The Pristine survey of the metal-poor Milky Way

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AGENCE NATIONALE DE LA RECHERCHE ANR

Pristine goals

- ***Oldest/most metal-poor stars*** inform us on
  - early star formation
  - first supernovae
  - early build-up of galaxies
- ***Metallicity decomposition of MW — Galactic archaeology***
  - structure as f([Fe/H]) → type/history of hierarchical accretion
  - added dimension to deconstruct MW, even in Gaia era
- ***A thorough study of (very) faint dwarf galaxies***
  - weeding out foreground contamination
  - efficiently building large samples of spectroscopic member

CaHK photometry → cheap

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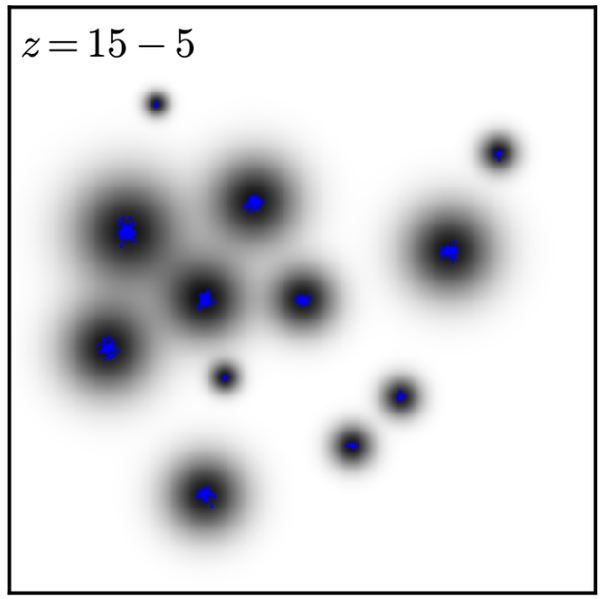
Early build-up of the Milky Way

El-Baddry et al. (2018)

1) First stars form across many low-mass halos.



young stars

older stars

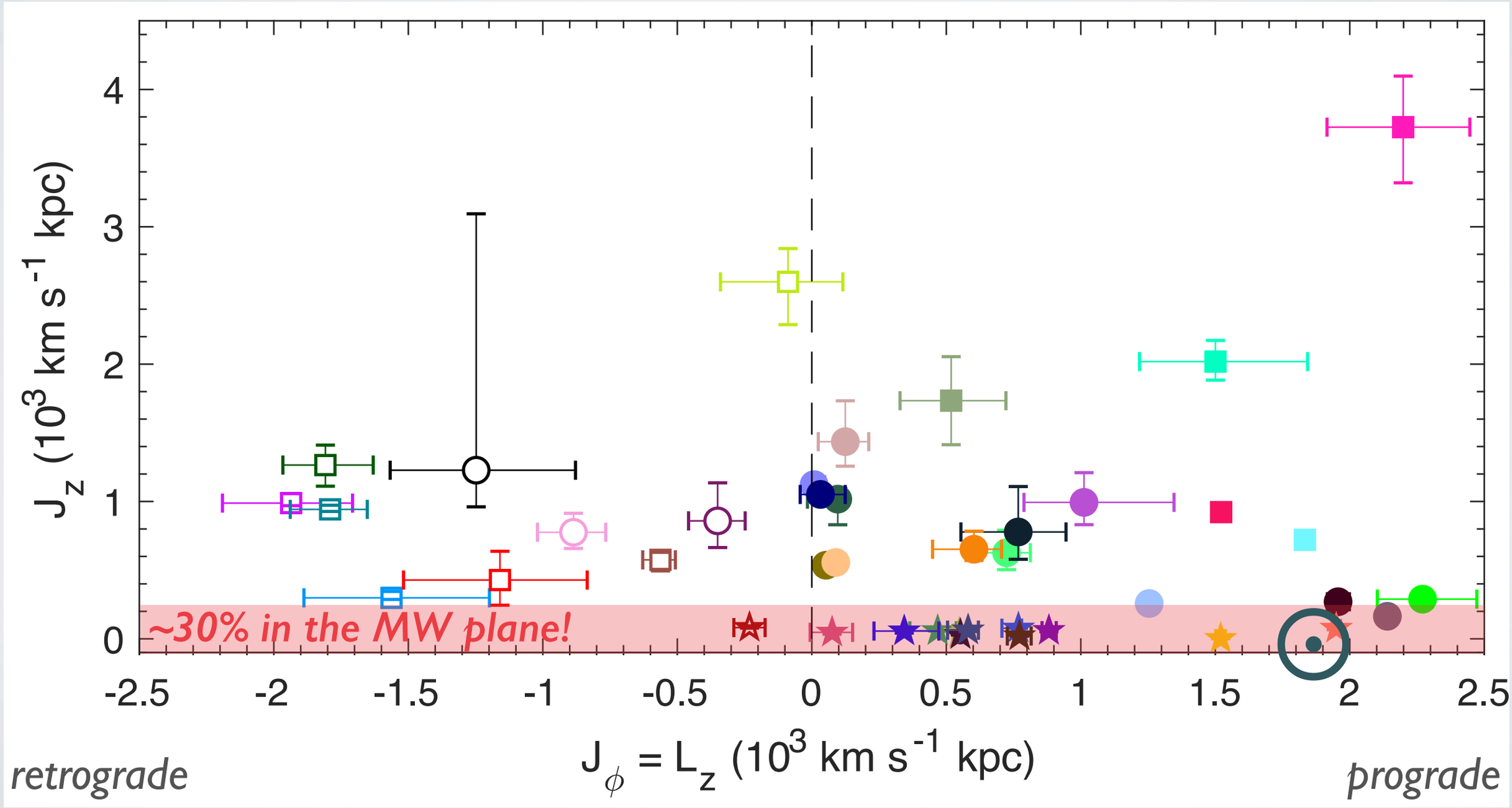
gas

Is it what we see?… No!!

Sestito, Longeard, Martin et al. (2019)

