Chemical characterization of dwarf galaxies with SkyMapper photometry

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Massachusetts Institute of Technology
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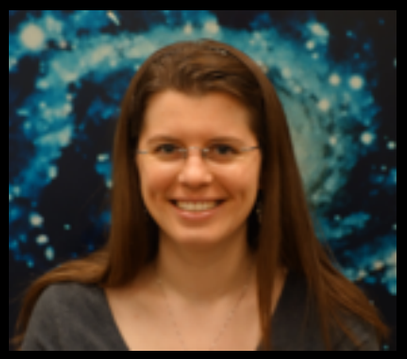
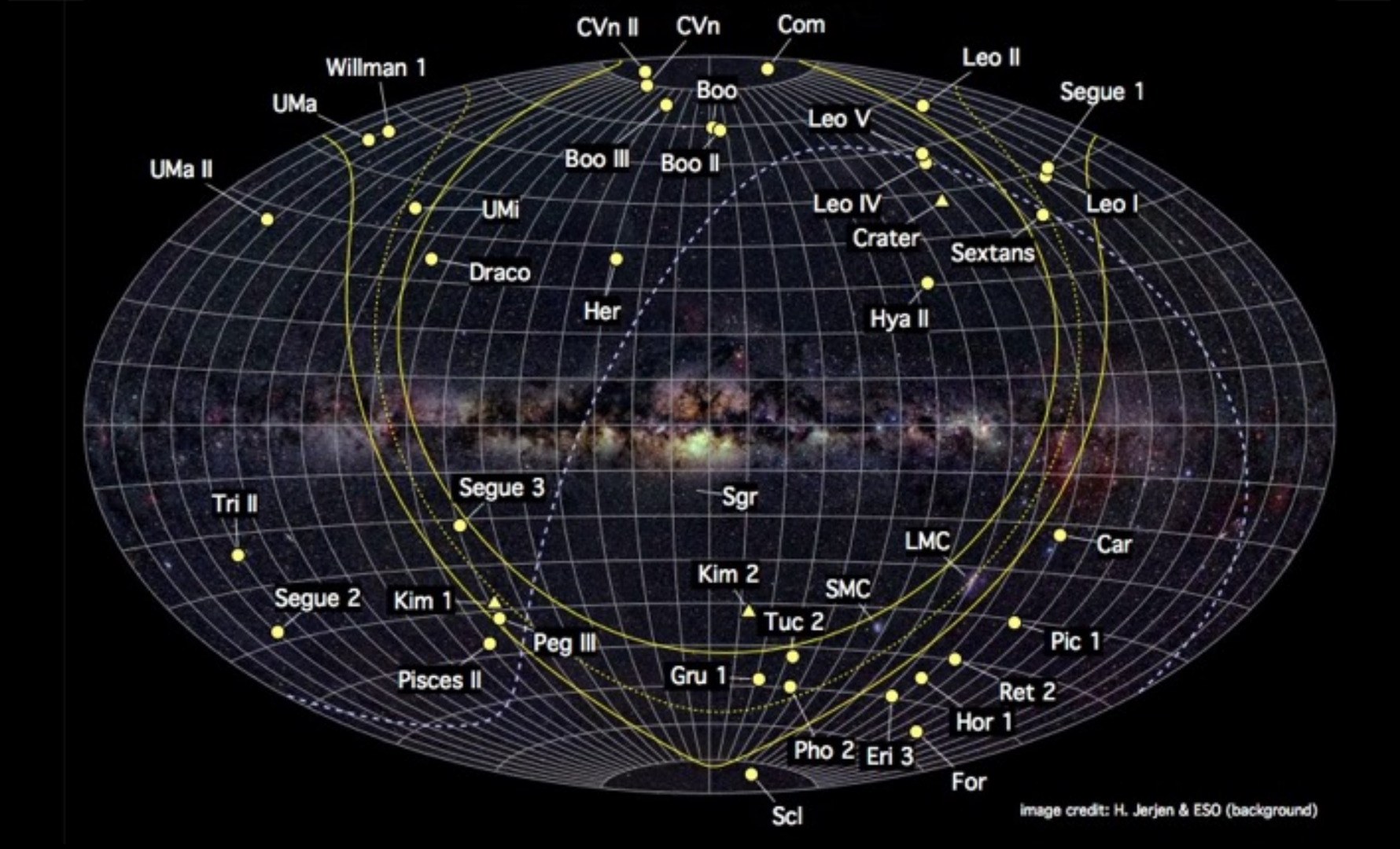



Ultra-faint dwarf galaxies are some of the oldest systems (~13 Gyr) in the Milky Way halo.

—> The metal content (or "metallicity") of their stars can place strong constraints on early chemical enrichment.



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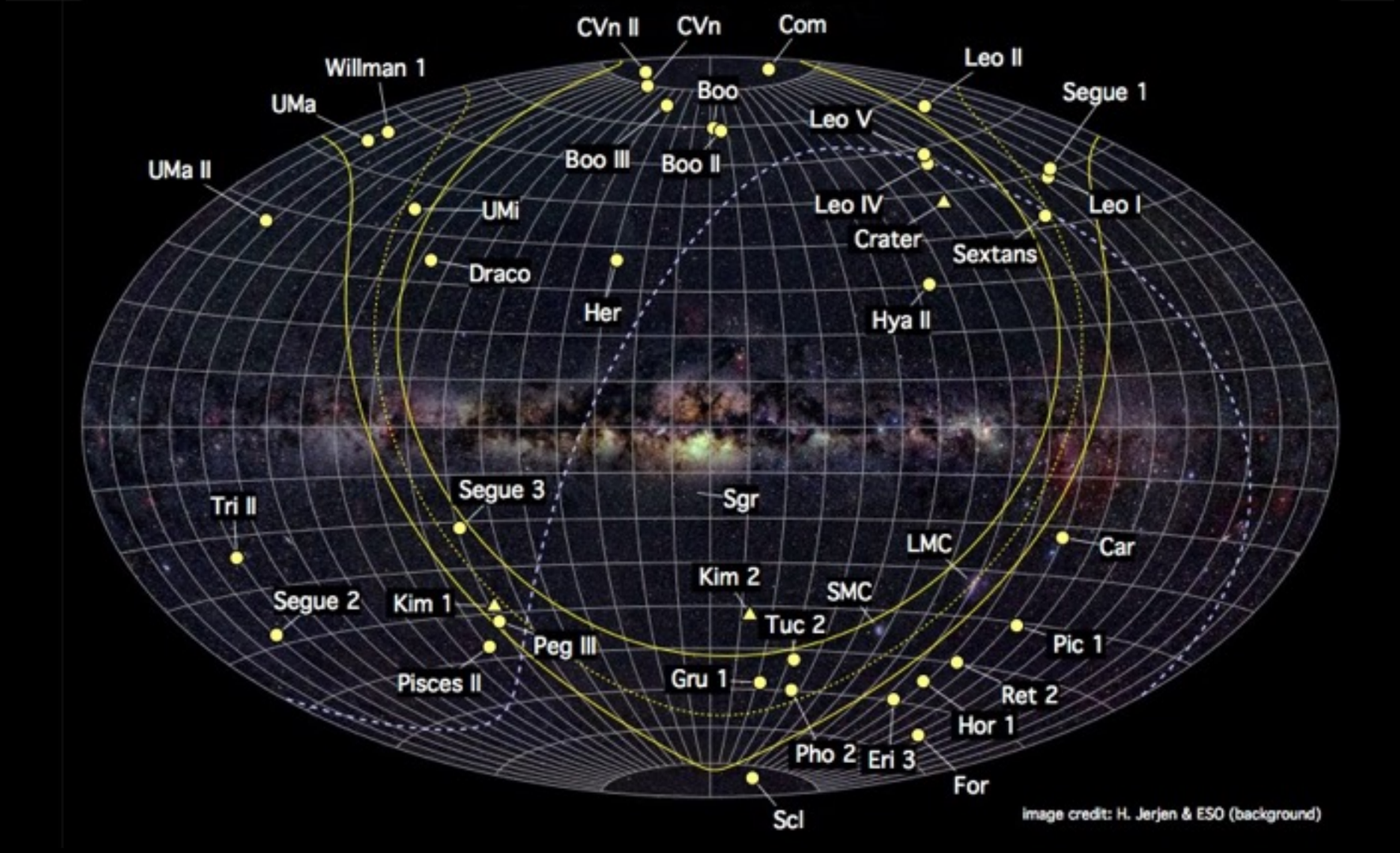
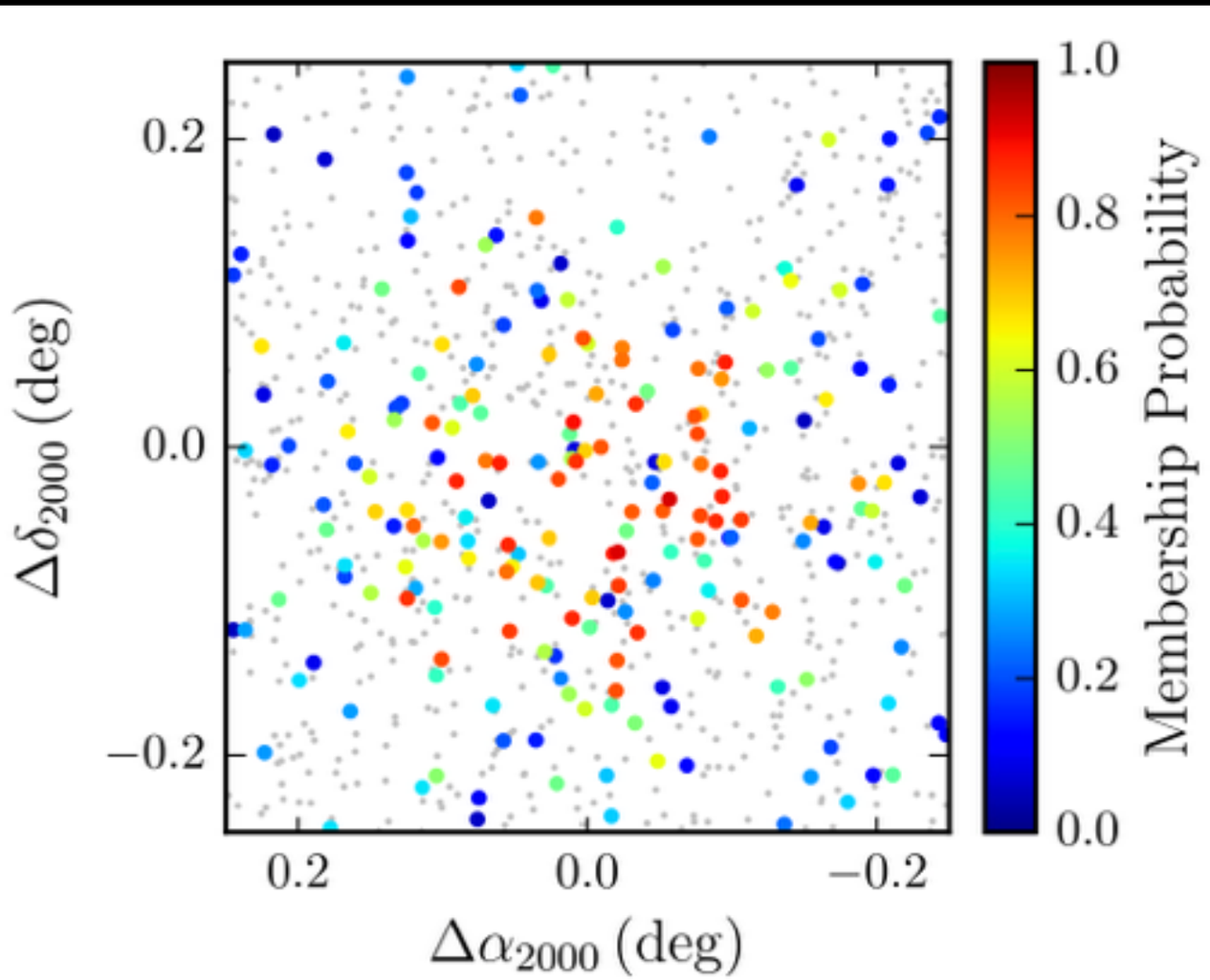
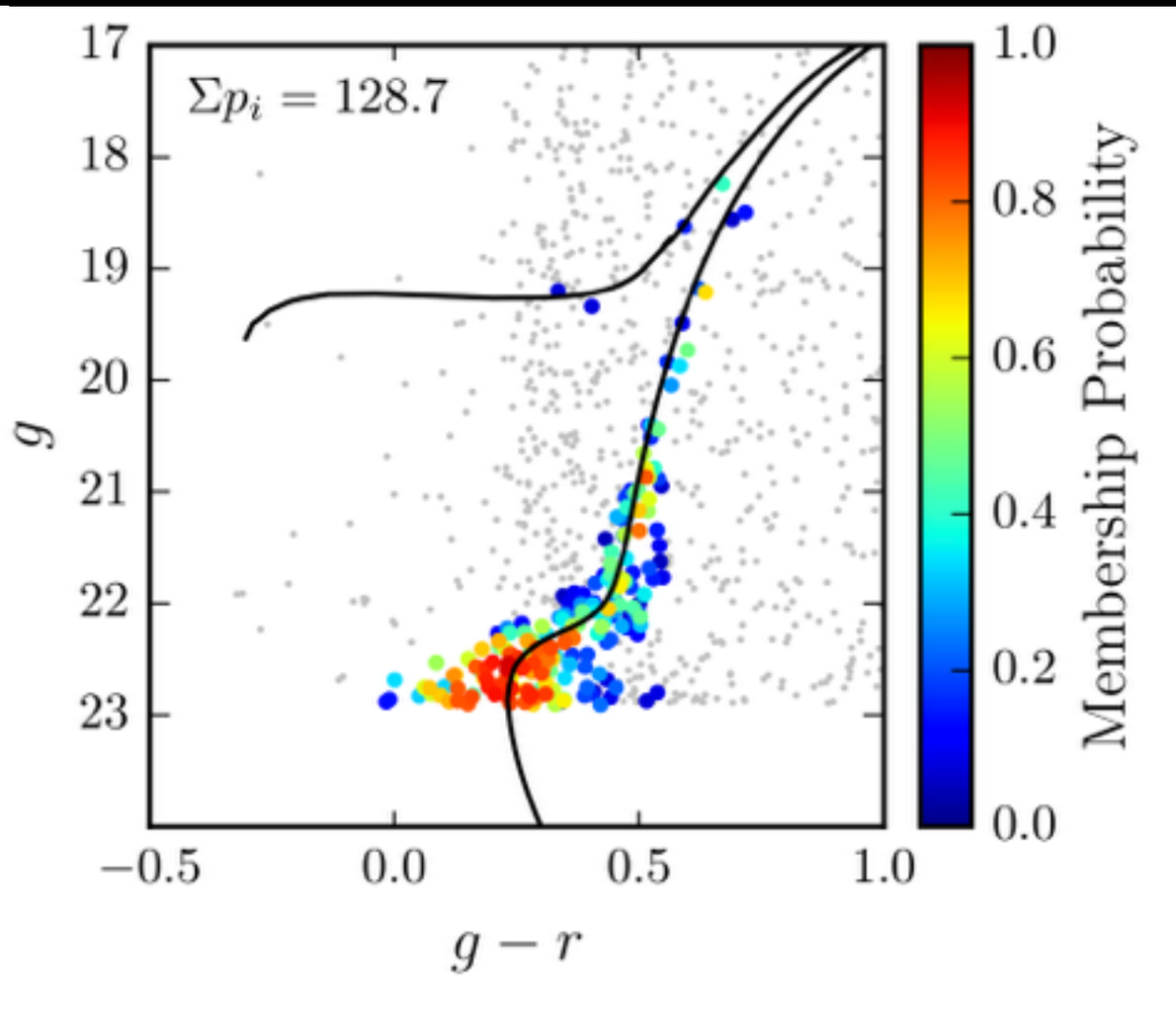


However, their low surface brightness makes it hard to spectroscopically observe their member stars

Most stars in the Tucana II UFD are too faint to be efficiently identified with spectroscopy





Figures from Bechtol et al. (2015)

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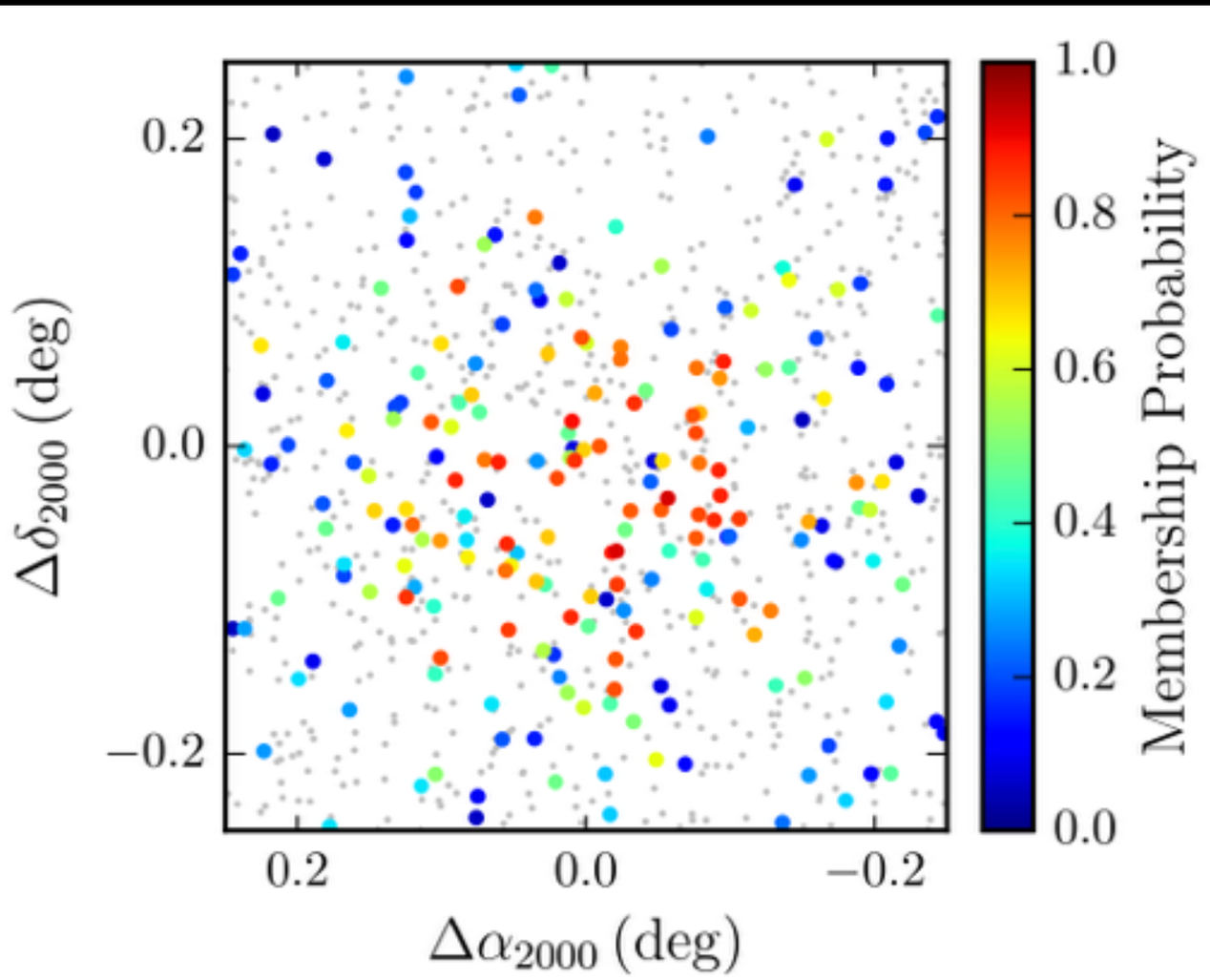

