2480 nm
- R = 10000
- -2.5 < [Fe/H] < -0.5 (Arentsen+2019)

XSL SSPs (Verro+2022b)





XSL GKM Star Abundances in the NIR

Zanatta+25 (in prep) H-band (1500 - 1700 nm)

- Line-Strength Fitting
 > 200 GKM Stars Good S/N!
- -2.35 < [Fe/H] < 0.57

Features

- Molecules
 - CN, OH, CO
- **Alpha Elements**
 - Mg, Si, Ti, Ca
- Other
 - Al, K

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Take away message

- 1. Extragalactic GCs are important for galaxy evolution
- 2. We are entering a **"big data"** moment for **NIR photometry/spectroscopy**
- 3. There is **a big offset** between current SSP models and Extragalactic GC observed properties and we don't know exactly why.
- 4. There is plenty of work to be done here!



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Thanks for your attention!



emiliojbzanatta@gmail.com