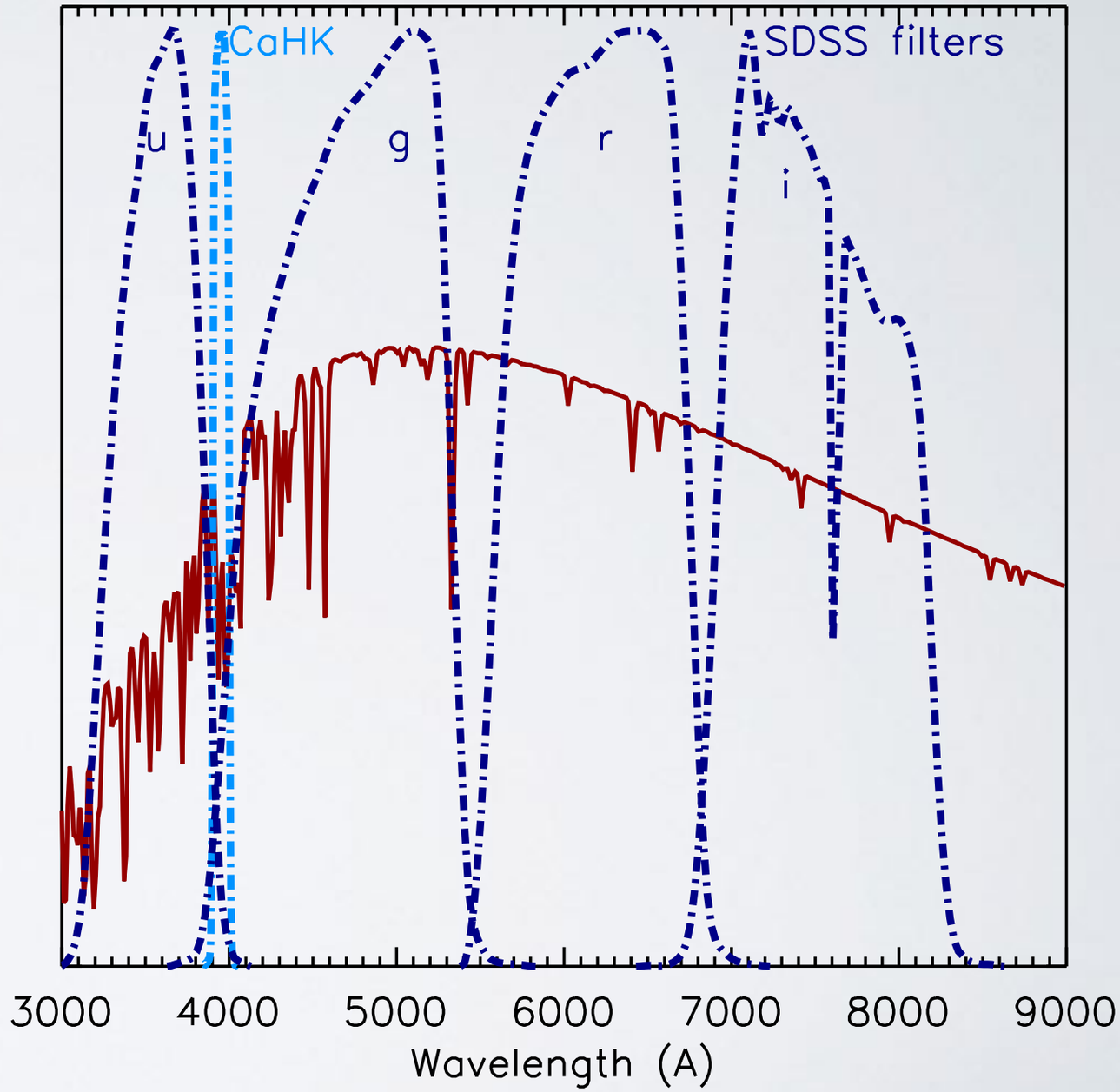
All 42 known stars with [Fe/H]<–4.0

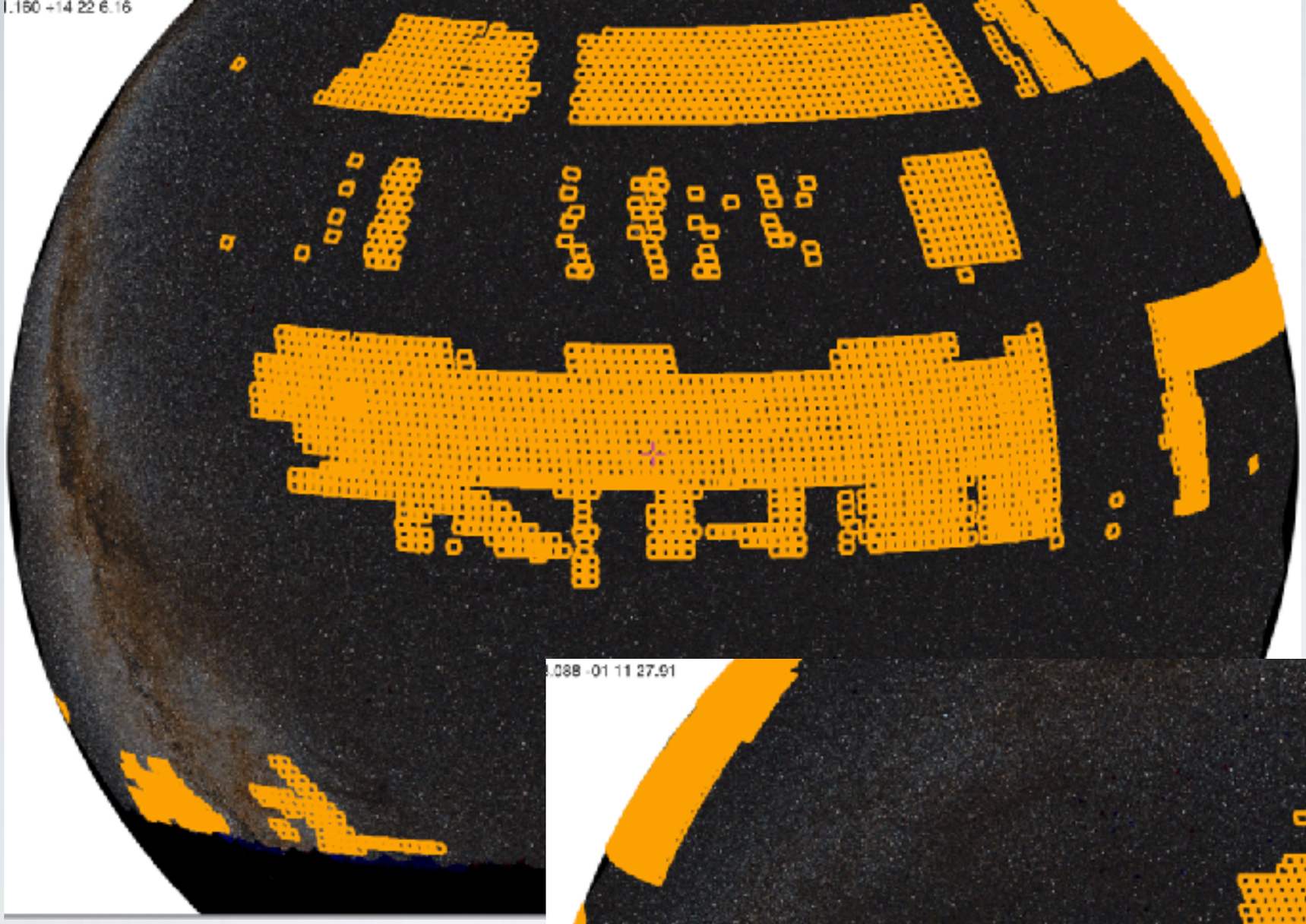
Distances + orbits using Gaia DR2 + isochrone models



Narrow-band photometry

- Technique inspired from earlier prism surveys (Beers et al. 85; Christlieb et al. 02)
- **Pristine** in the northern hemisphere with ***CFHT***
  - rely on SDSS/Pan-STARRS1/ Gaia for broadband photometry