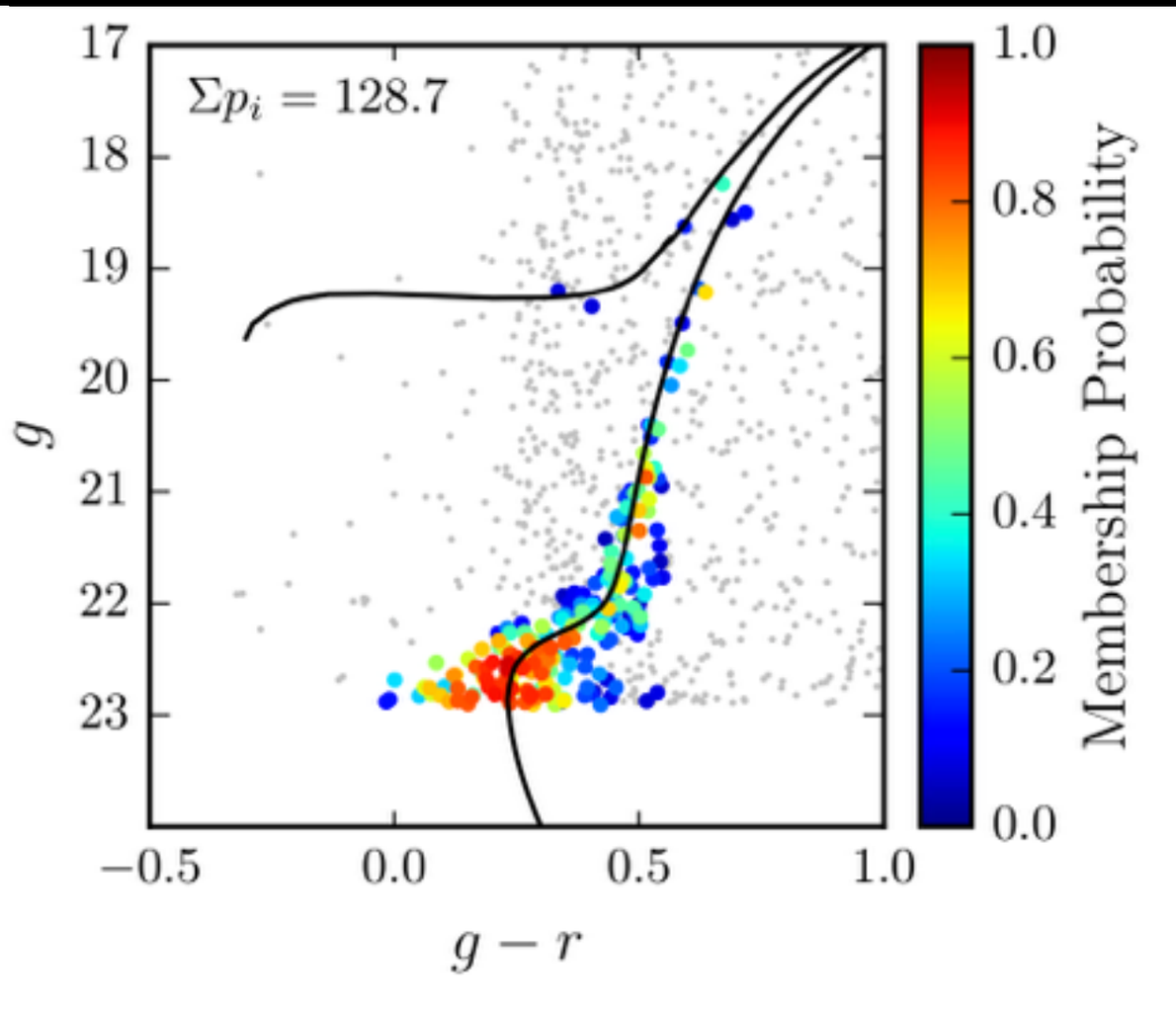

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2. Not a high probability that any given star is a member

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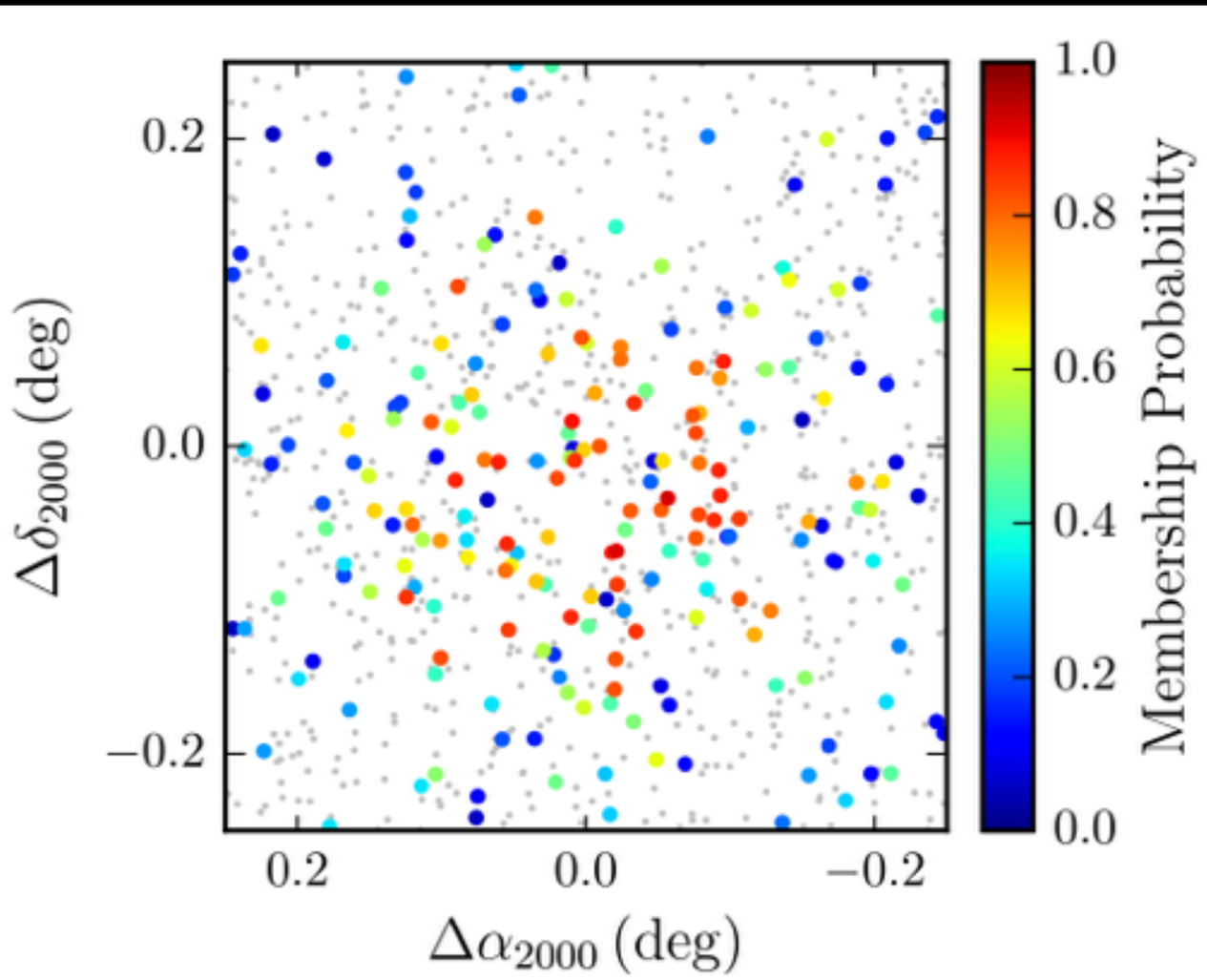

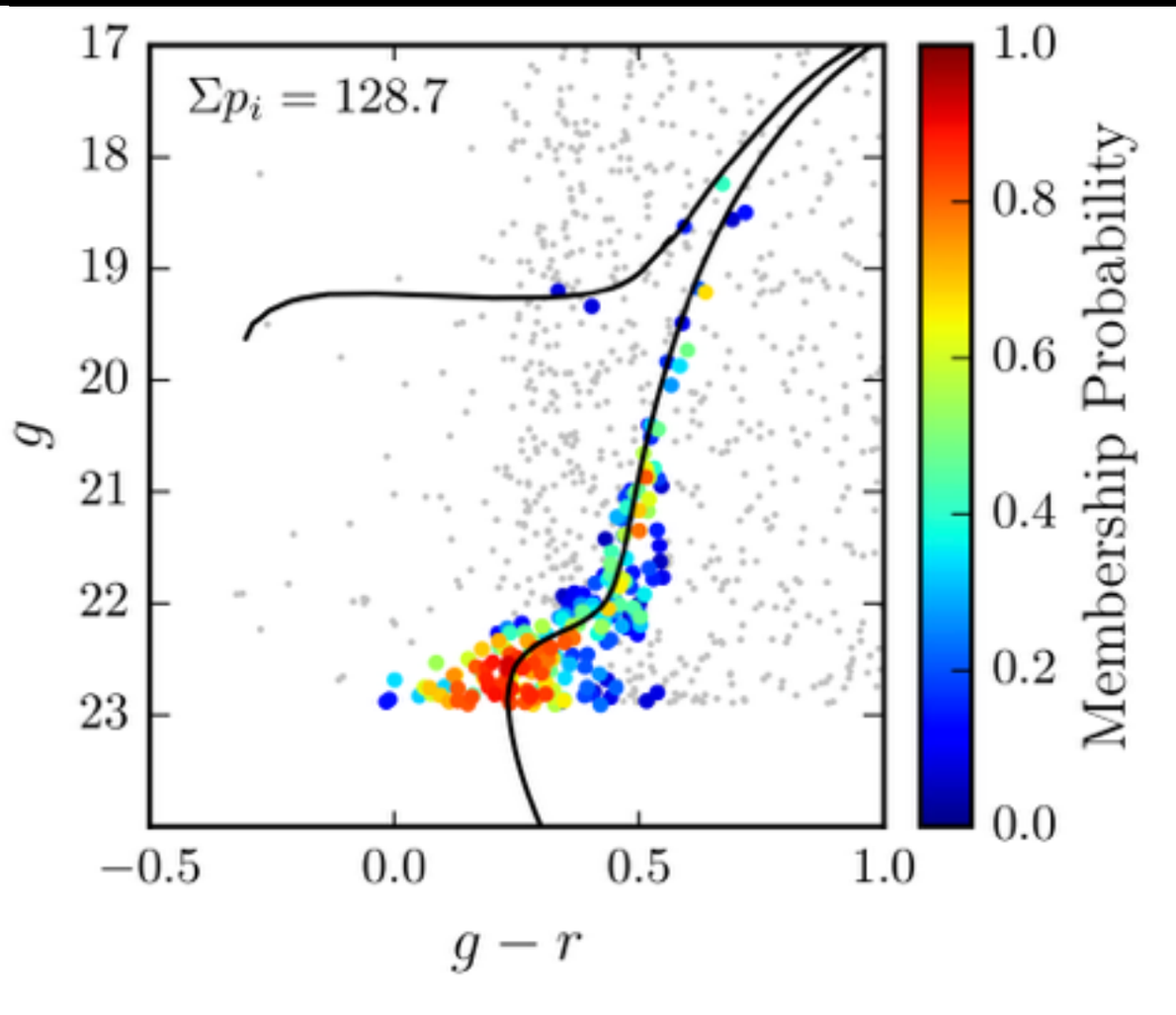

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=> Need a method to observe many stars at the same time (e.g., multi-object spectroscopy)

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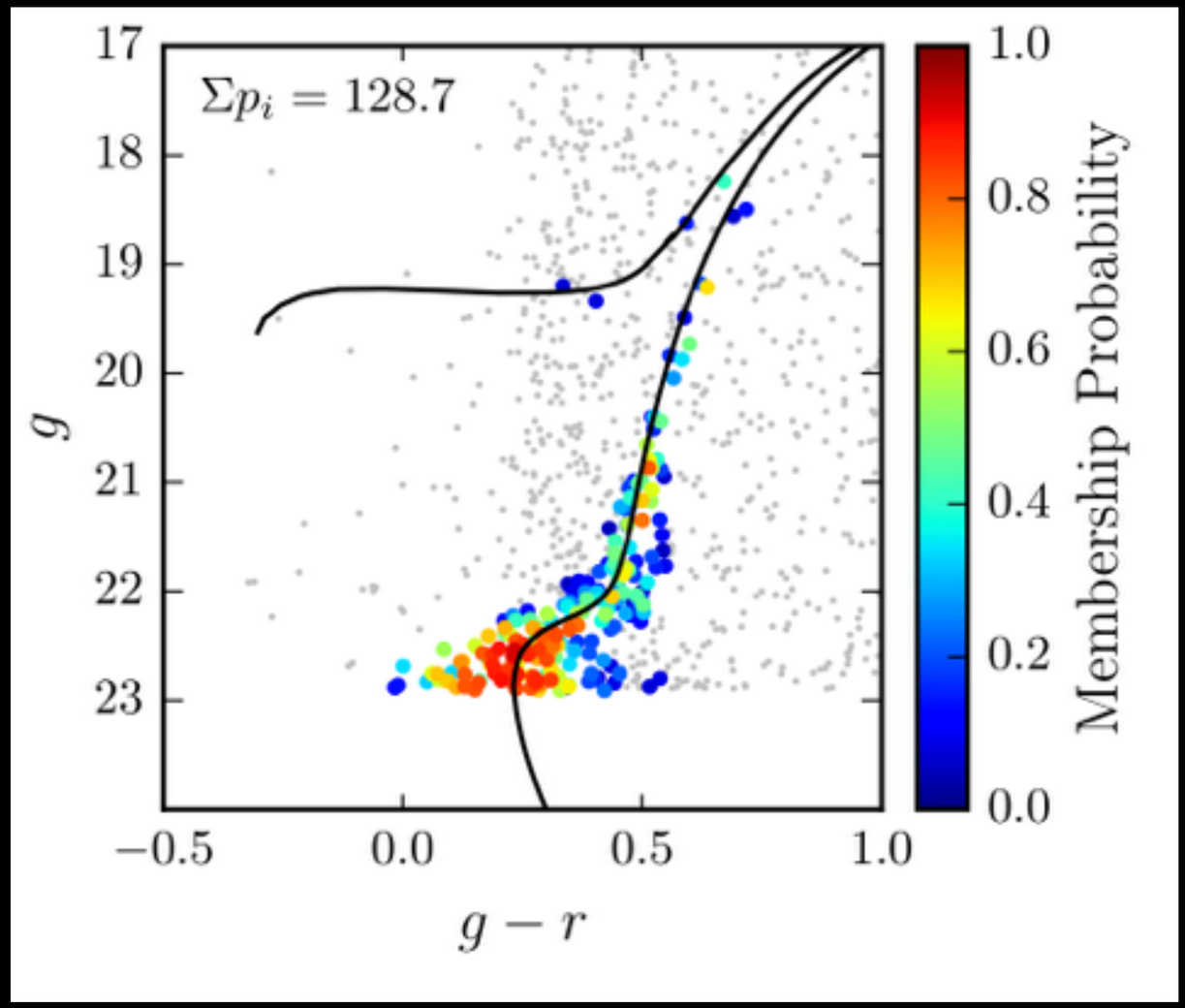

Accessible with high-resolution spectroscopy (one star at a time, ~6 hr per star)

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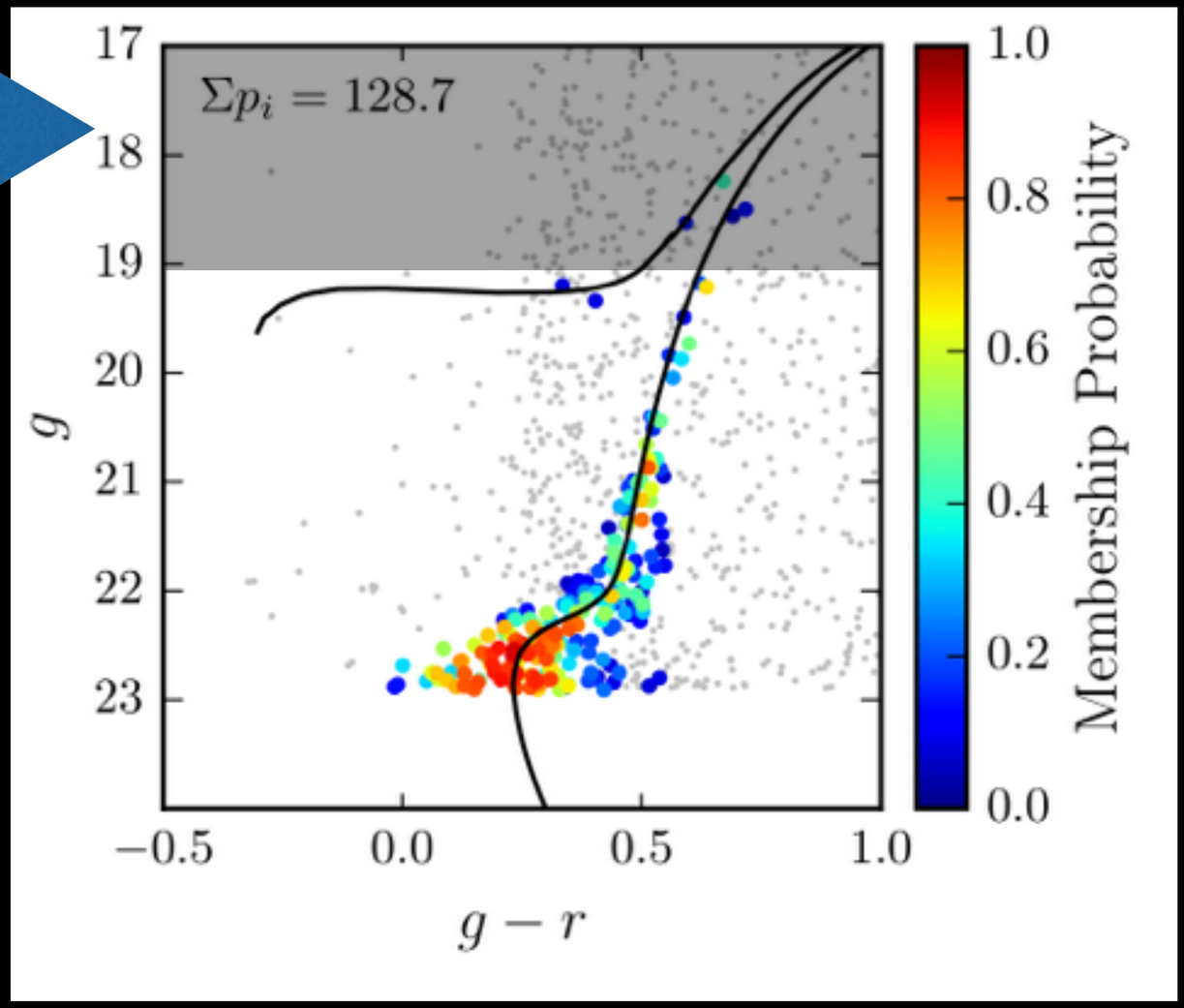

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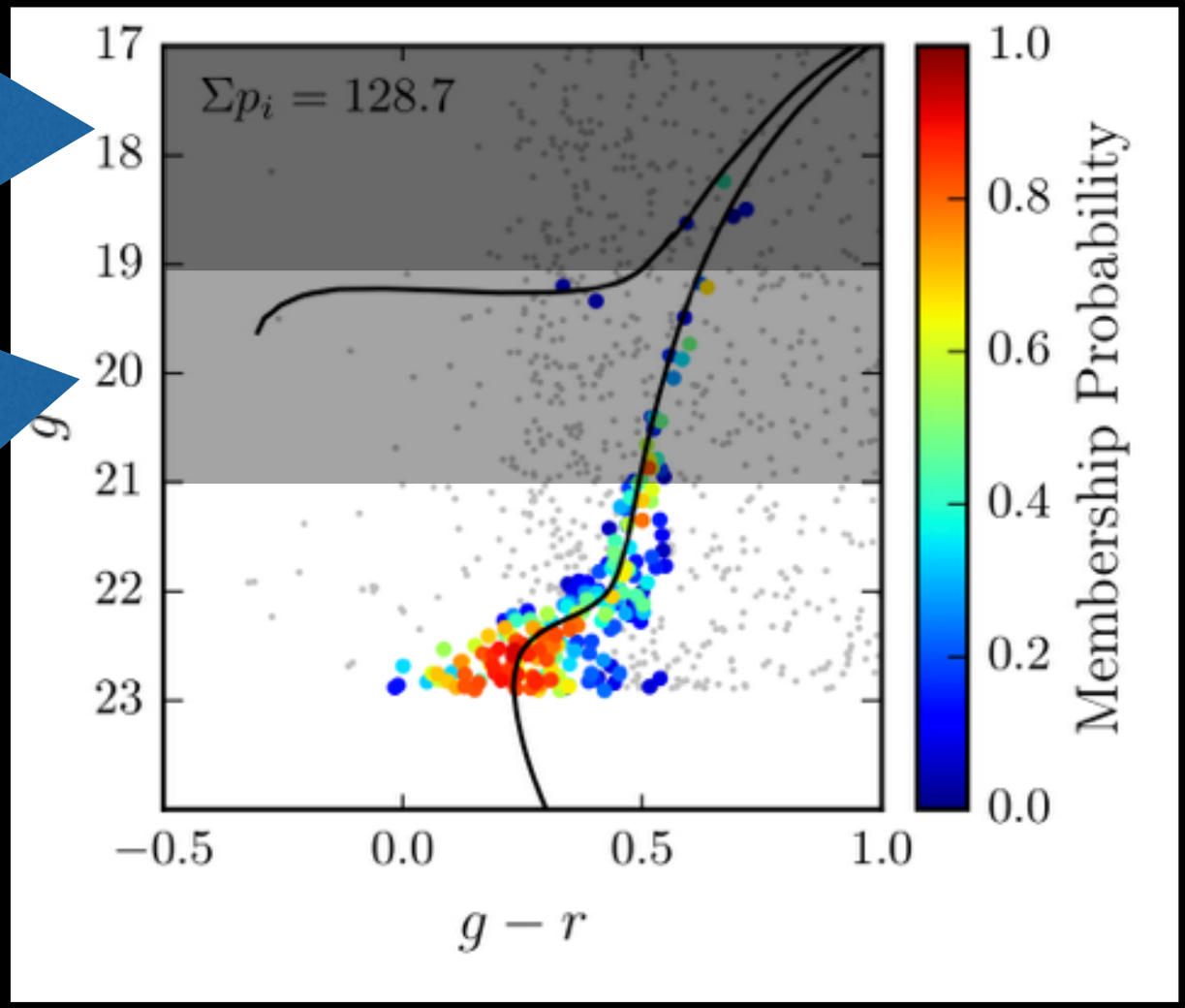