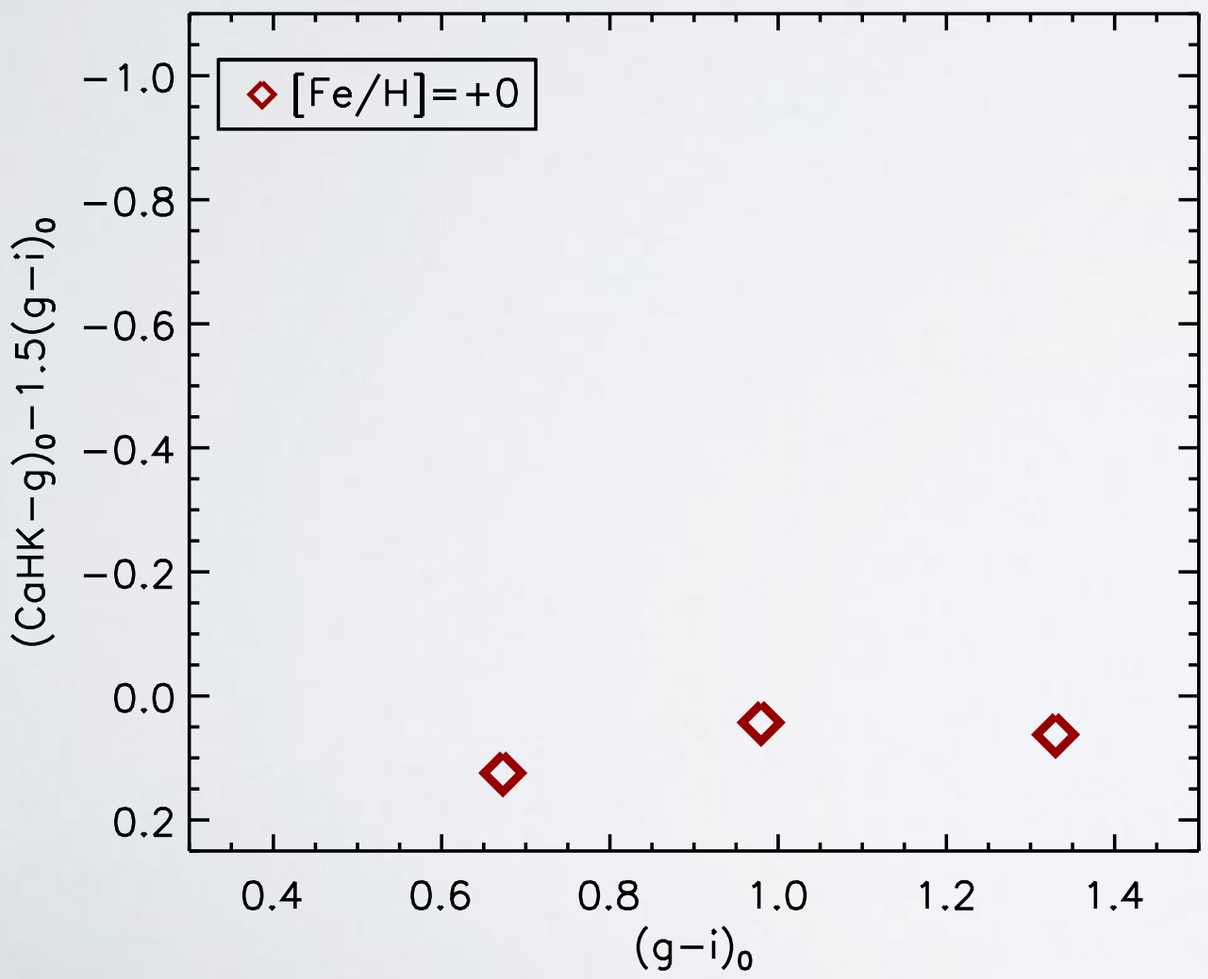
7,000+ images

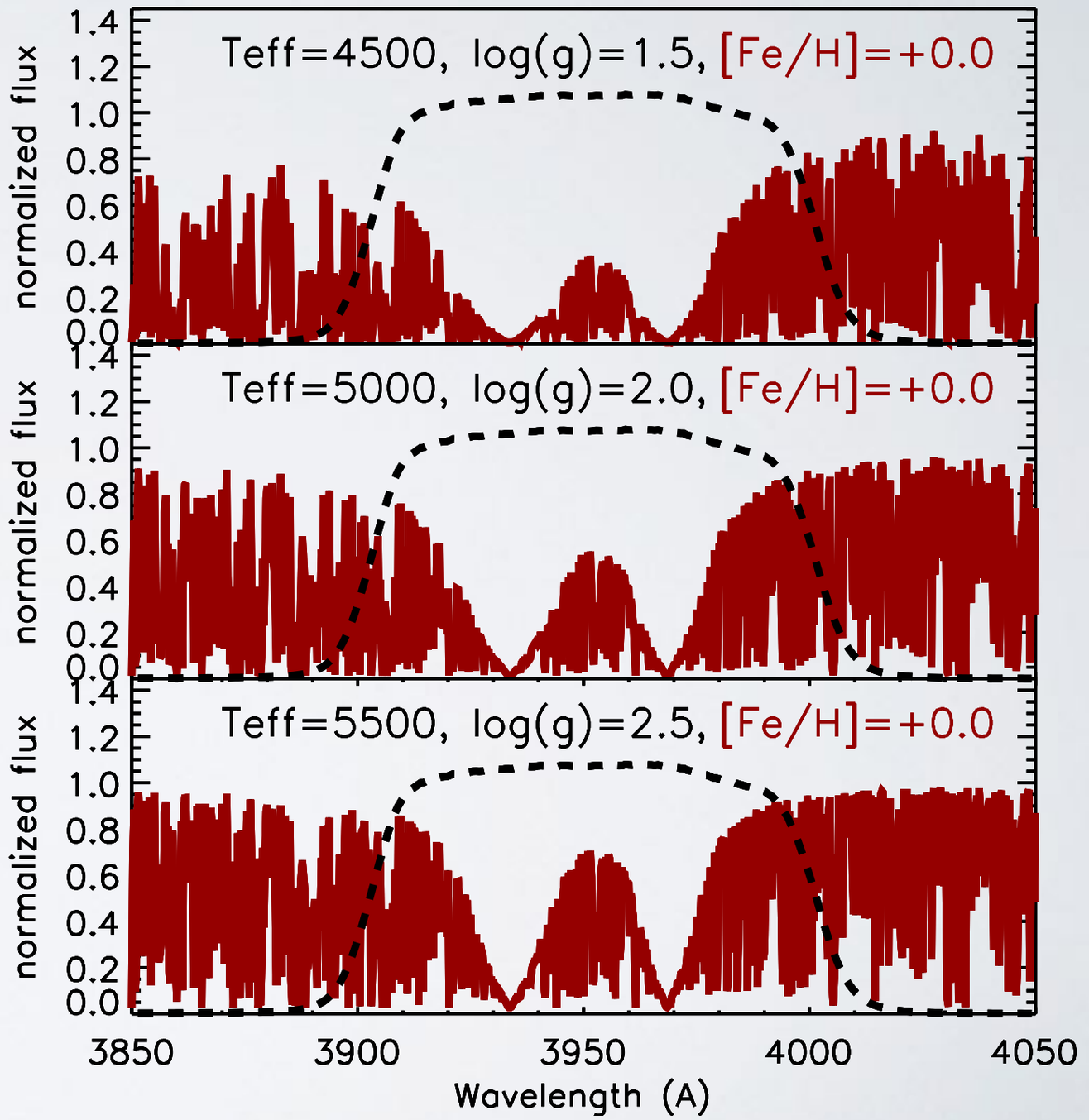
6,000+ deg^2

86+ nights of bad weather time since 2015

The Ca H&K doublet

Starkenburg, Martin et al. (2017)





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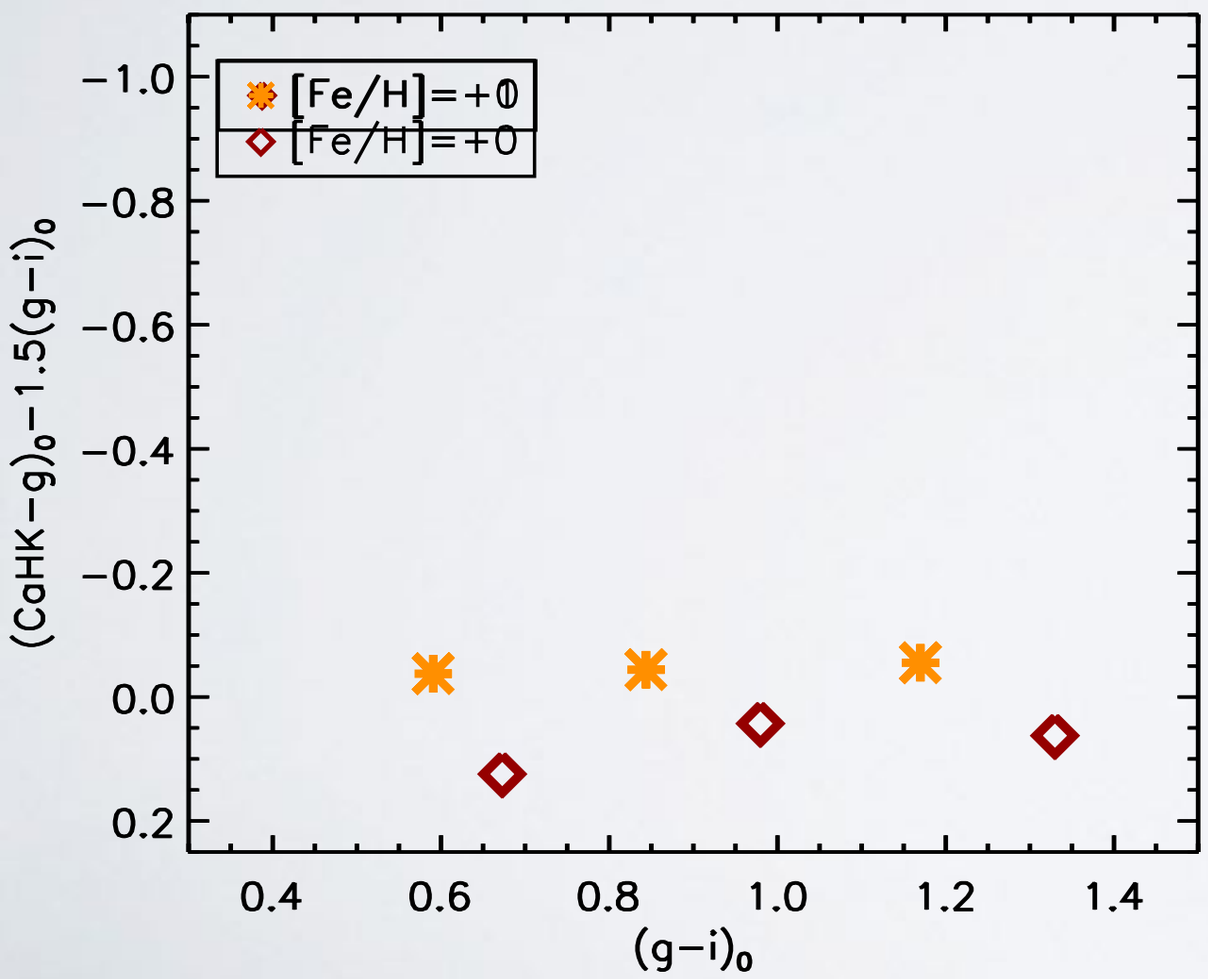

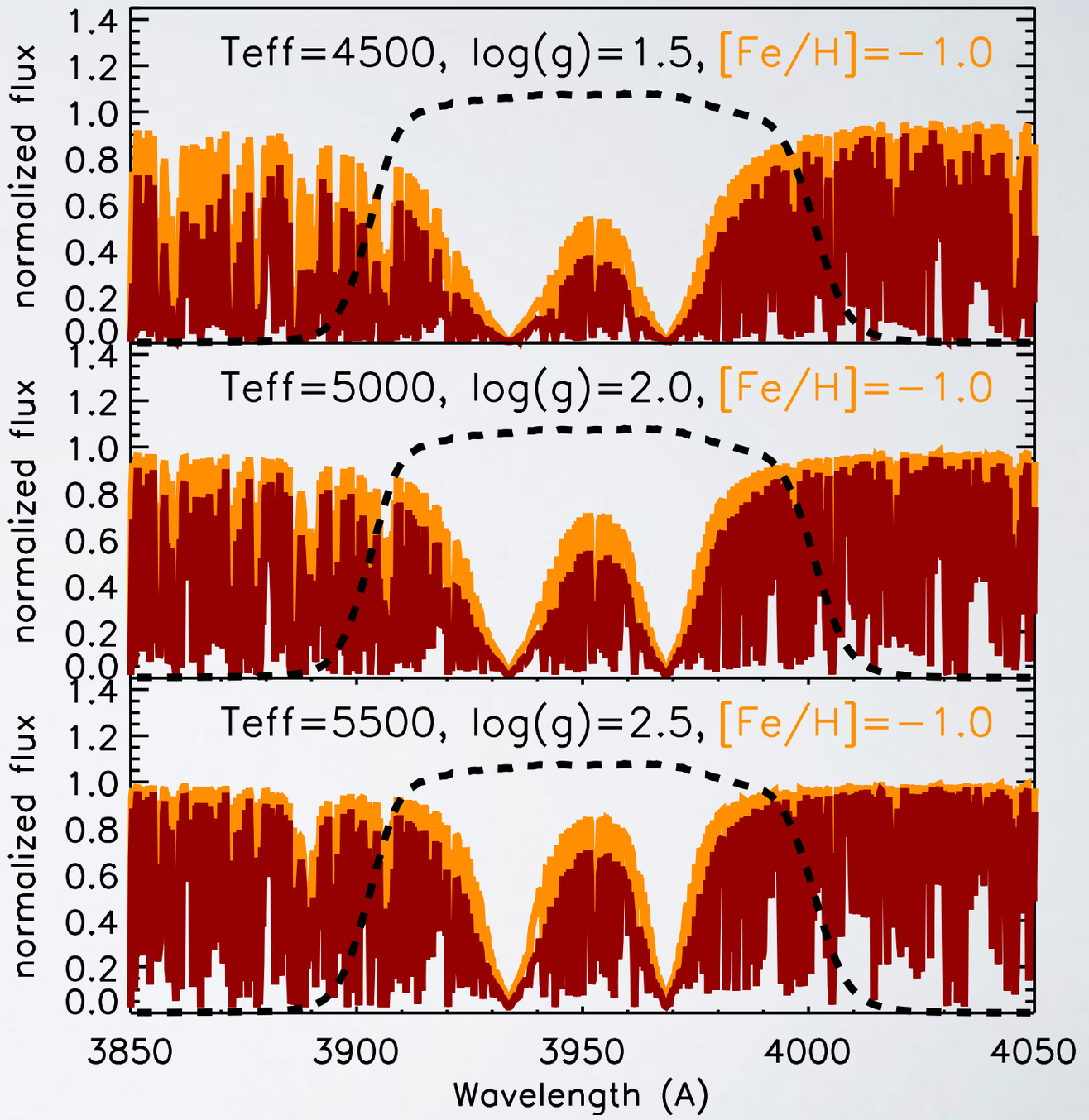

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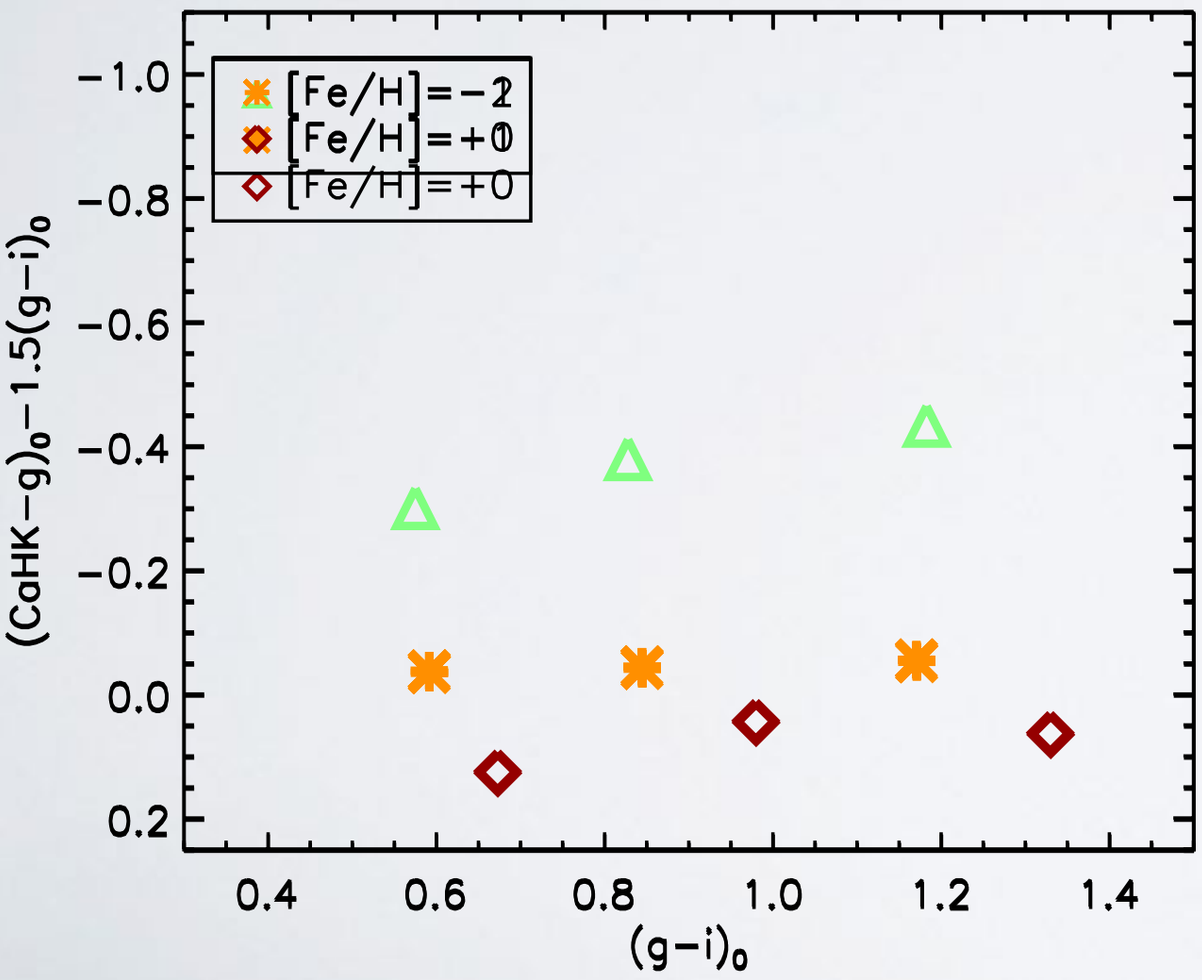