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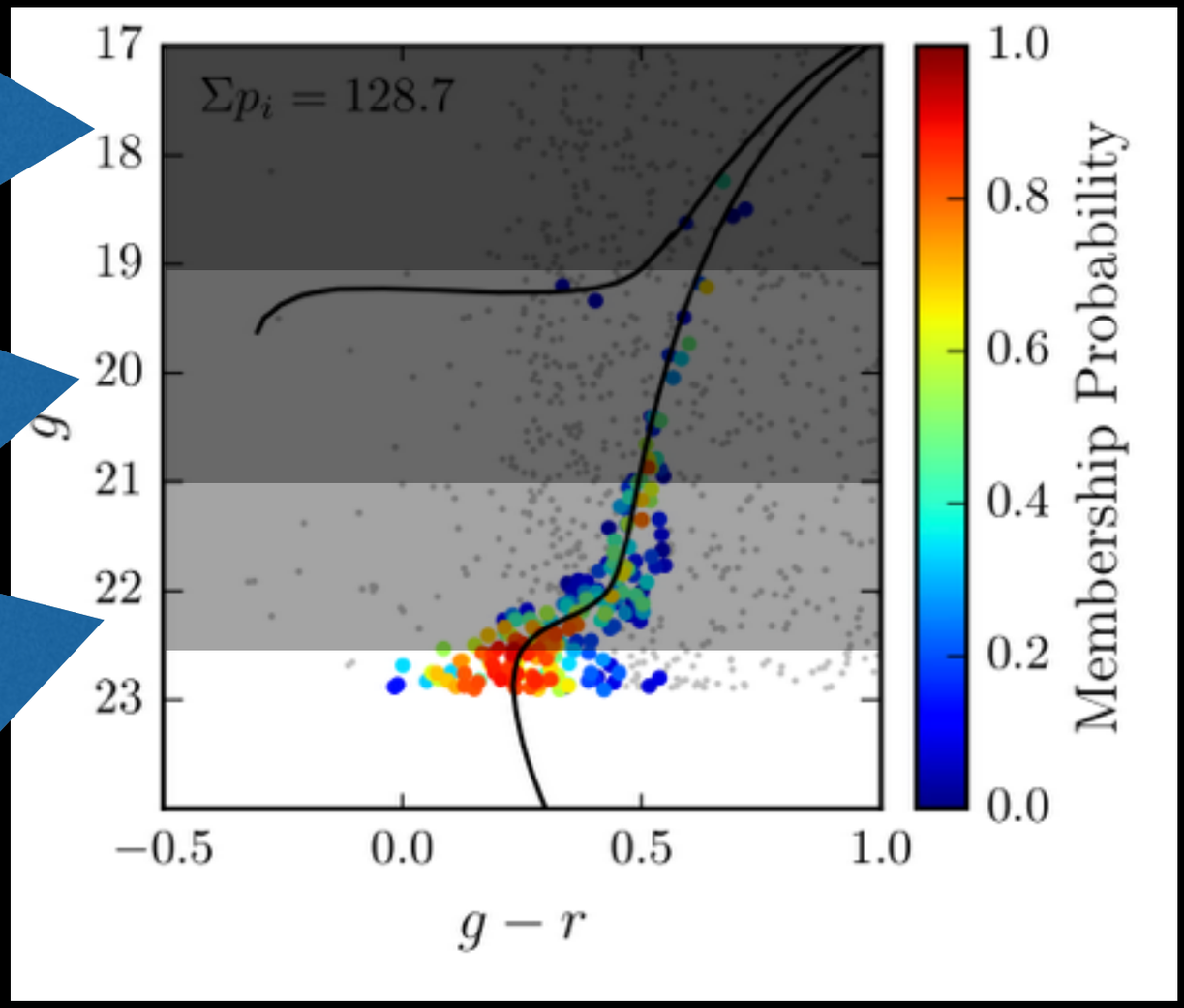

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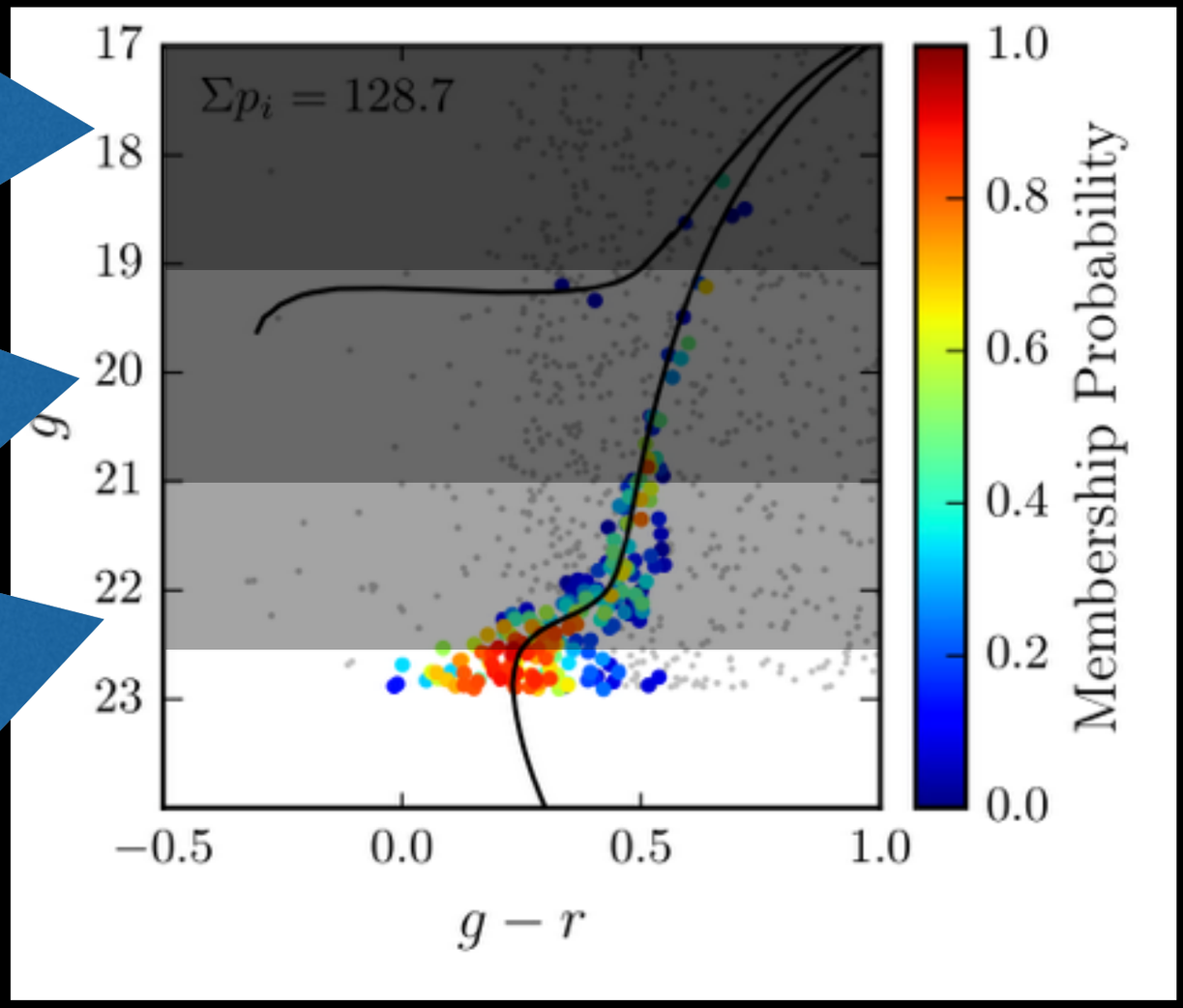


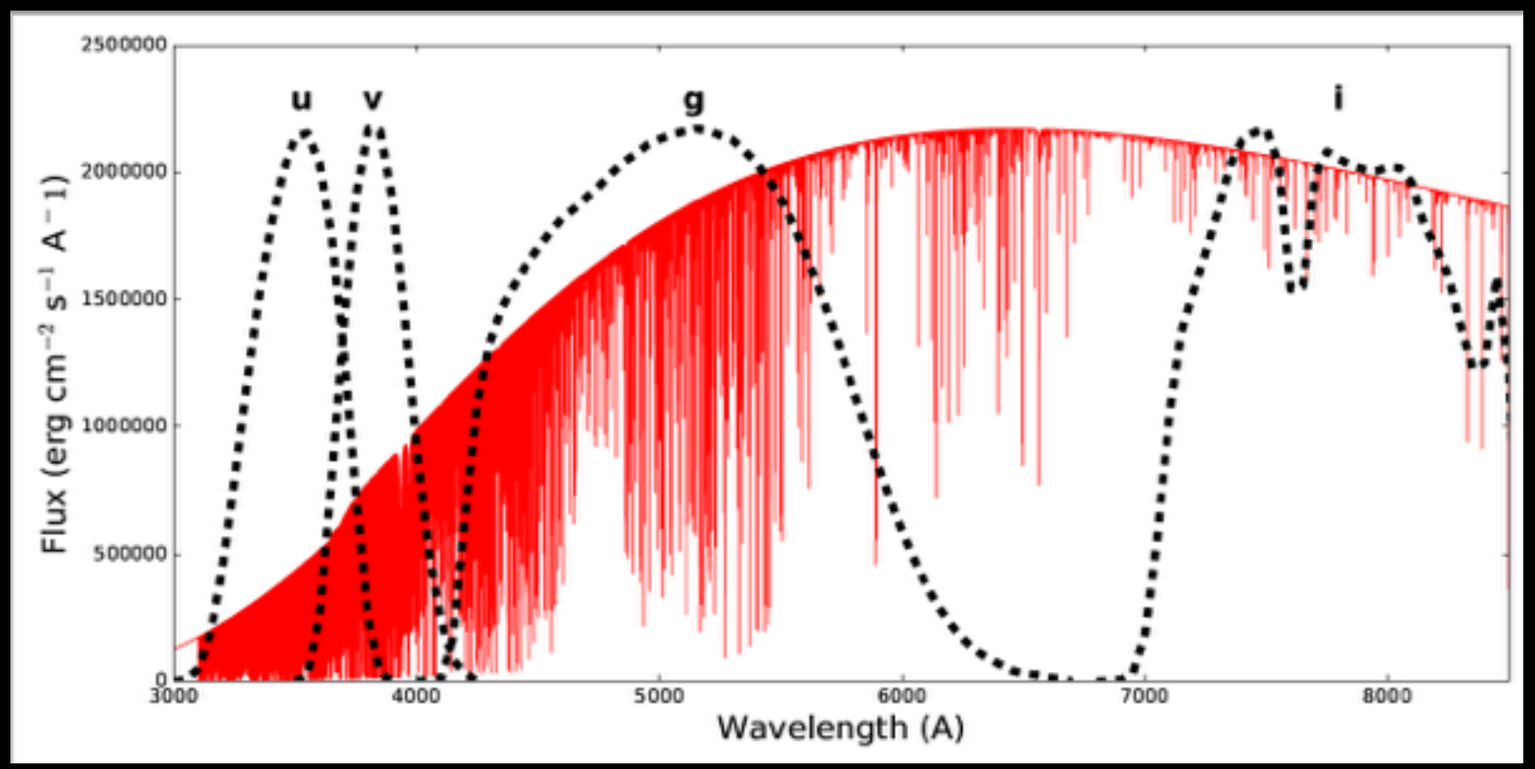
Aim:

We will use narrow-band photometry to chemically characterize stars in ultra-faint dwarf galaxies to:

1. **Identify samples of bright, metal-poor stars in dwarf galaxies for spectroscopic study missed by previous searches**
2. **Identify features (chemical, spatial) using the "all stars simultaneously" approach enabled by photometry**

Technical specifications of the SkyMapper telescope

- Survey telescope used in photometric metal-poor stars
- The field-of-view is large (~2.3 deg x 2.3 deg), meaning each image covers multiple half-light radii of each UFD
- We use PI-time to observe dwarf galaxies for ~13 hours total in the *uvgi* filters (PI: Jerjen), down to g~22
- Flux through the narrow-band v-filter is sensitive to metallicity



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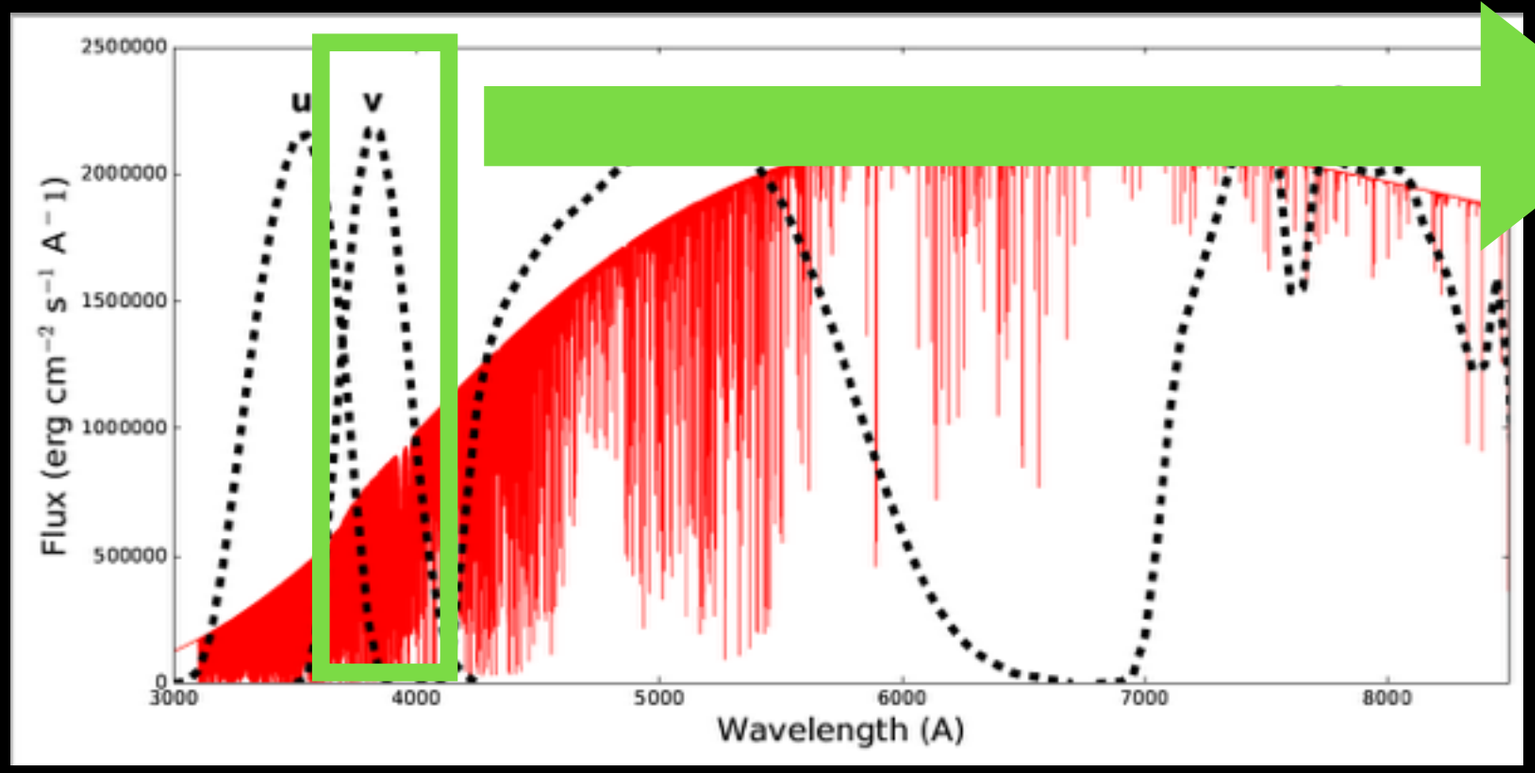
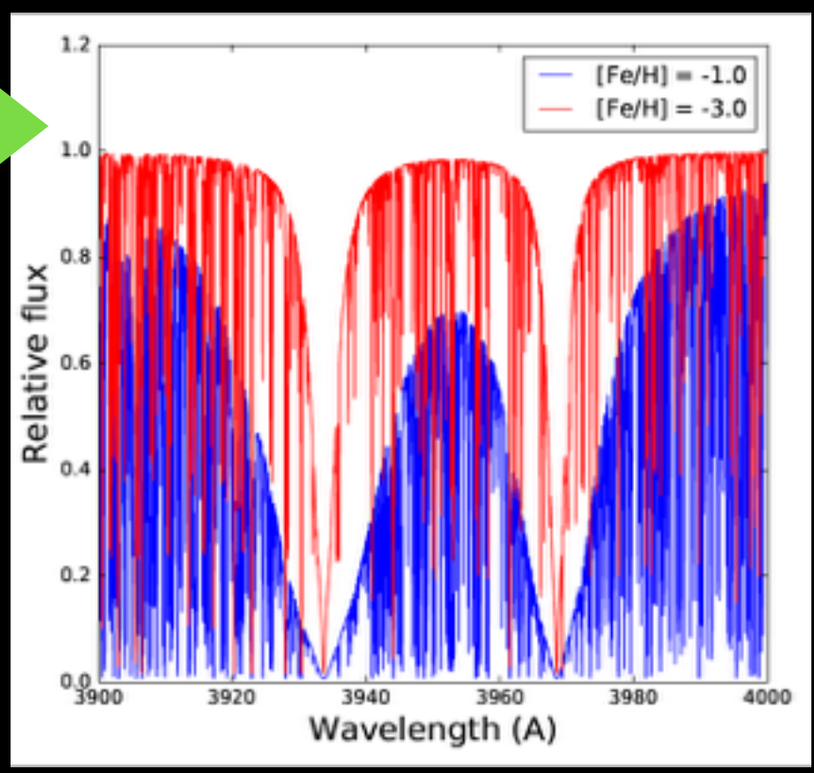
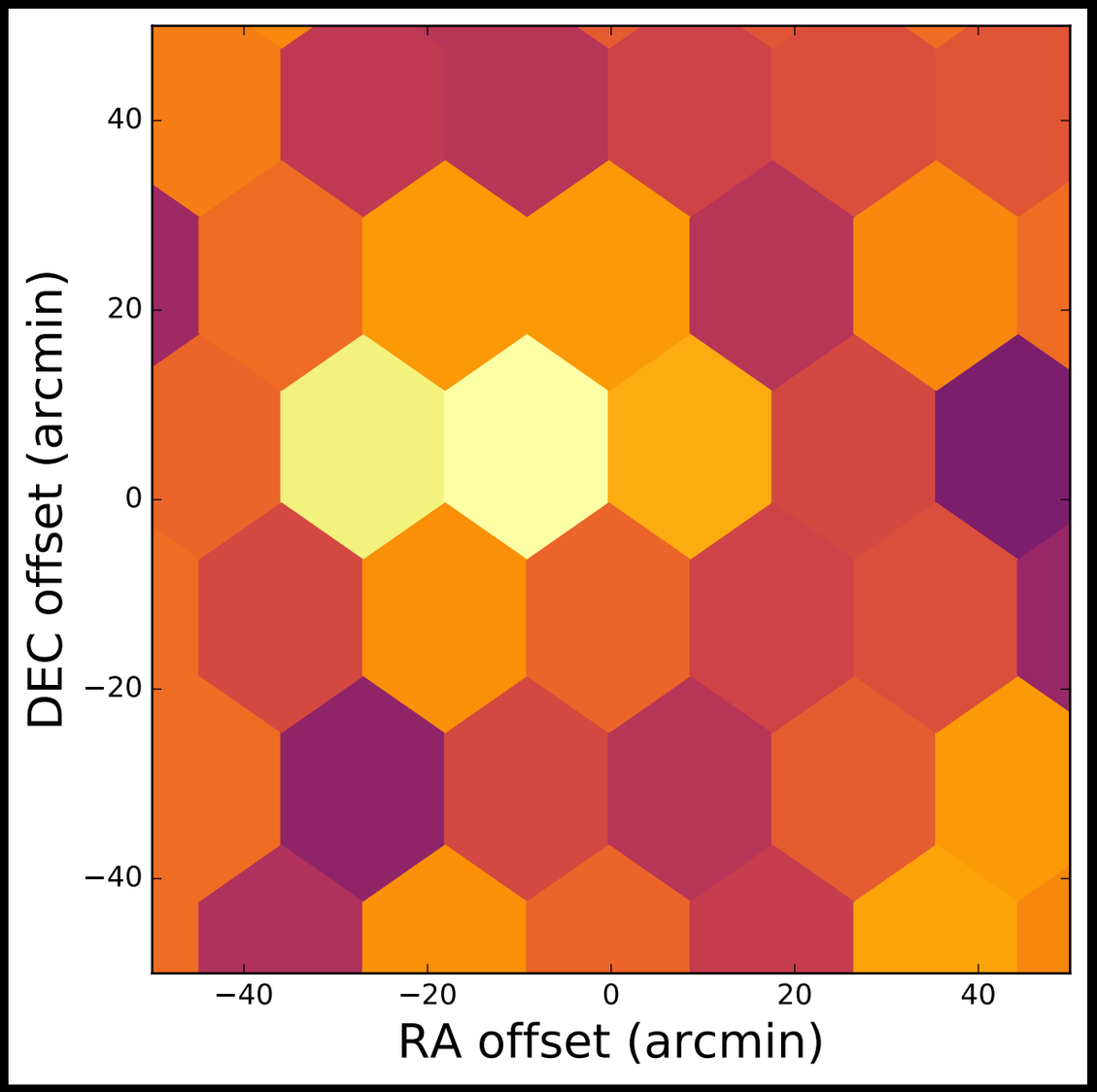




Key takeaway: We demonstrate that metal-poor members of ultra-faint dwarf galaxies can be rapidly identified and chemically characterized with narrow-band photometry

Tucana II density plot, traditional selection technique (isochrone)



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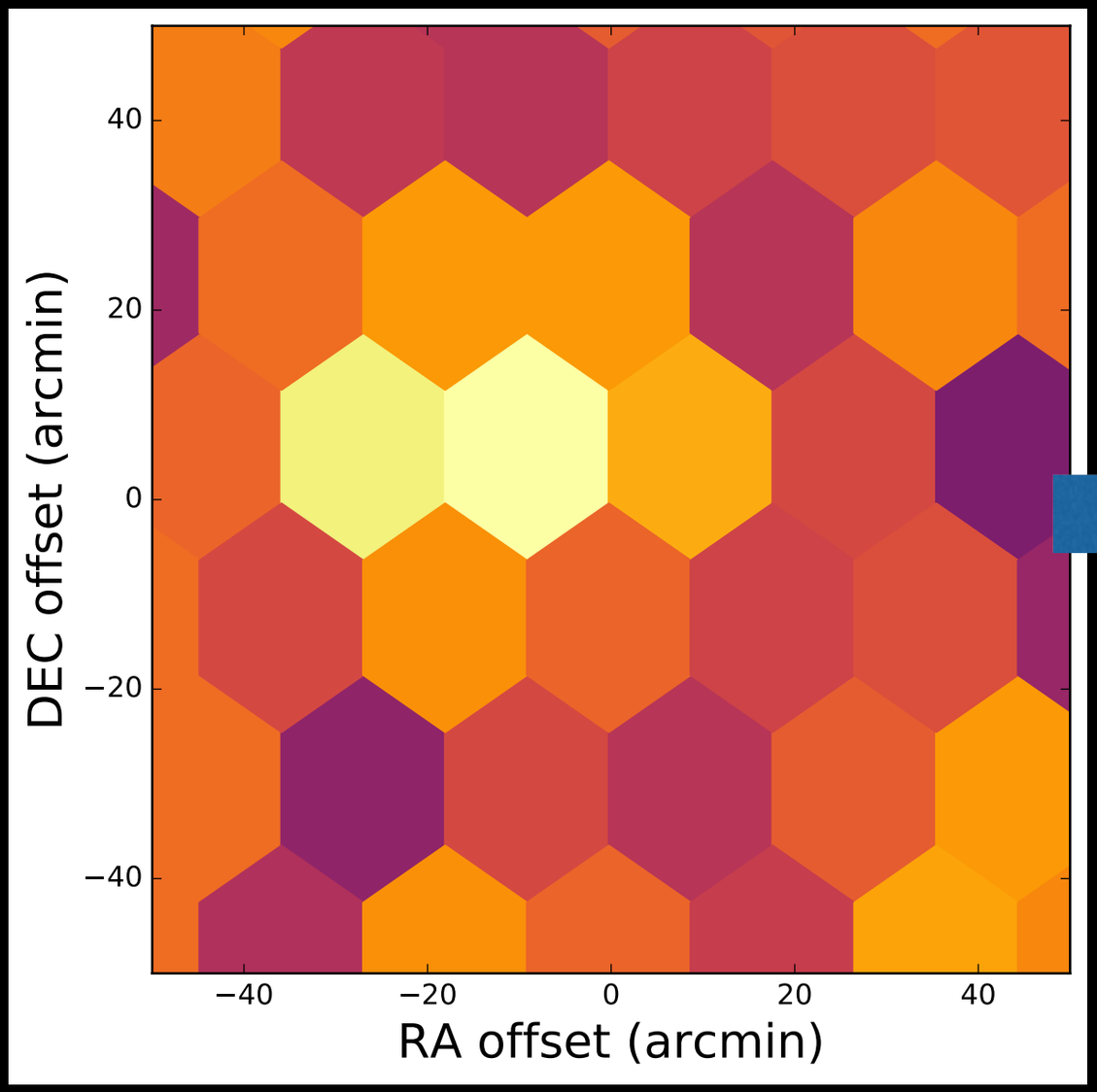
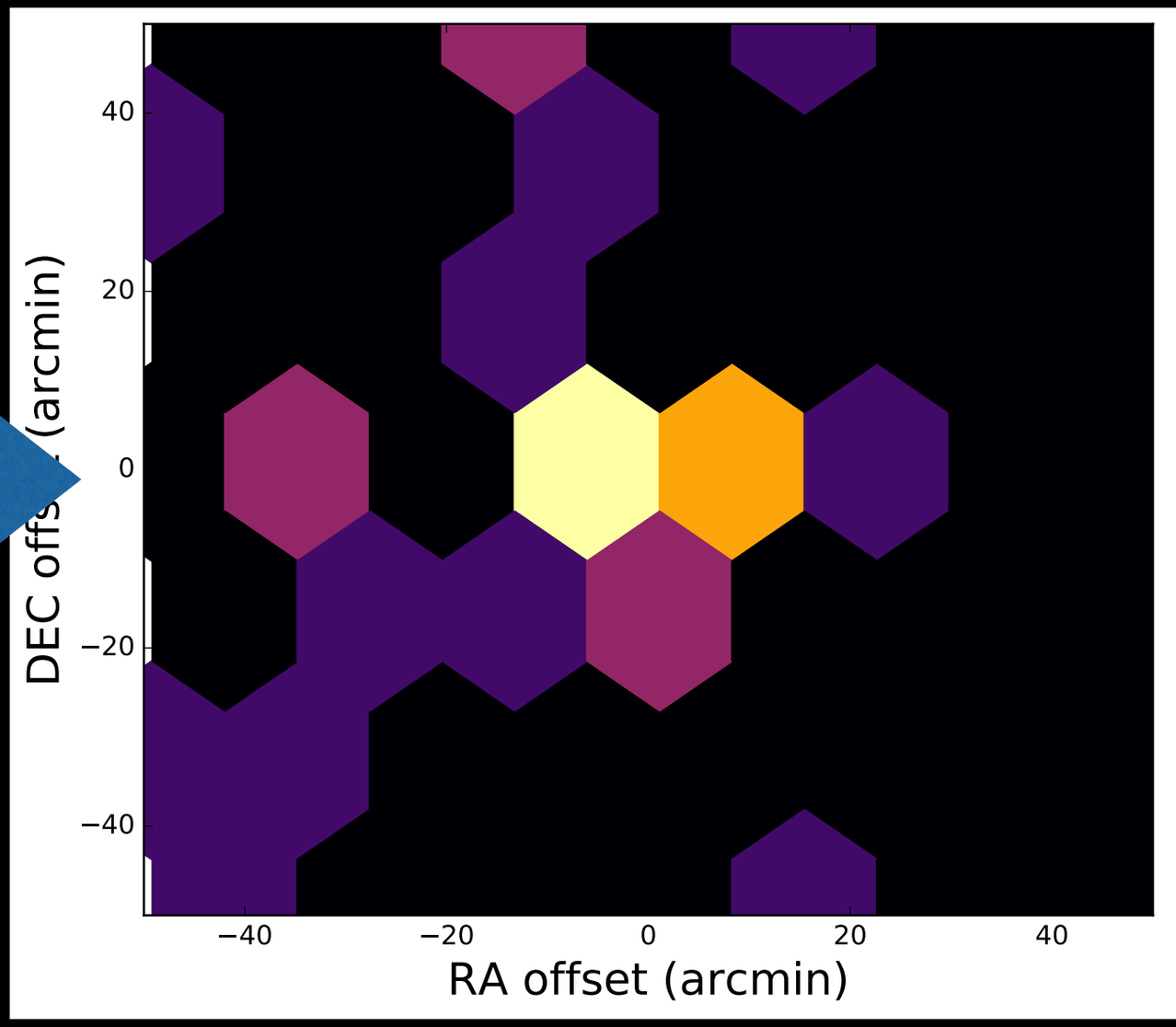
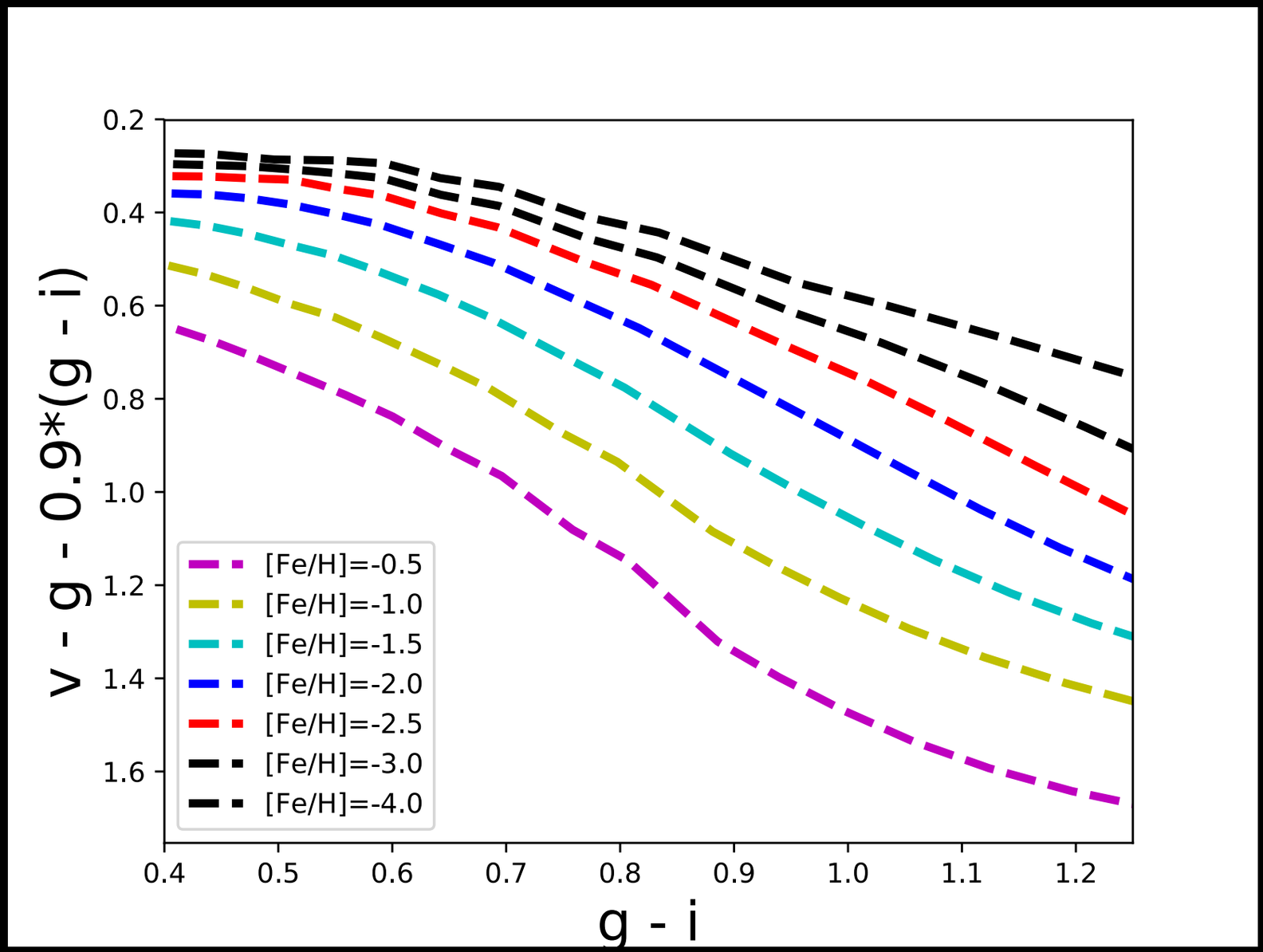


Tucana II density plot, after filtering with isochrone + SkyMapper photometry + *Gaia* proper motions



From photometry, we can clearly select stars below [Fe/H] = -1.5, and quantify metallicities down to [Fe/H] ~ -3.0



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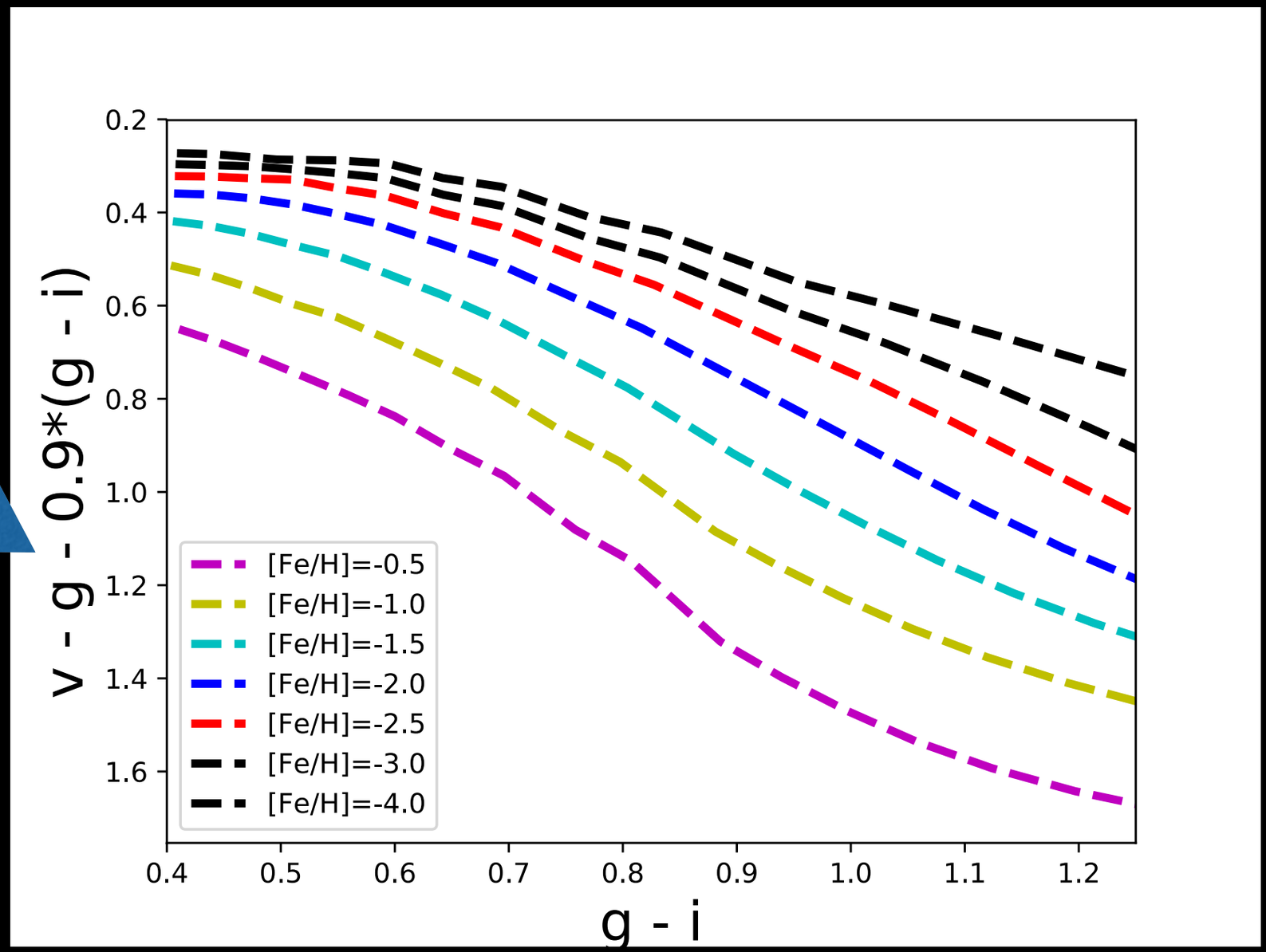