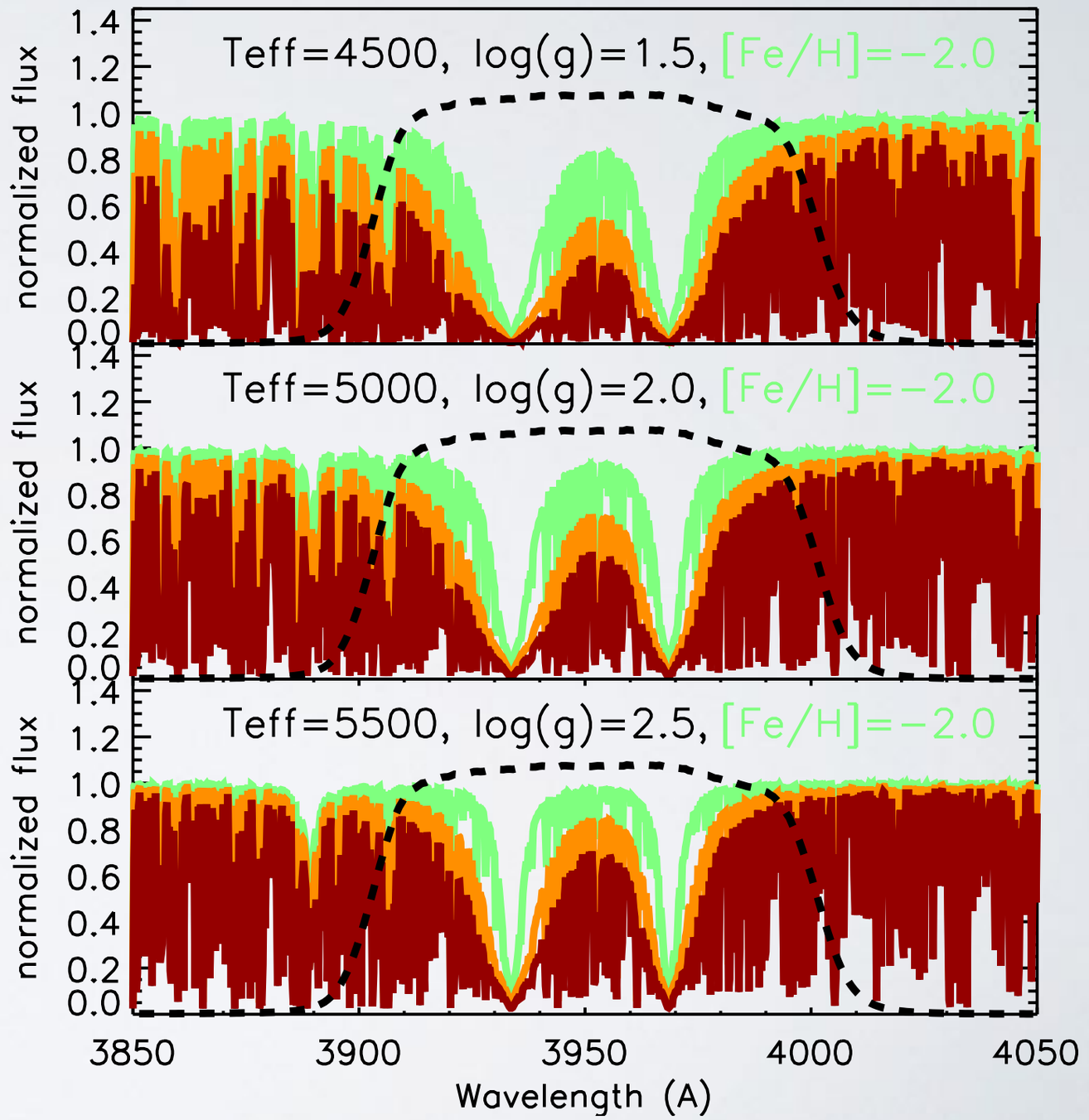

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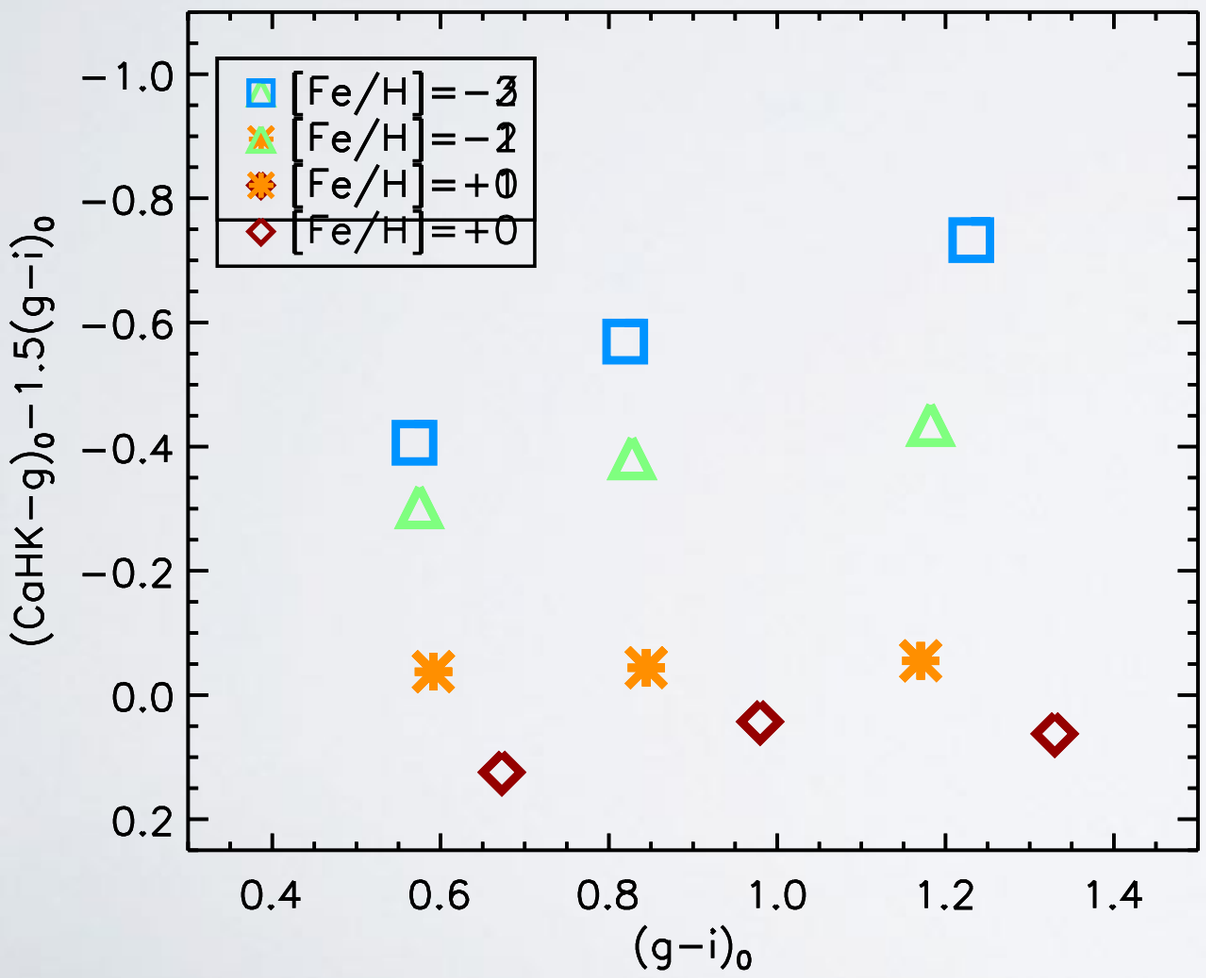