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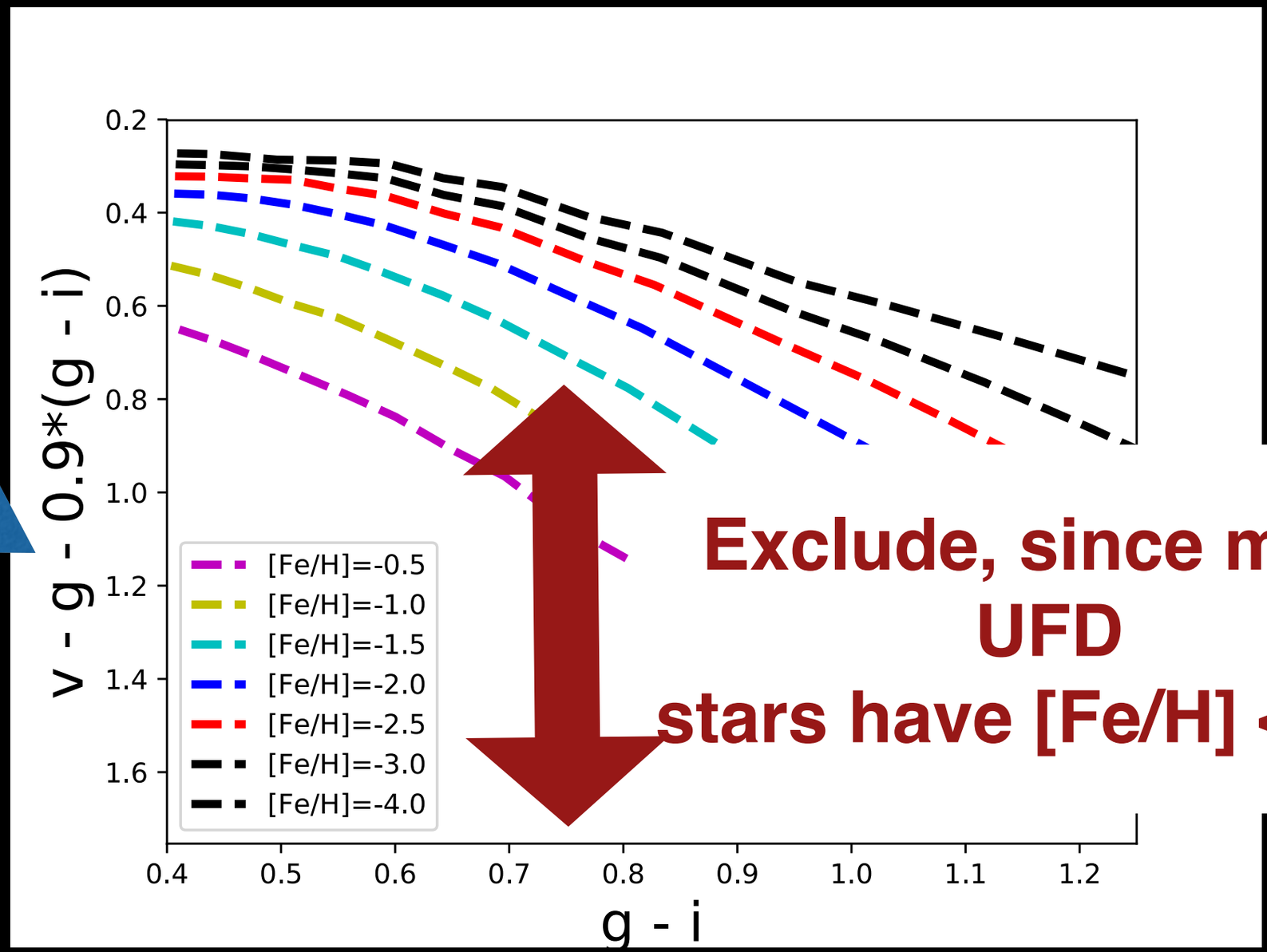
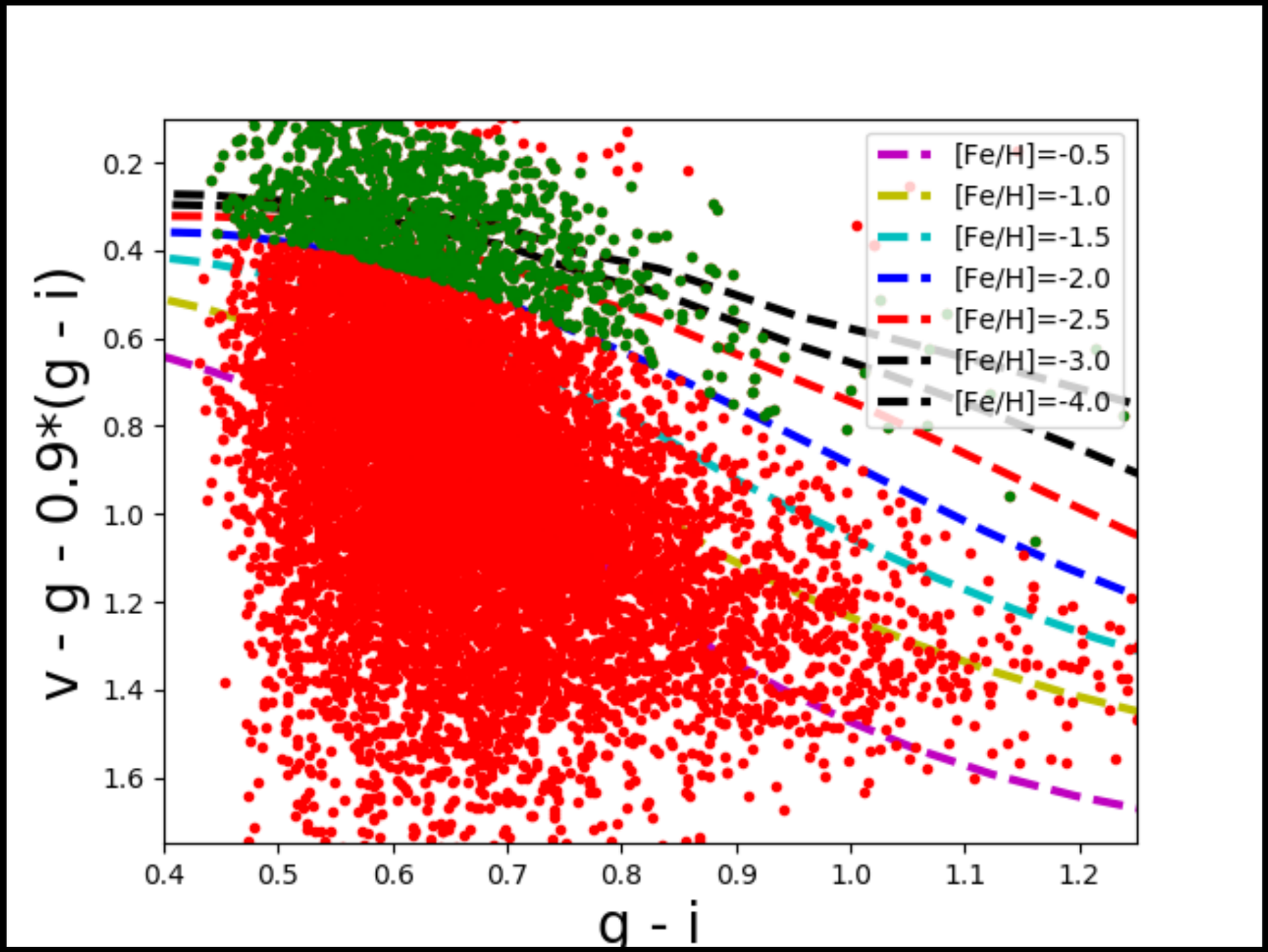


Metallicity-selection plot for the Sgr II uFD



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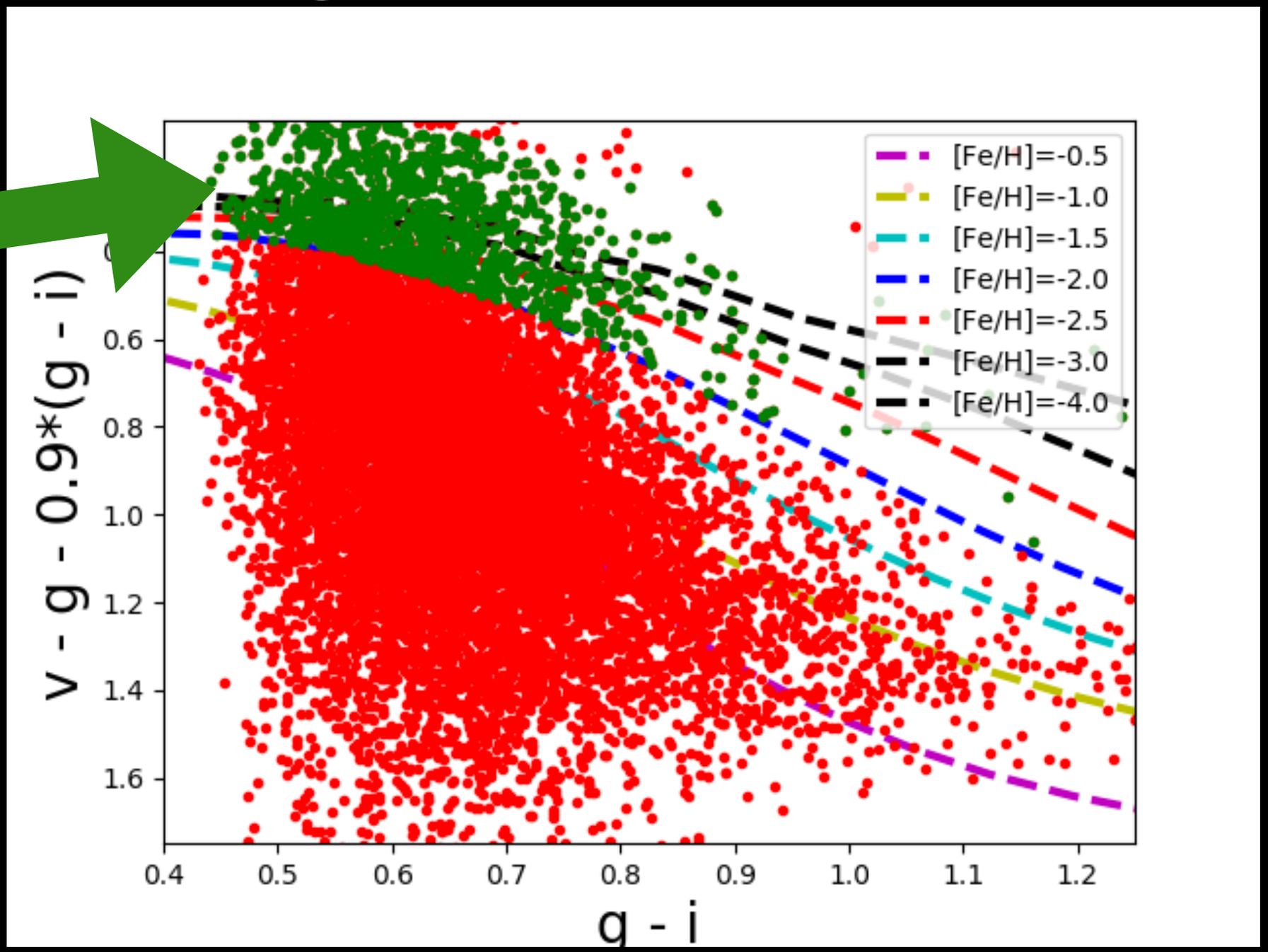
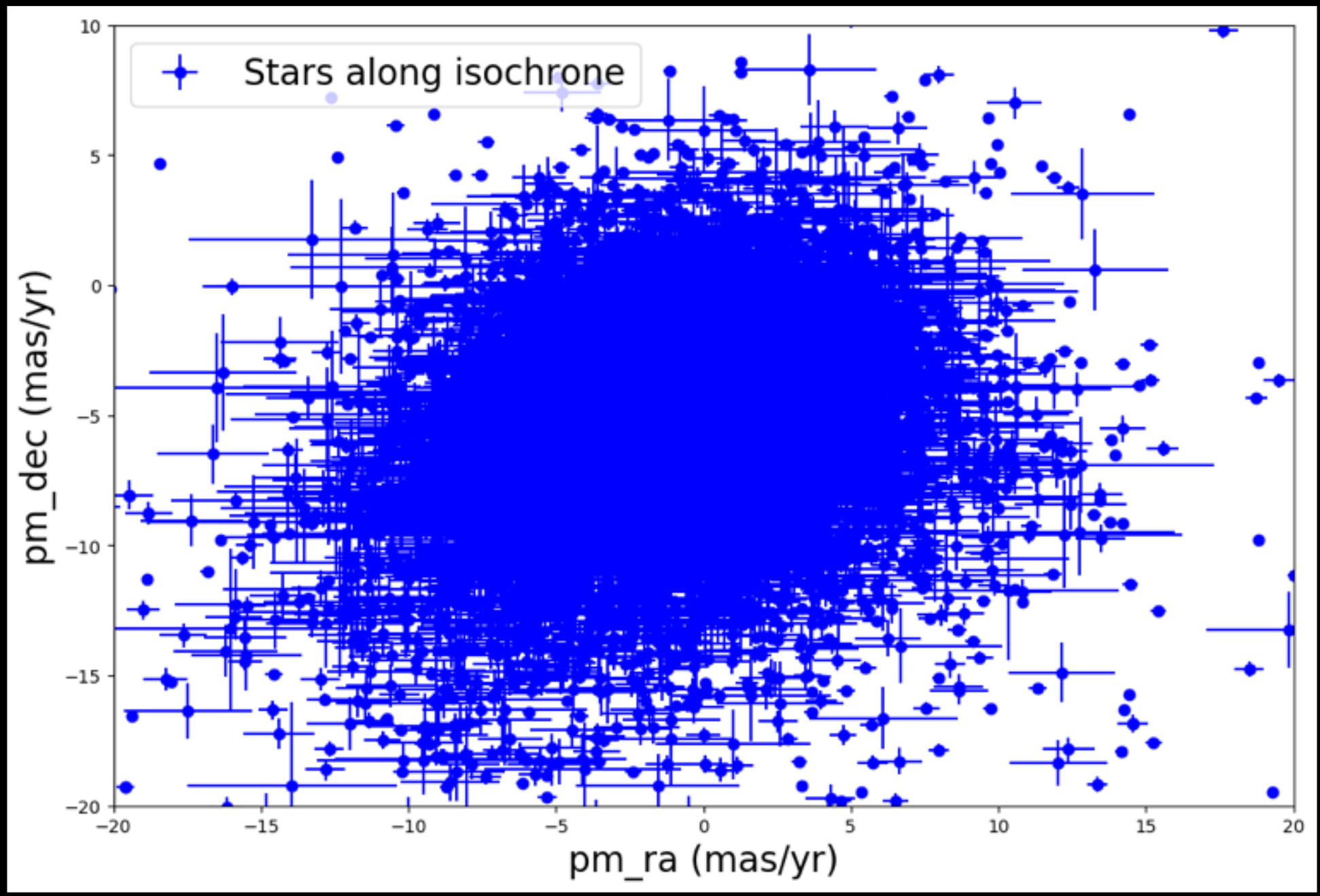
Very metal-poor candidates



Further constraining membership using *Gaia* proper motions



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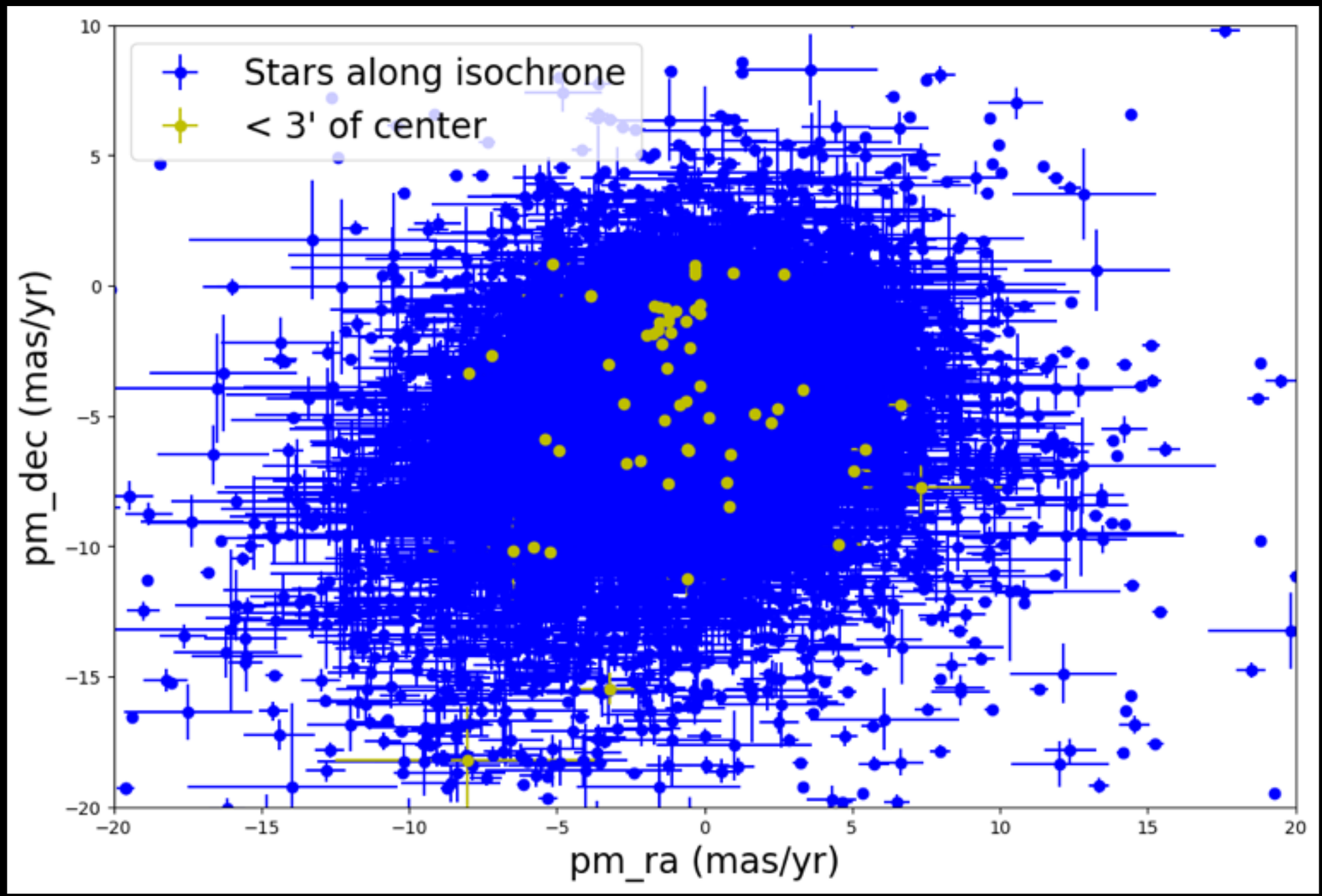

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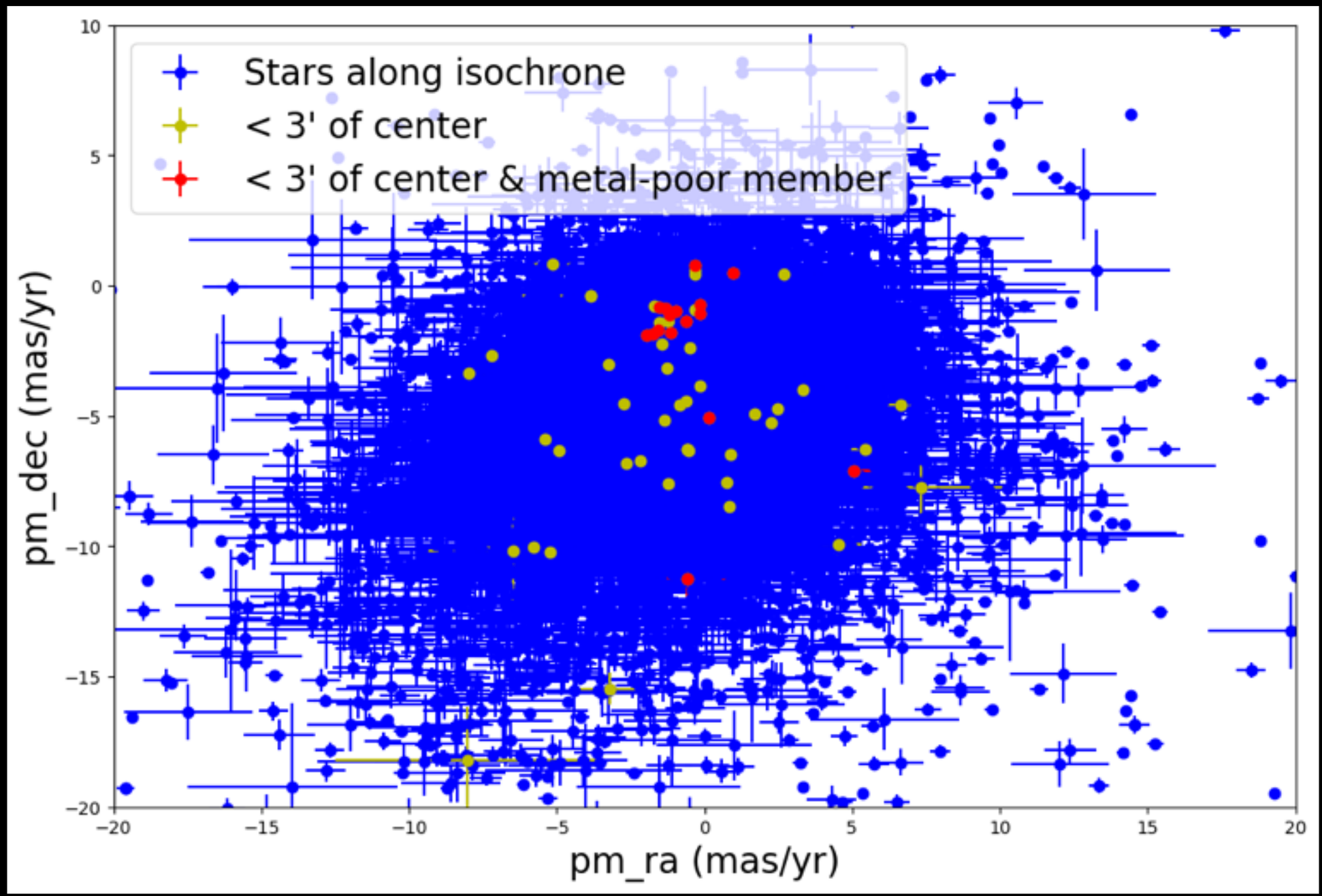

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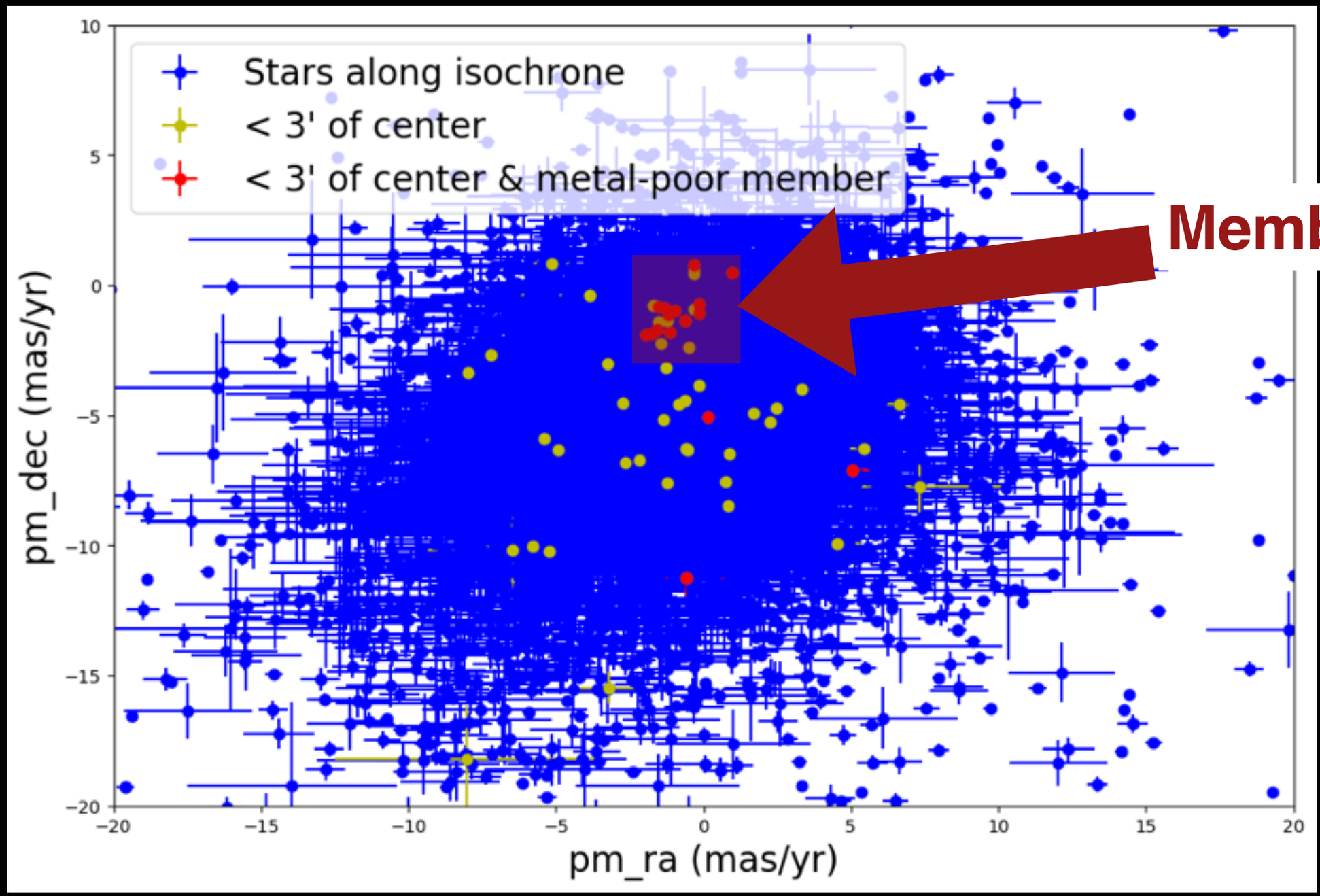
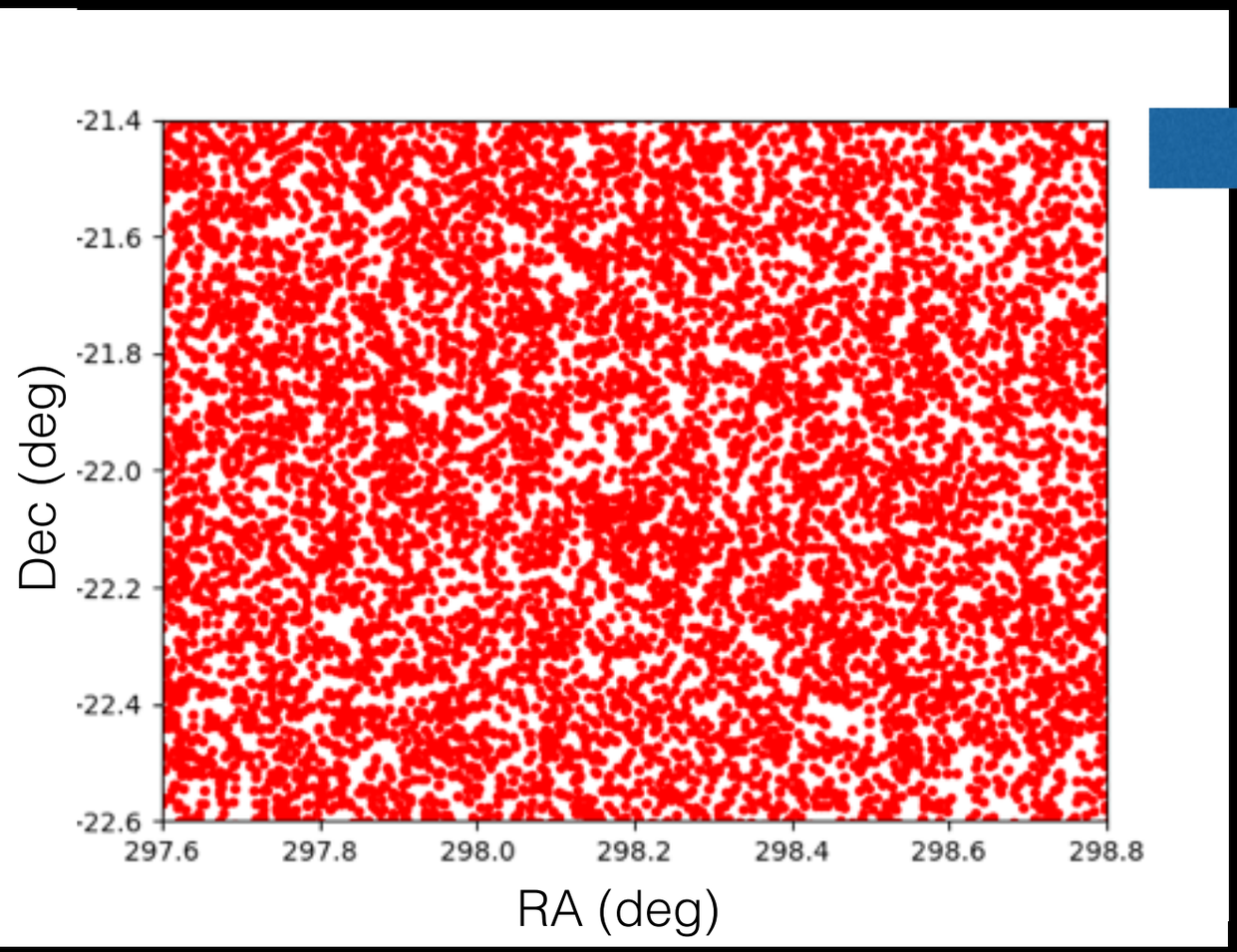
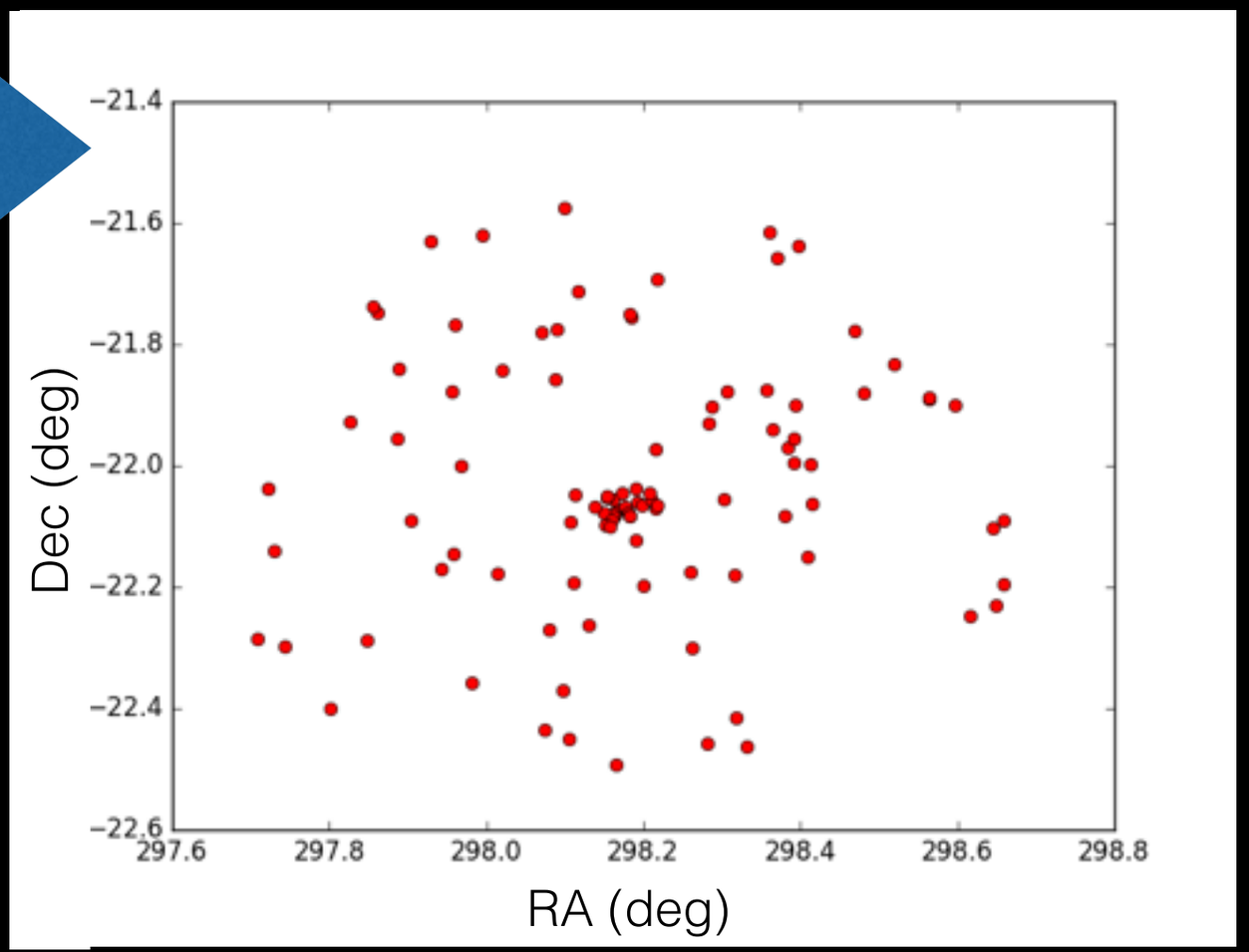


We can identify stars in the Sgr II ultra-faint dwarf galaxy for targeted, spectroscopic observation

Selection along the isochrone



Metallicity + proper motion cut



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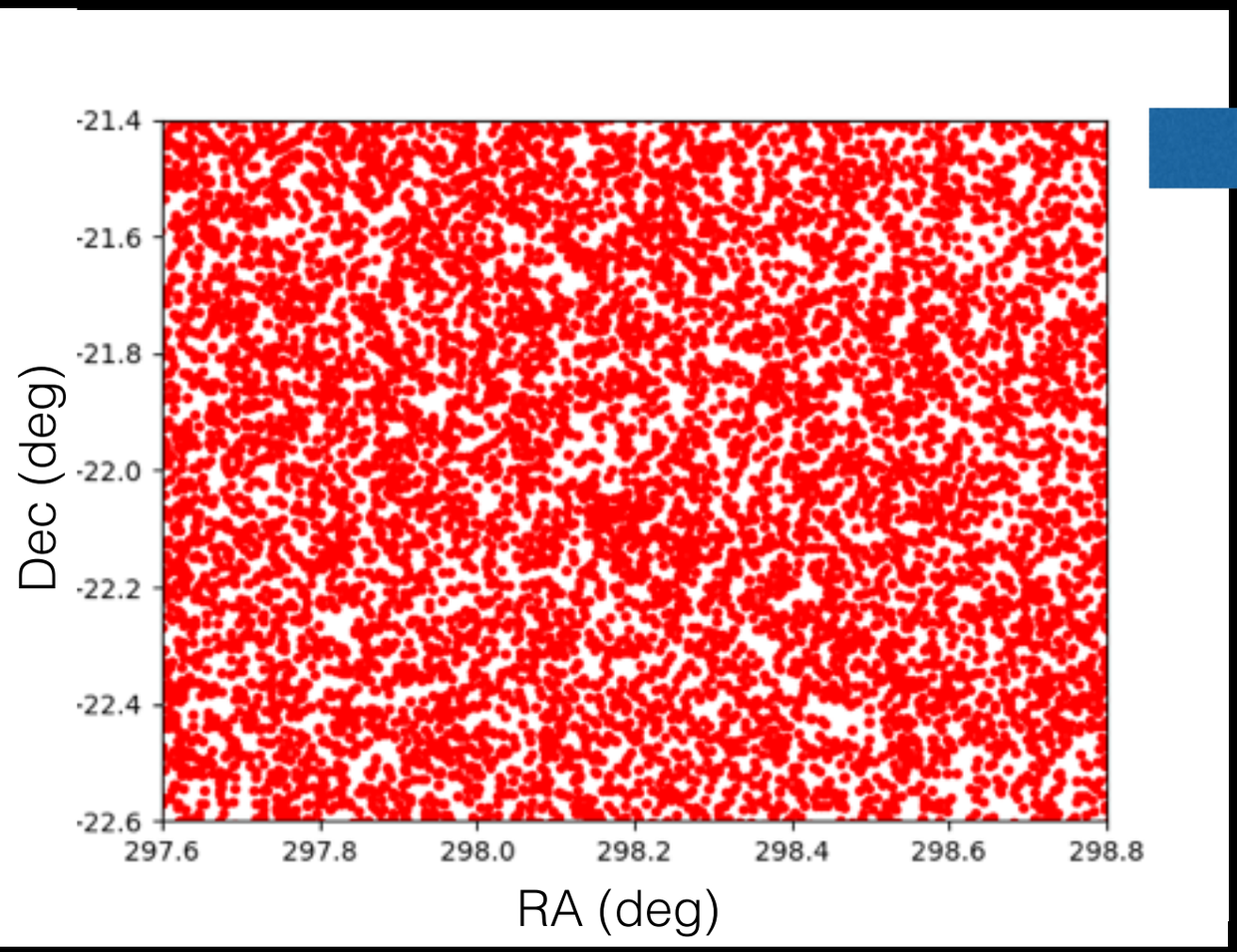

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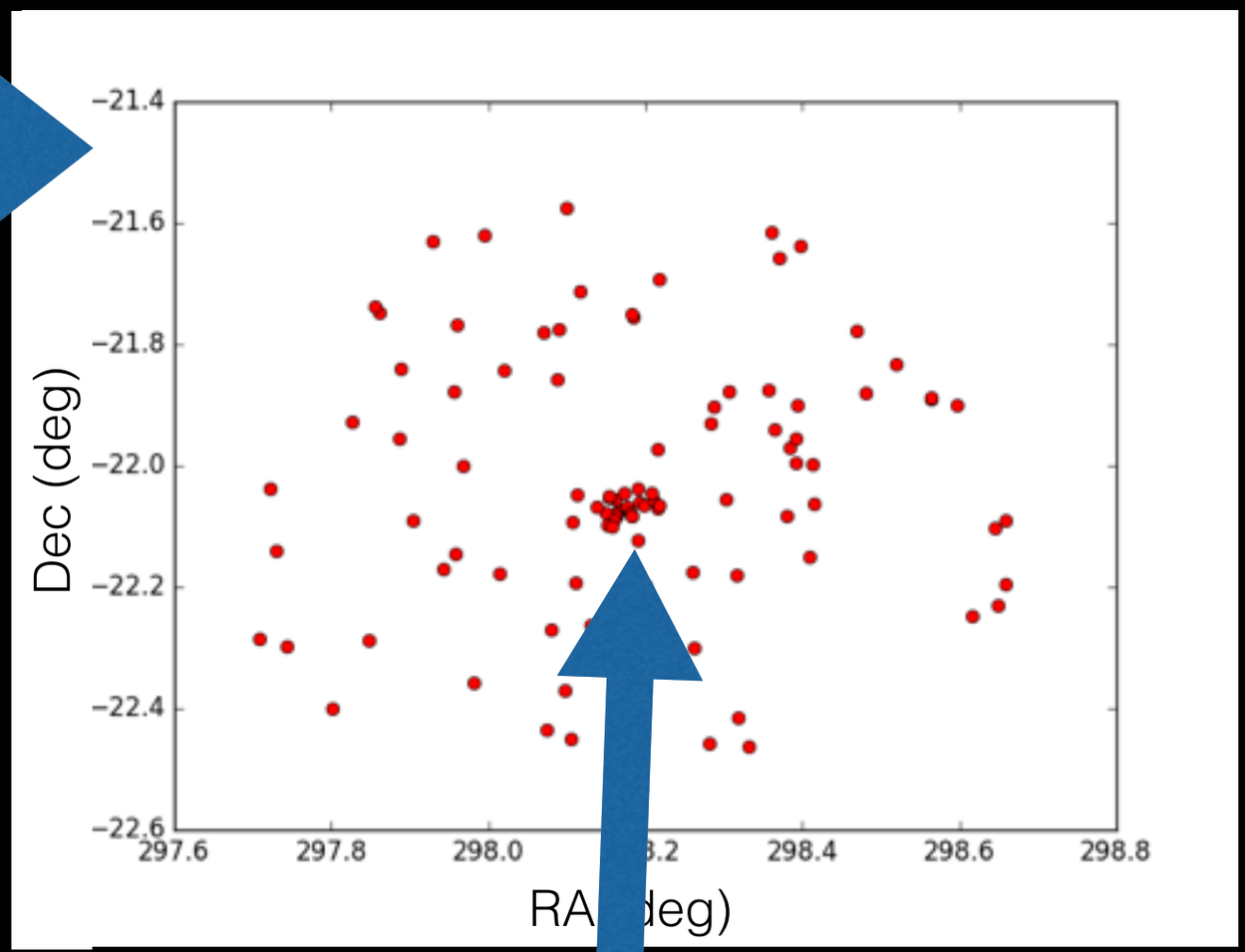
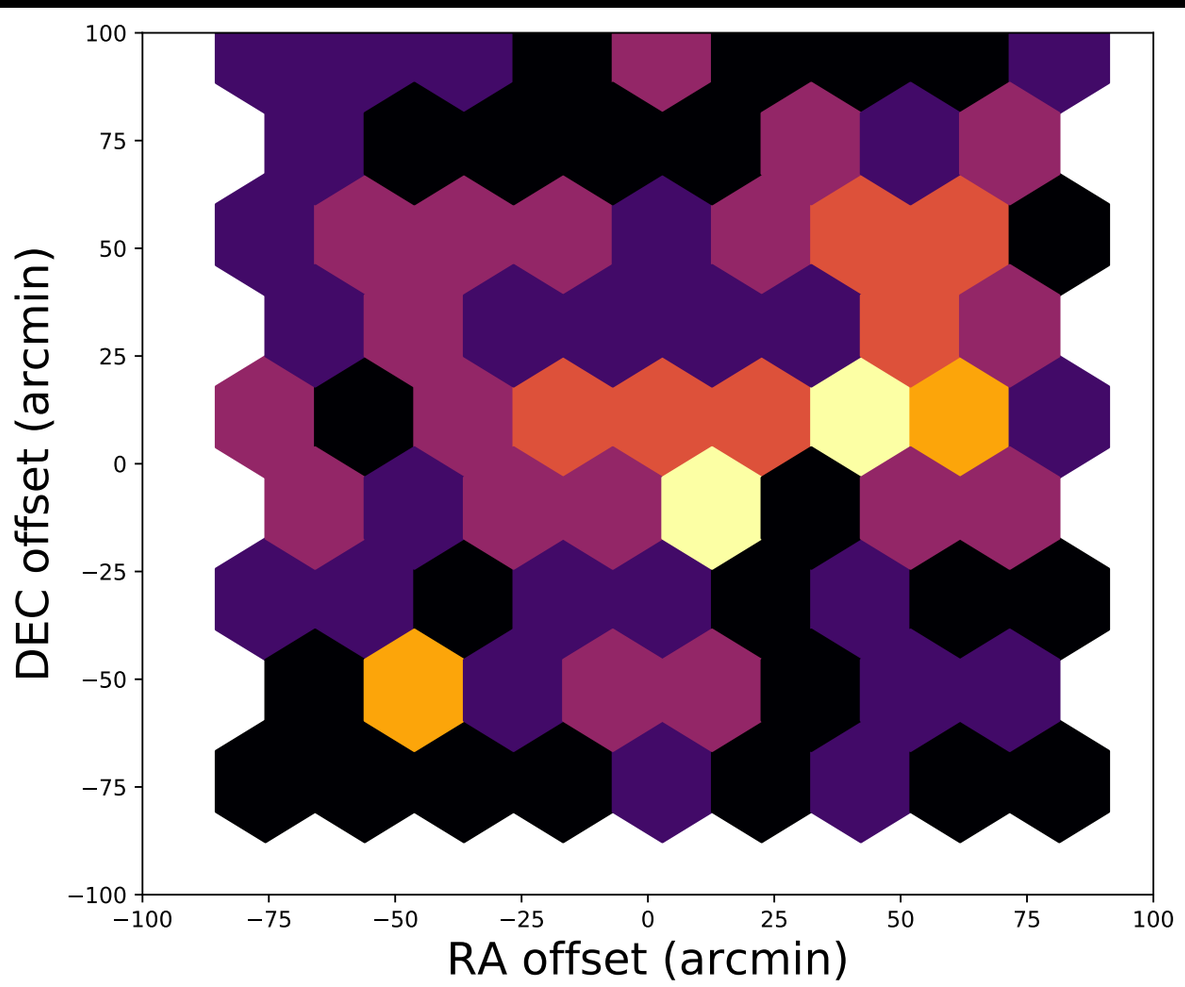
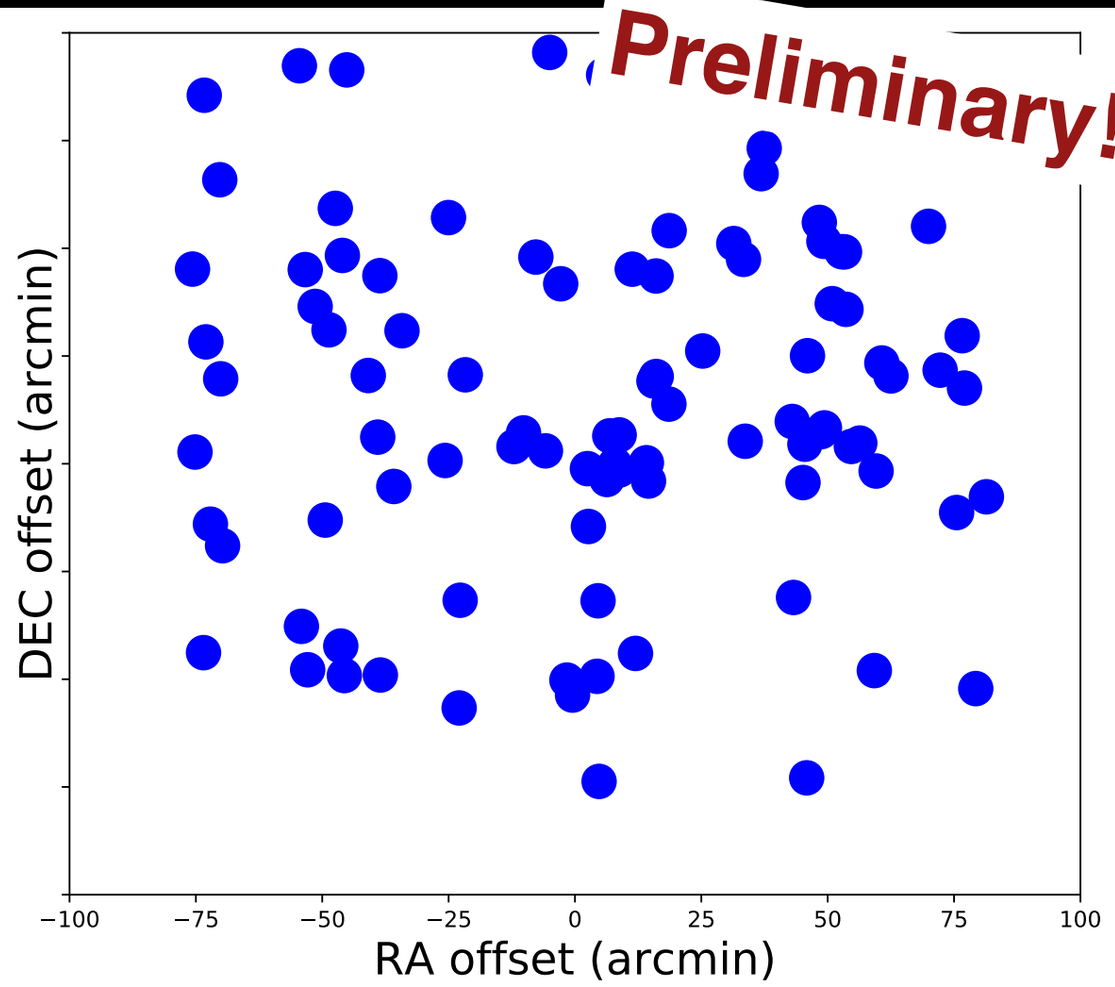