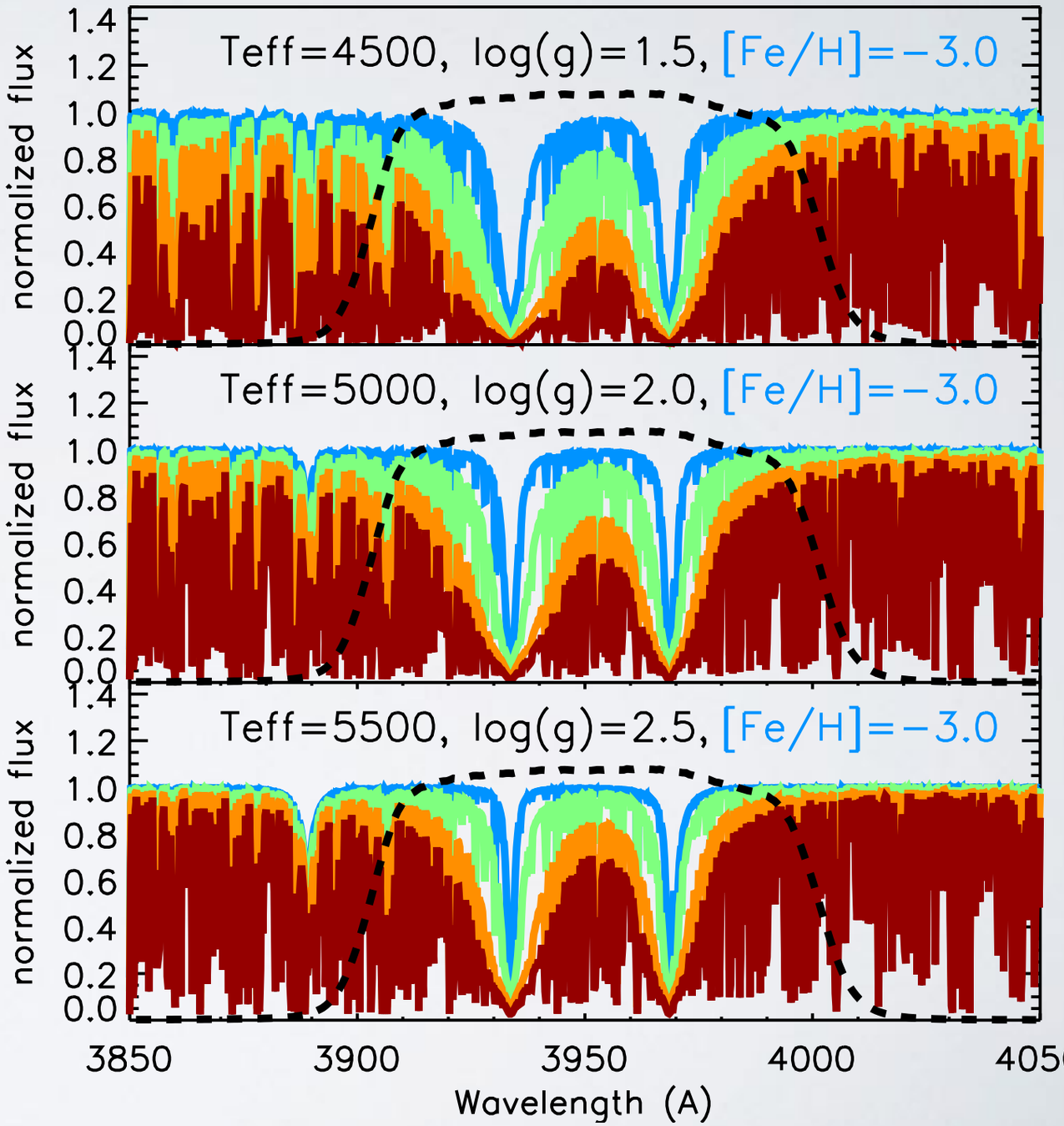

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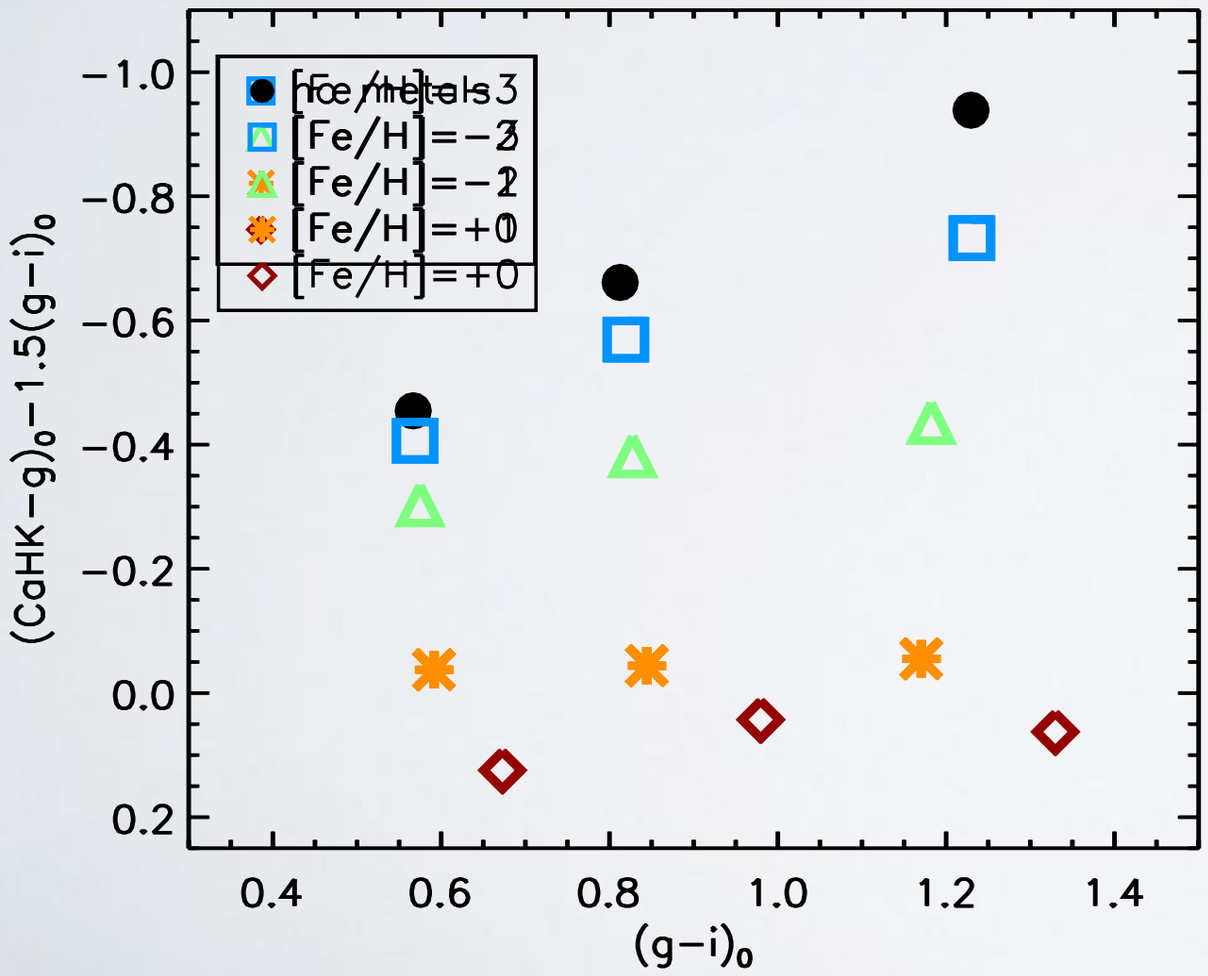
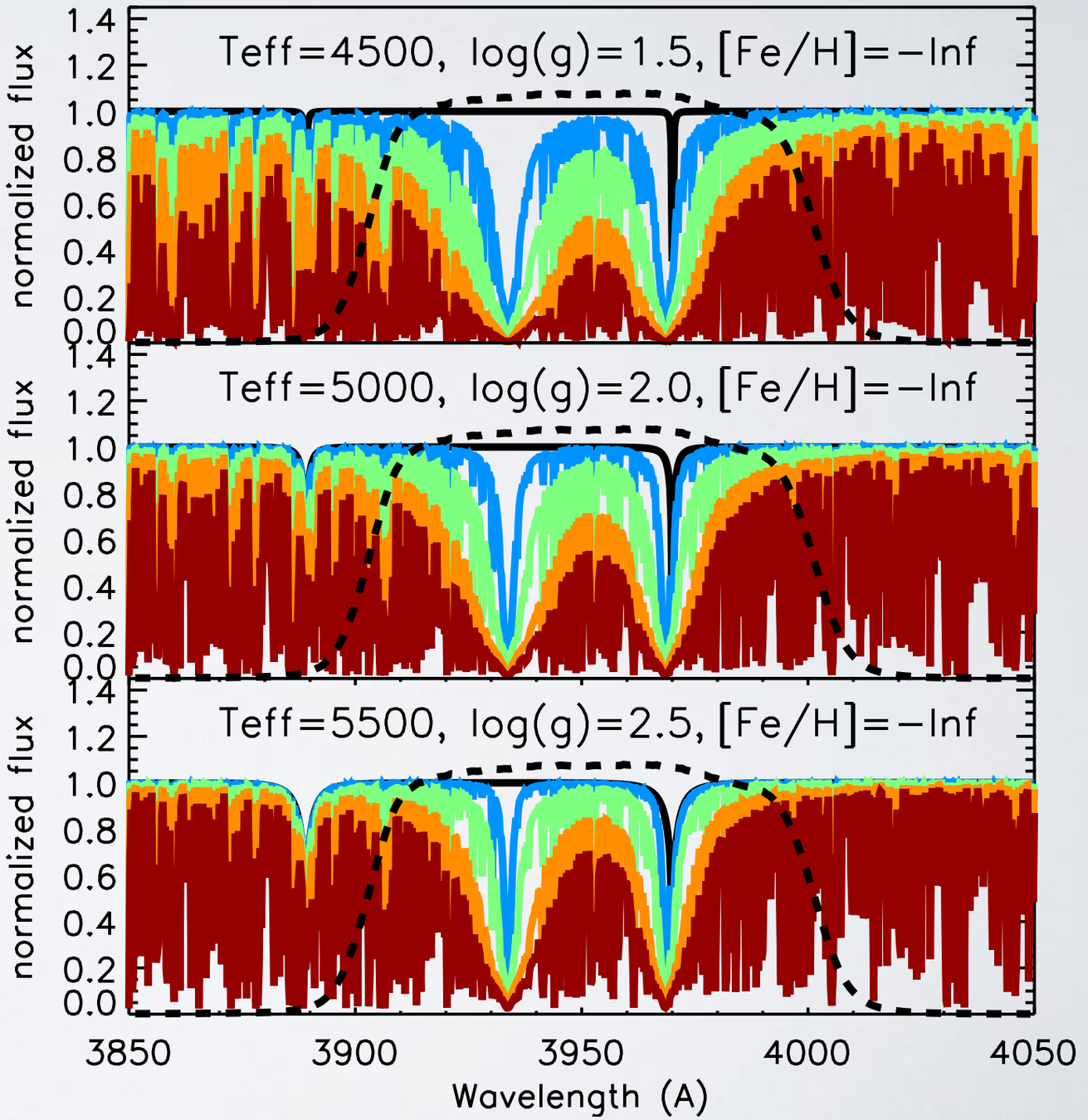
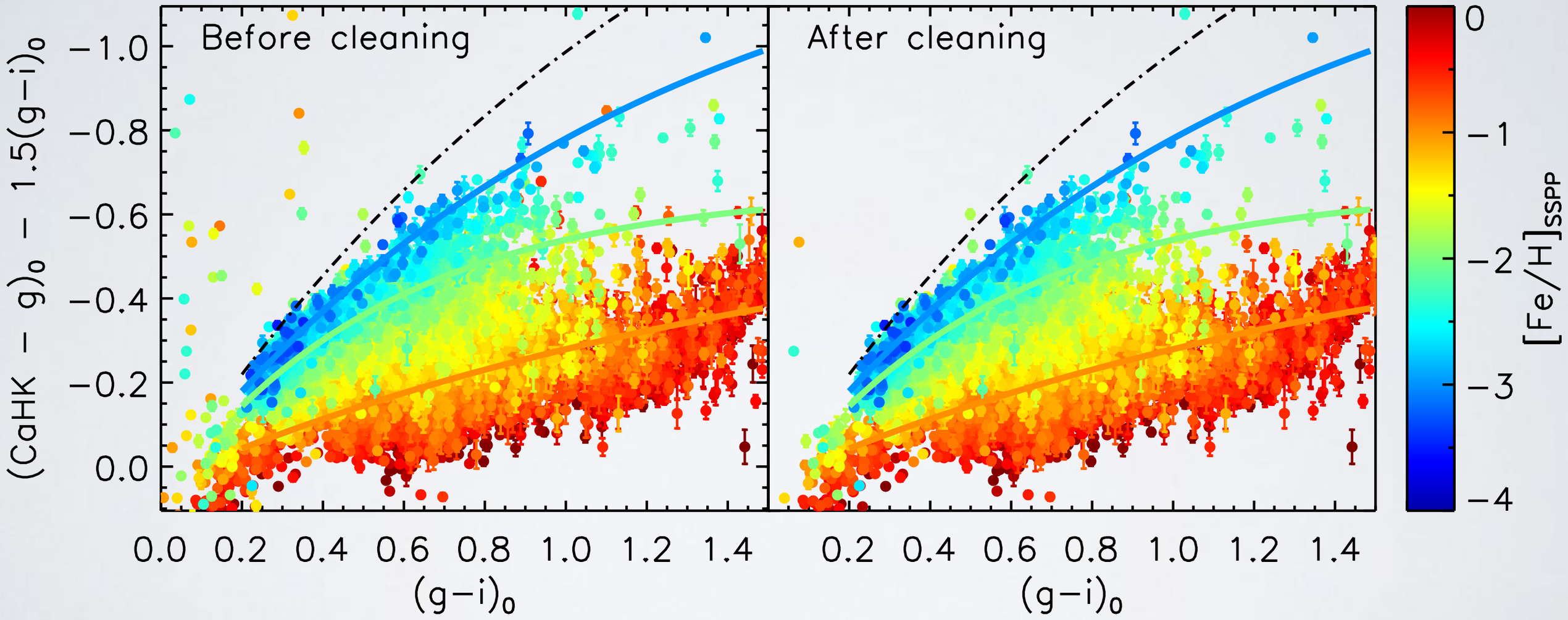