With spectroscopy, confirmed 3 stars as [Fe/H] ~ -2.5 members of this system

Likely detection of metal-poor tidal features in Tucana III dwarf galaxy





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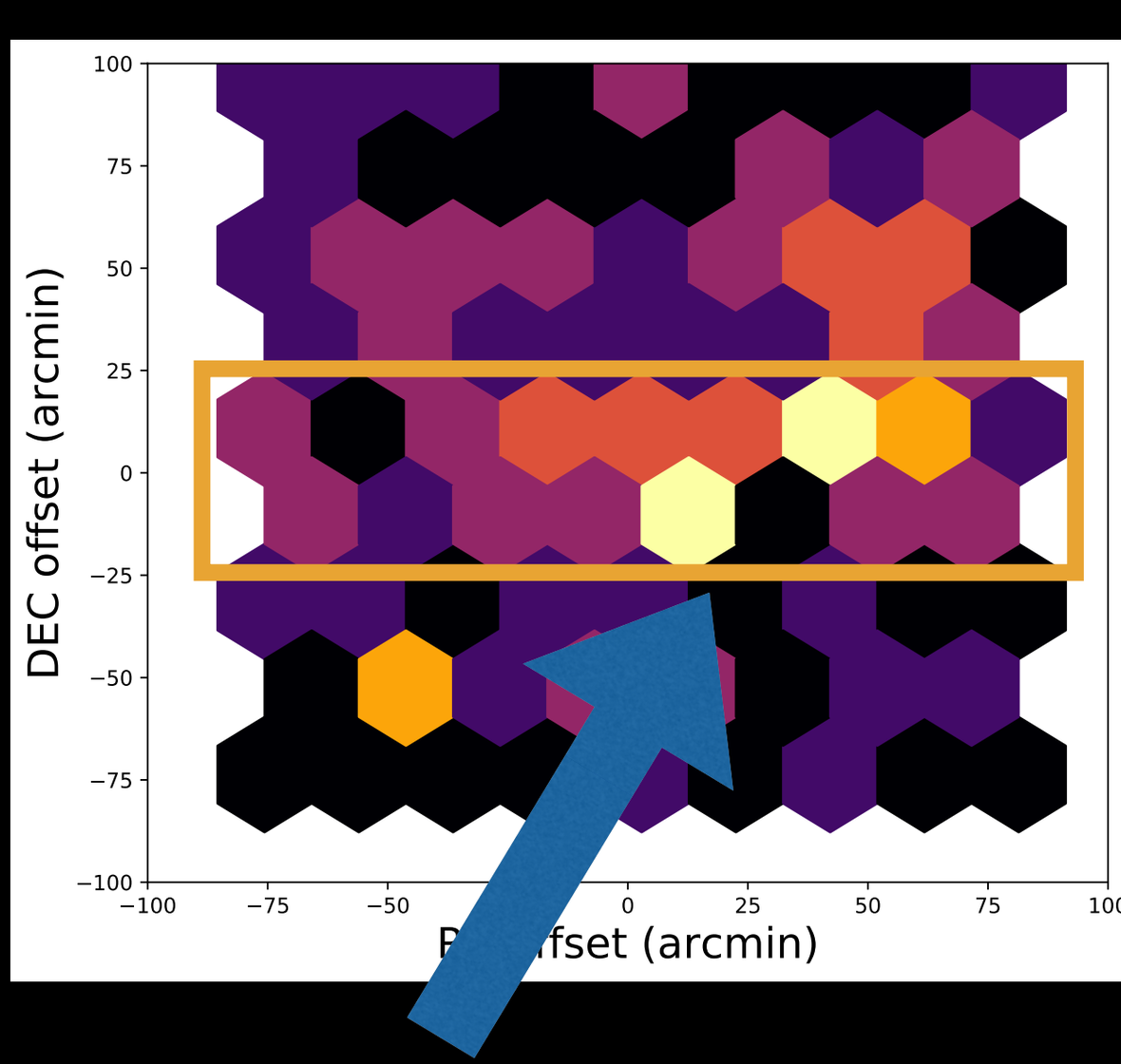

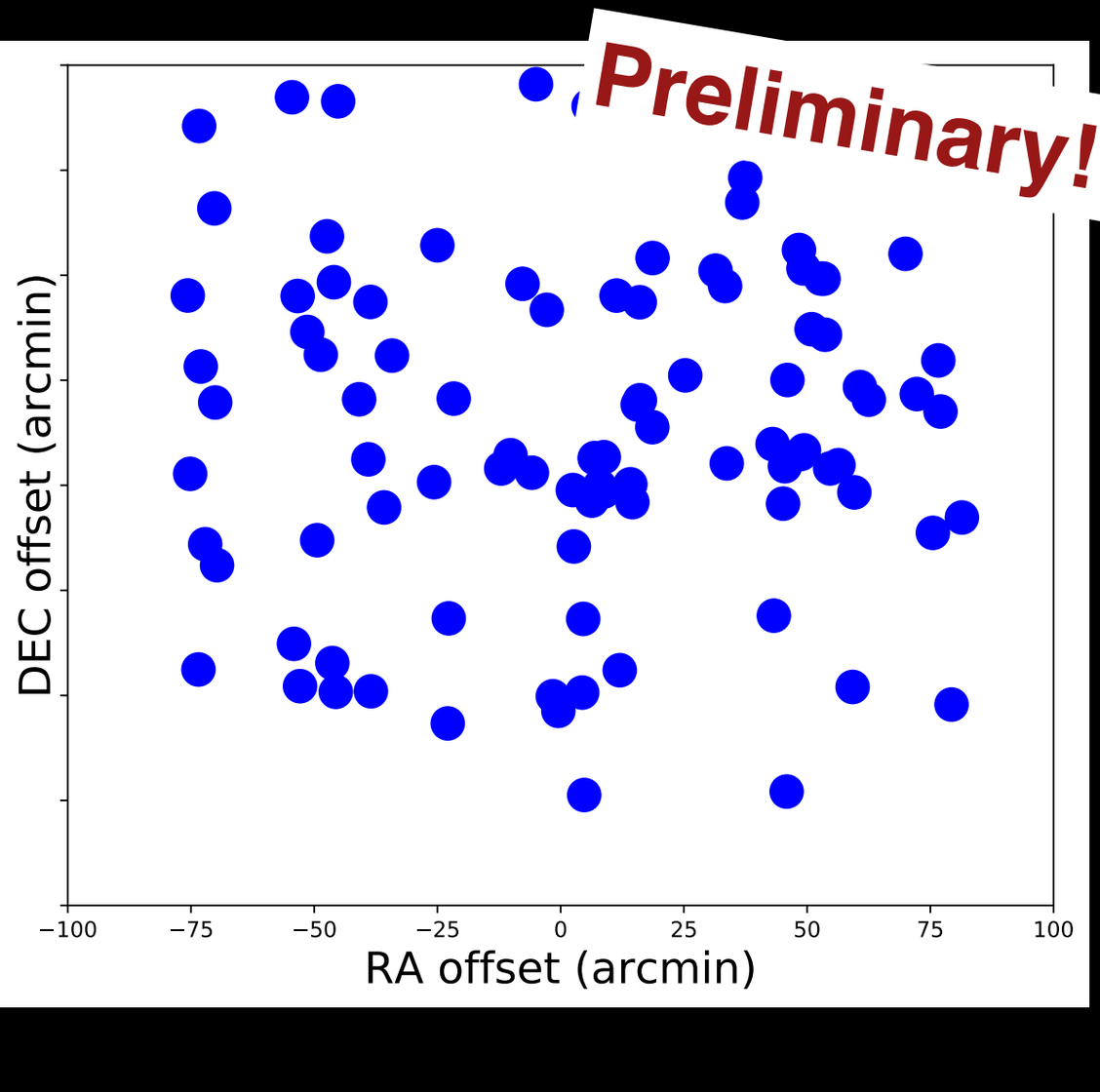

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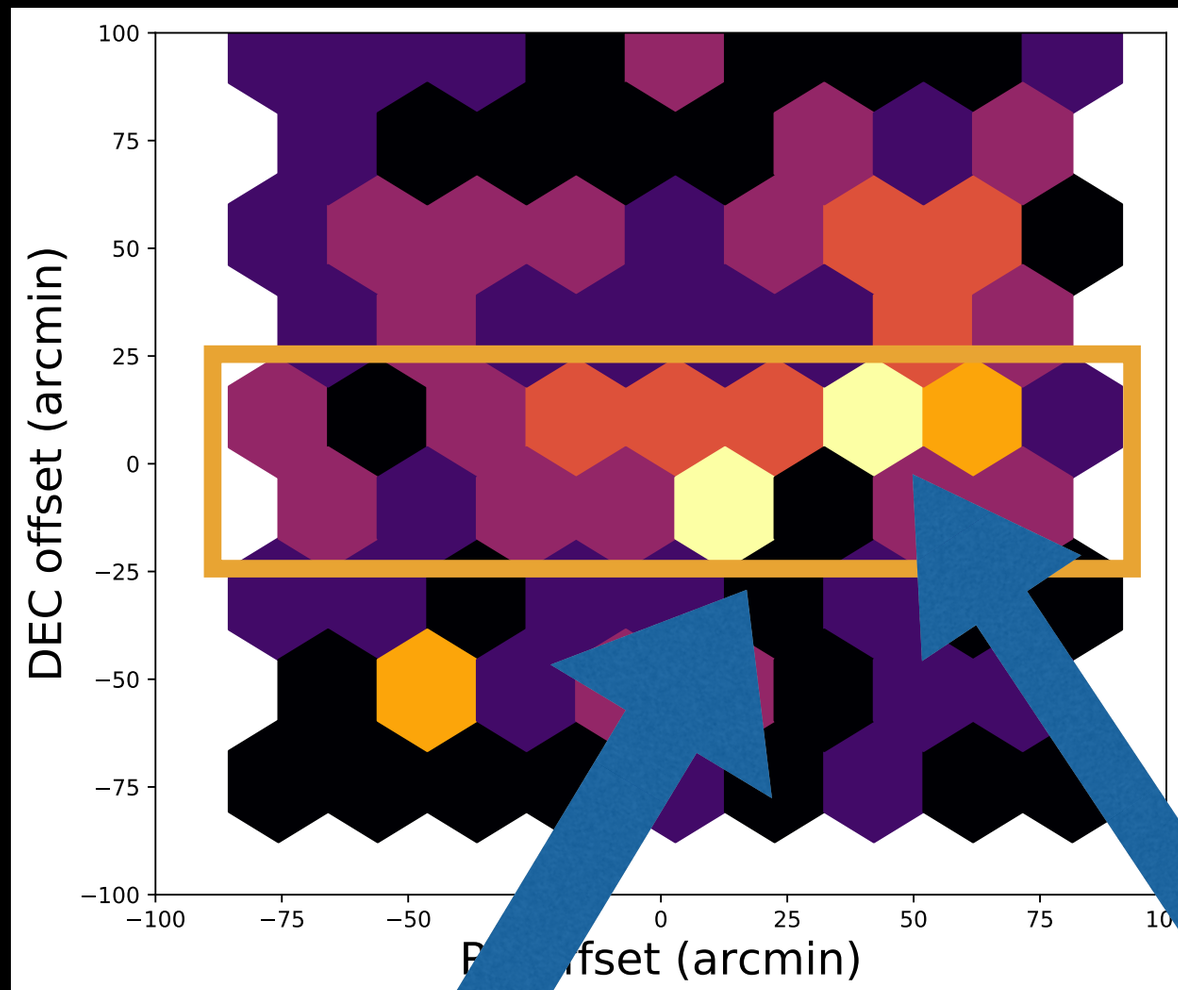