CaHK → [Fe/H] calibration w/ SEGUE

Starkenburg, Martin et al. (2017)

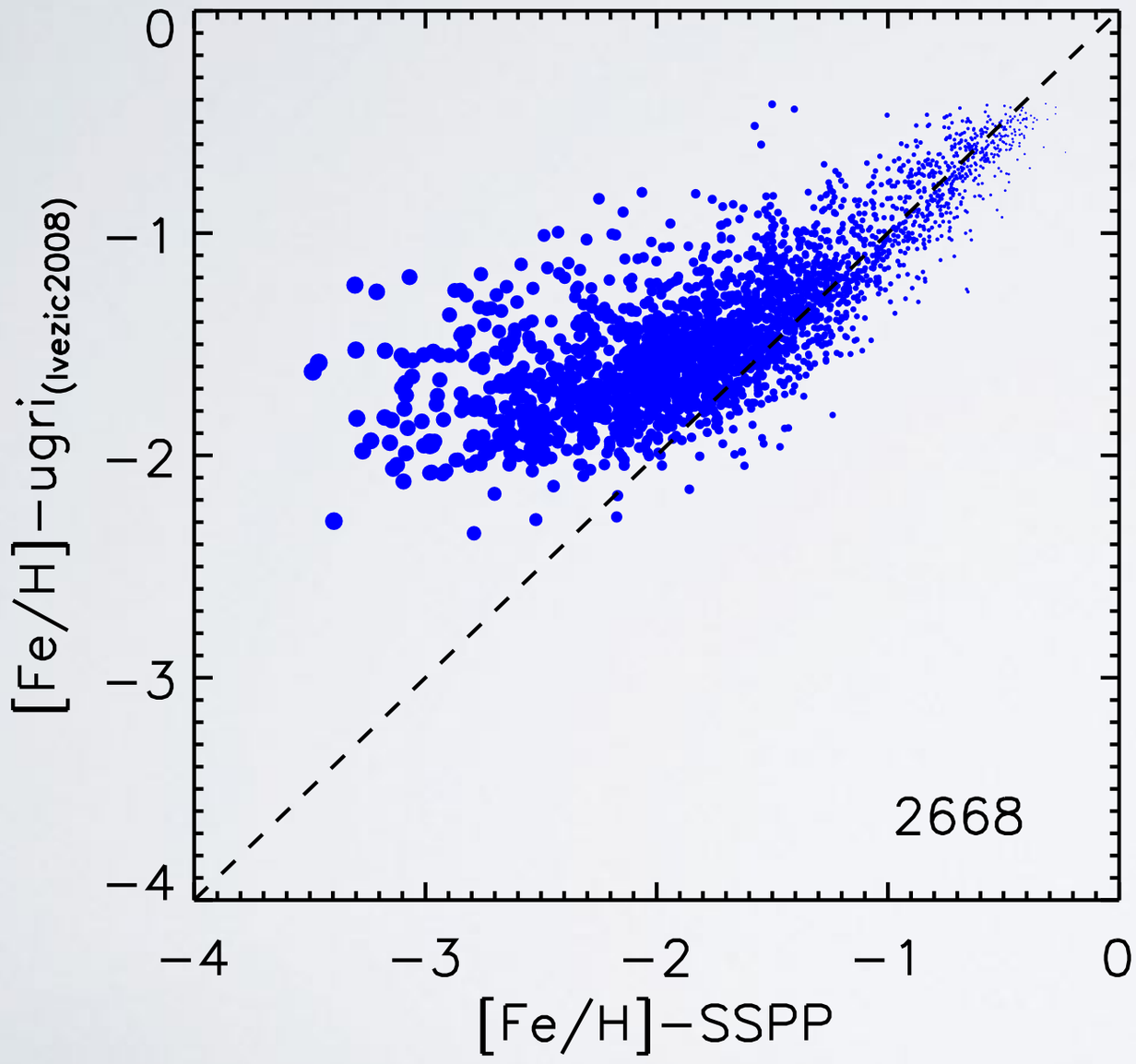
6,000+ SEGUE $[Fe/H]_{spectro}$ for calibration