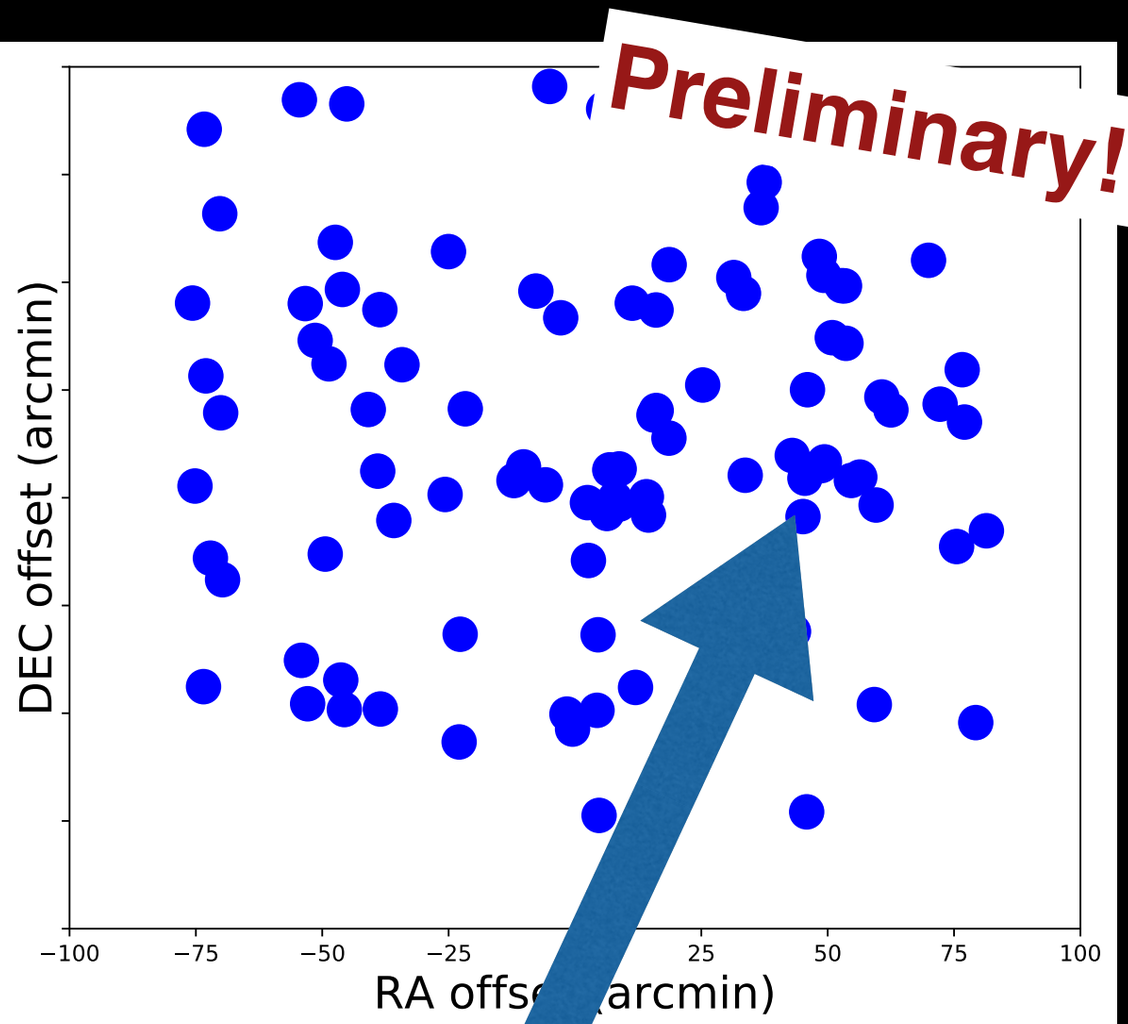

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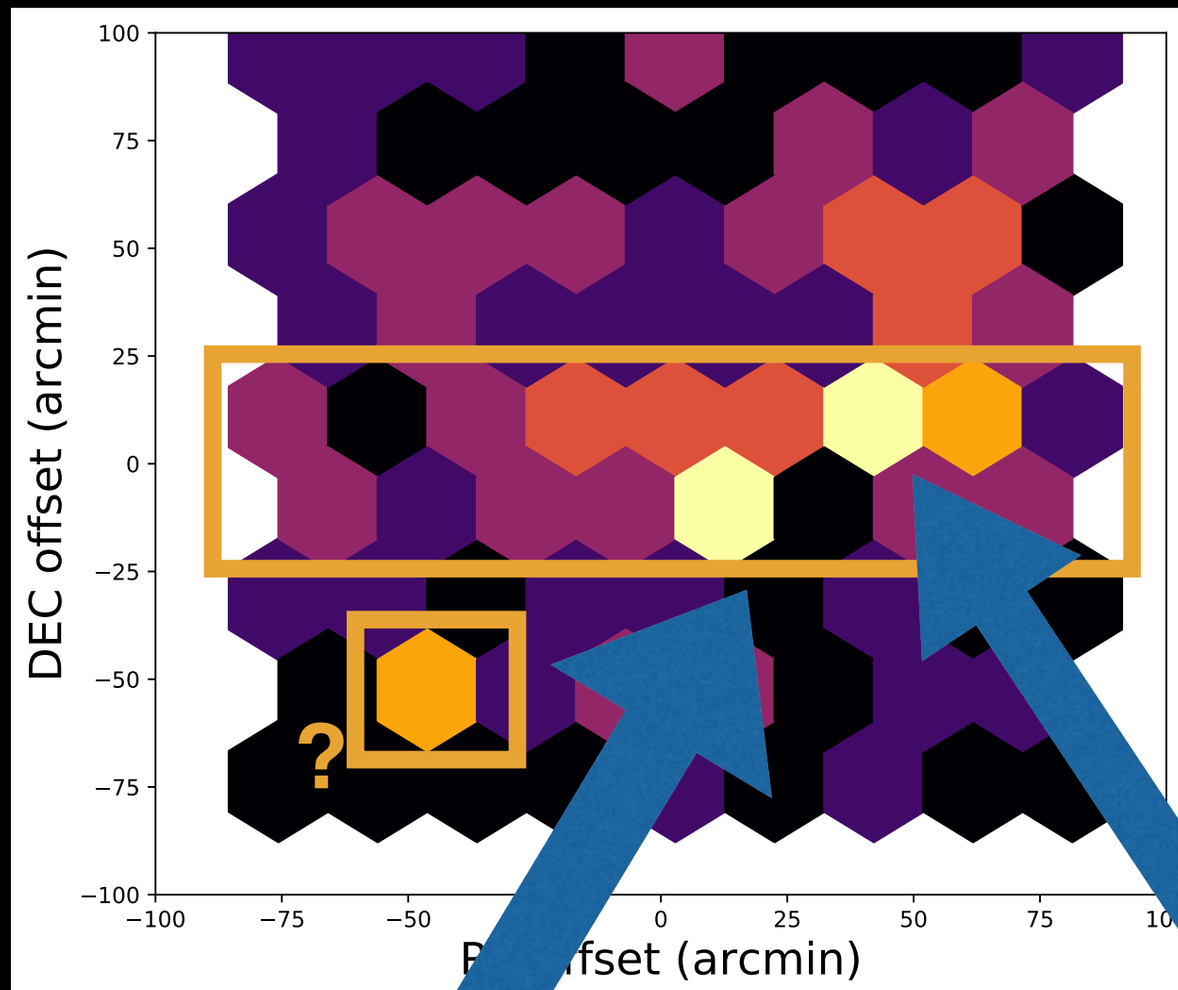

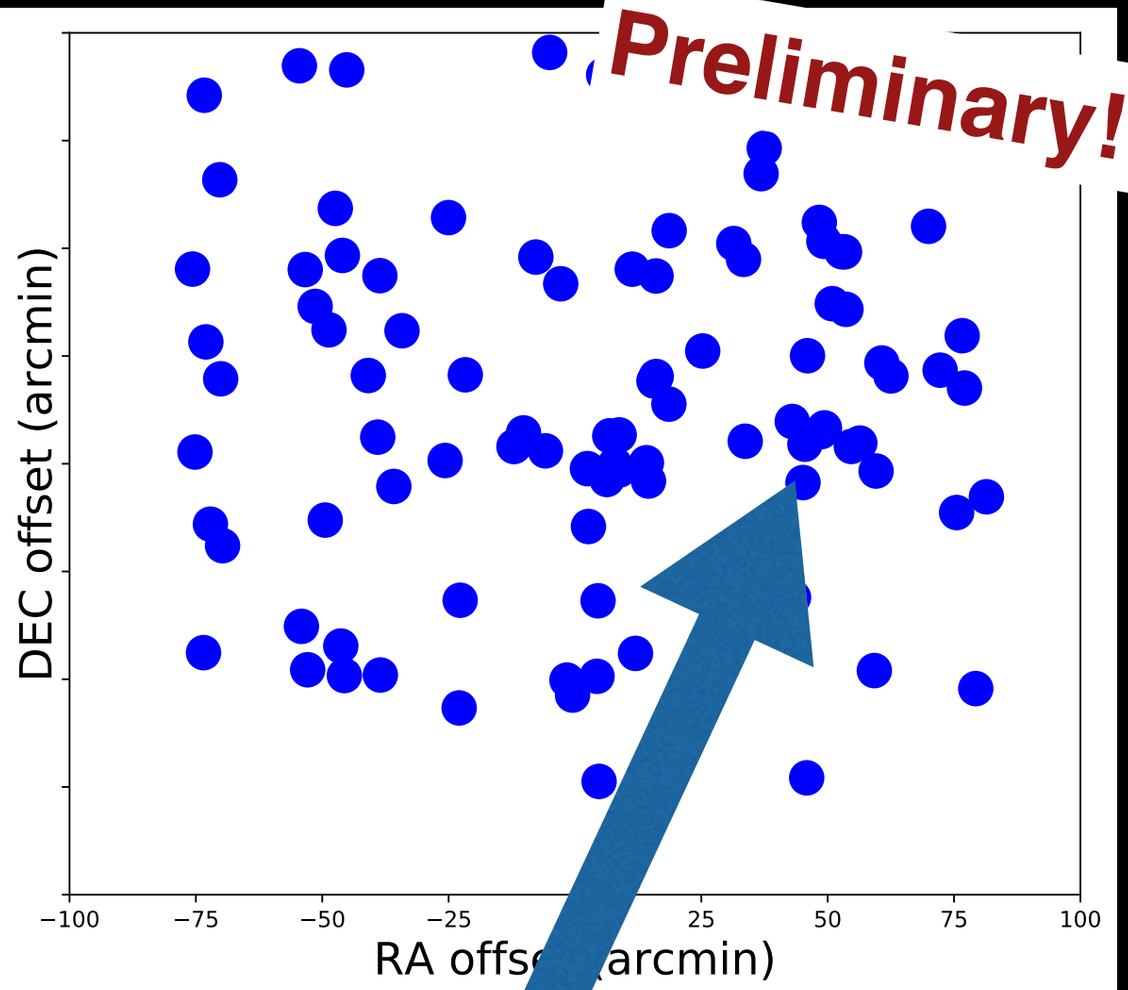

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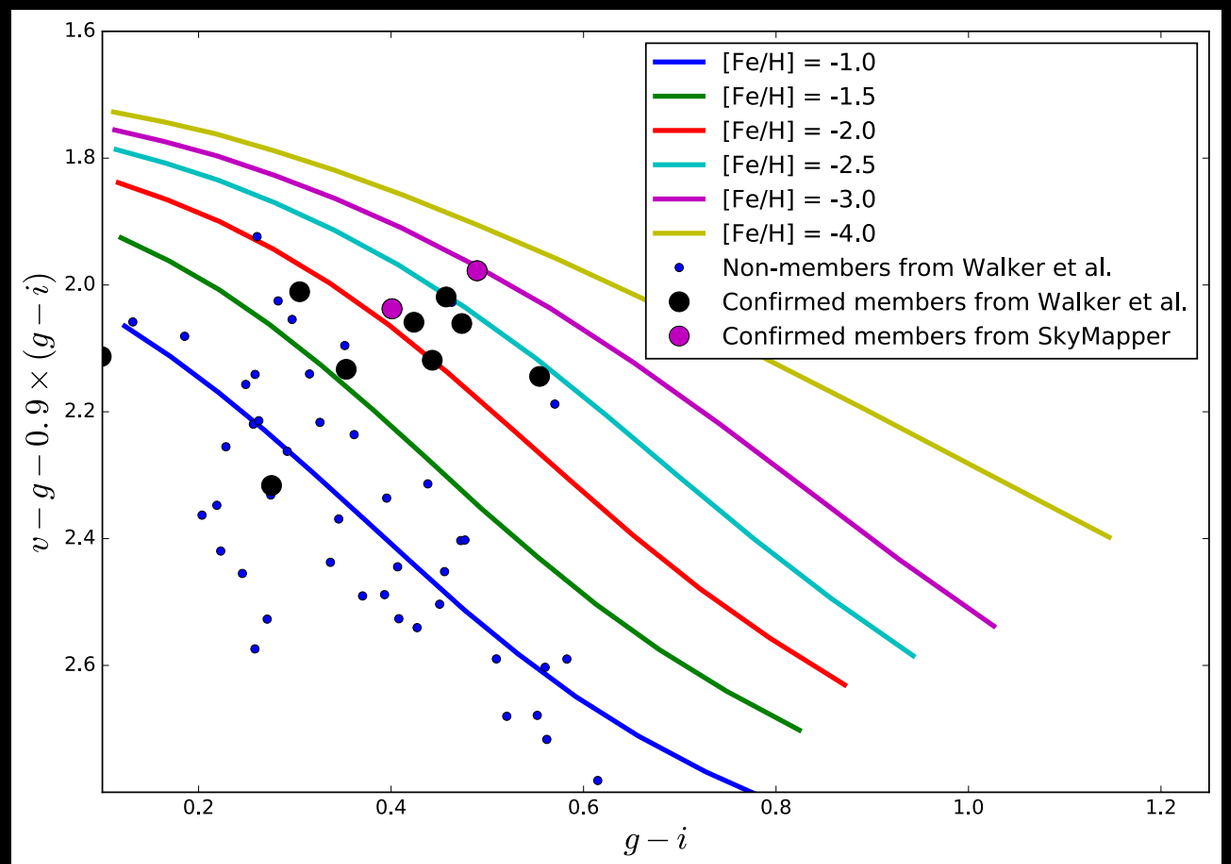
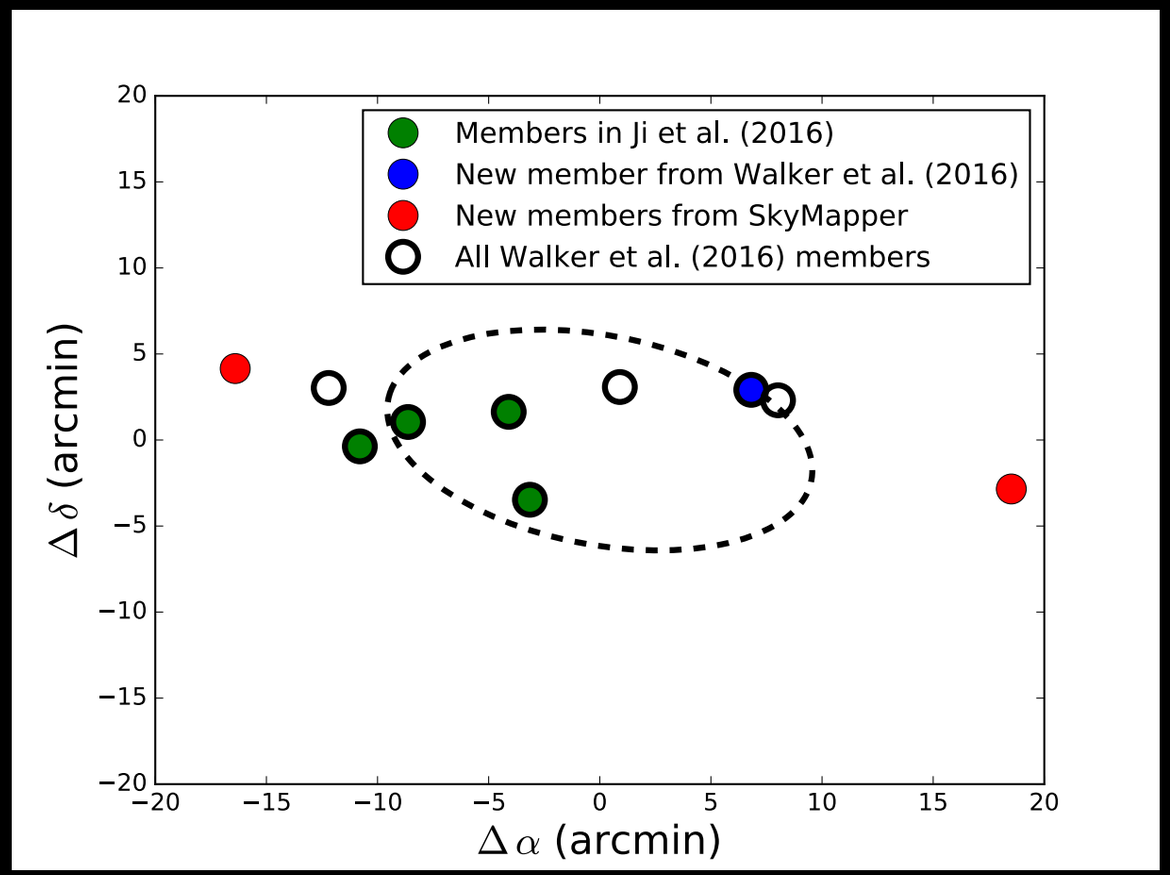
Identify new, bright member stars in Tucana II for high-resolution study (Chiti et al. 2018)





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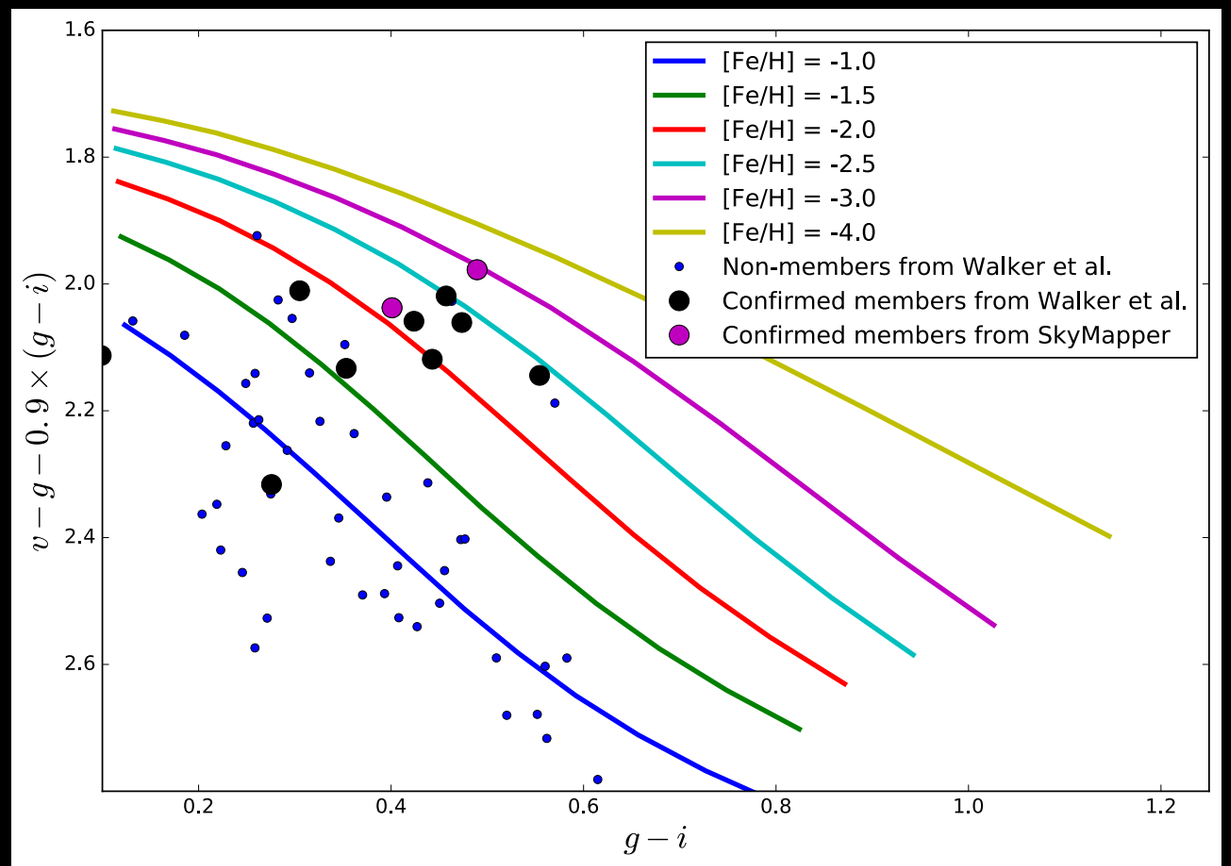

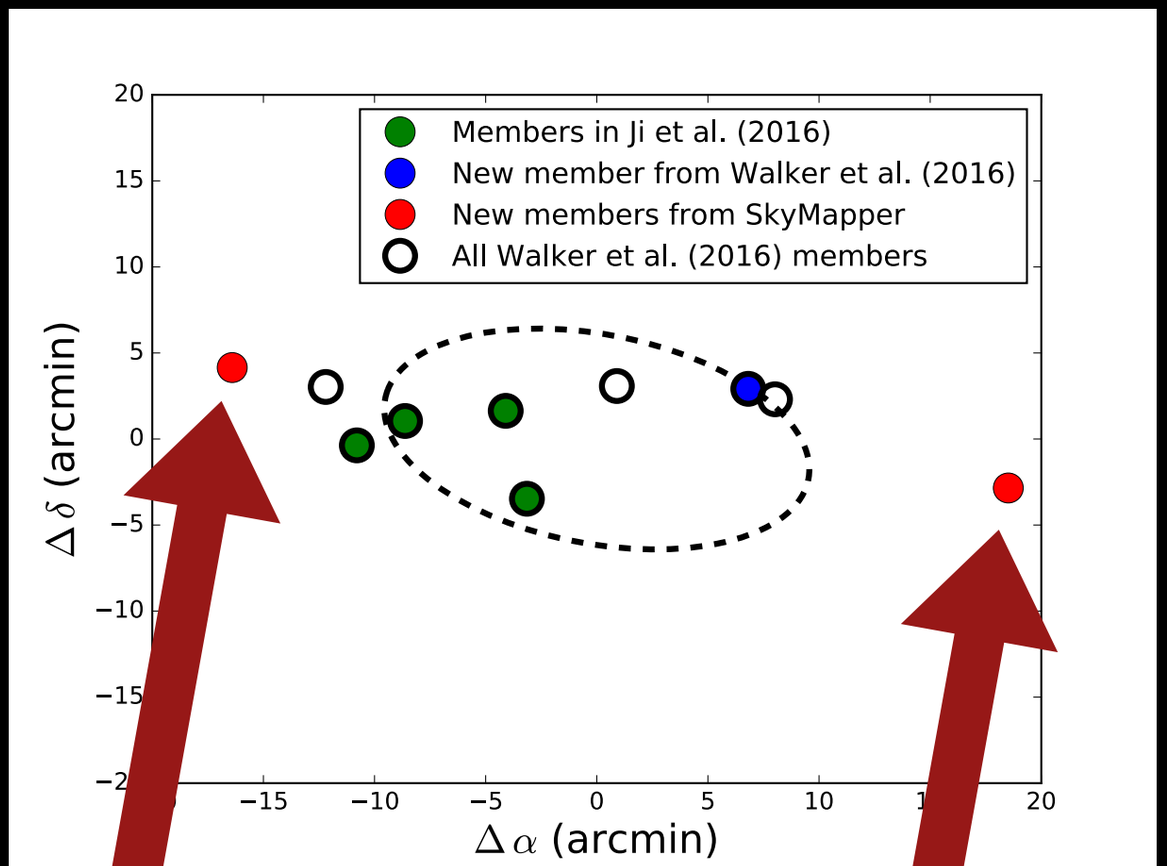

[Fe/H] = -3.08 **[Fe/H] = -3.34**

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   => Tidal features of Tucana III likely seen