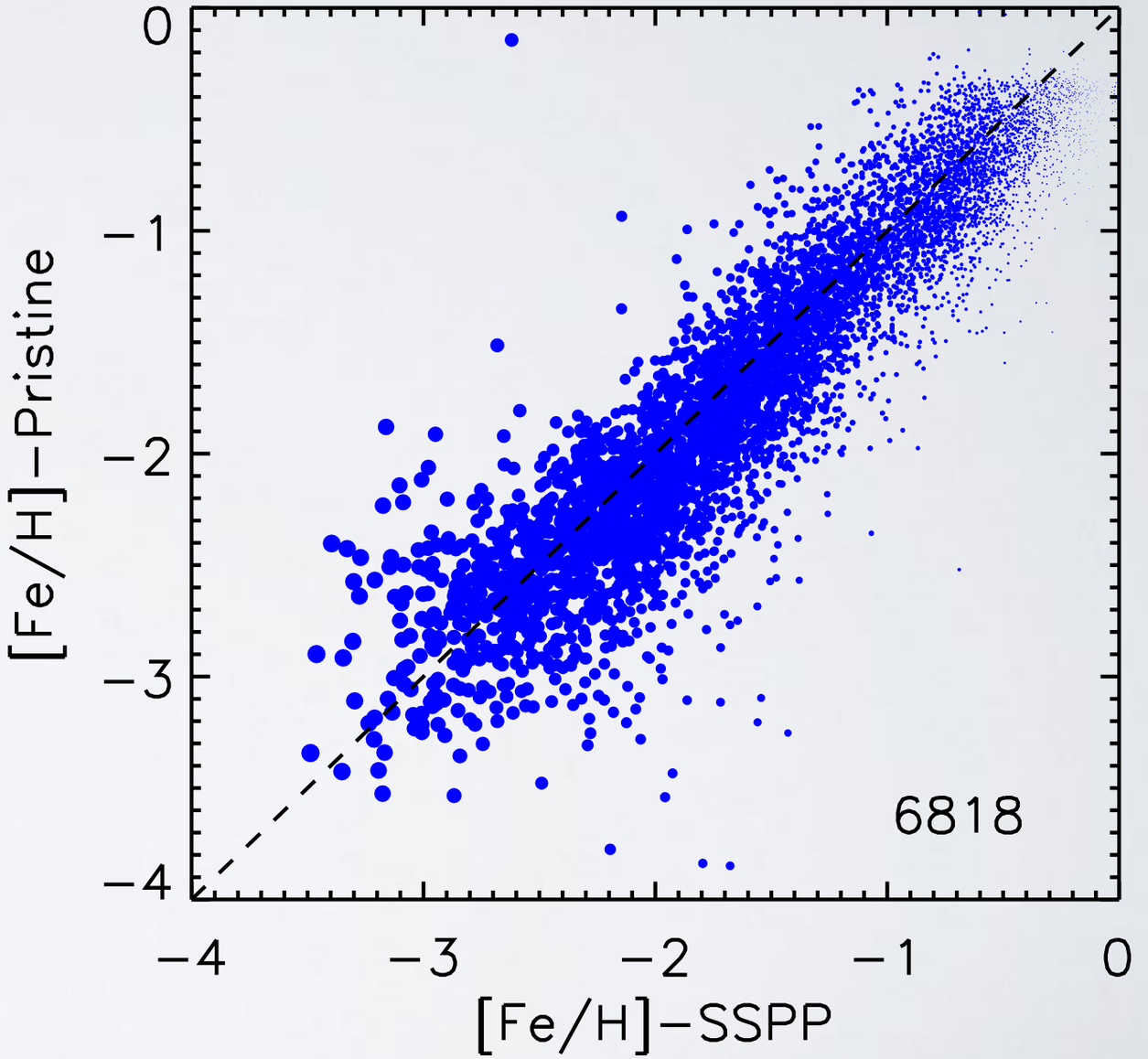
An accurate metallicity decomposition

Starkenburg, Martin et al. (2017)

Broadband ugriz



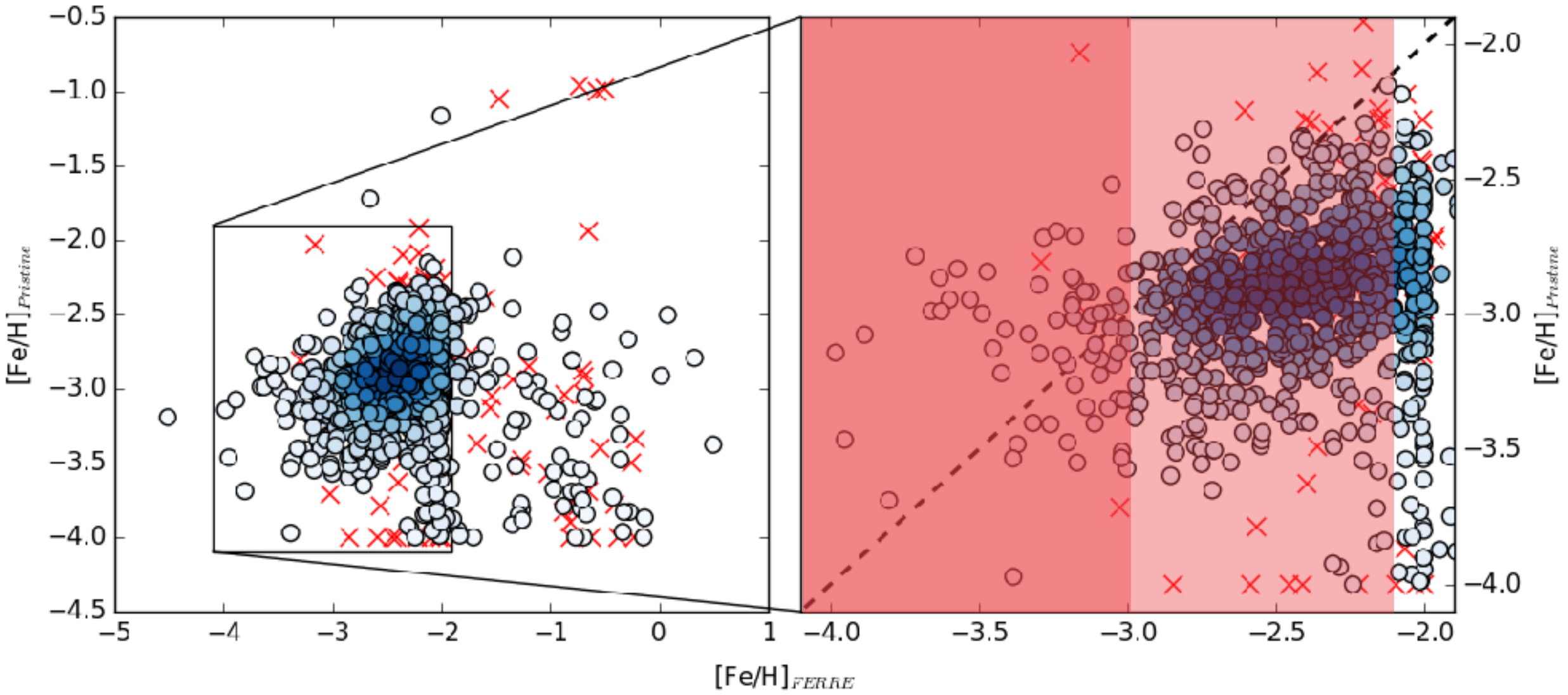
Pristine Ca H&K



Spectroscopic campaign results

Youakim et al. (2017)
Aguado, Youakim et al. (in prep)

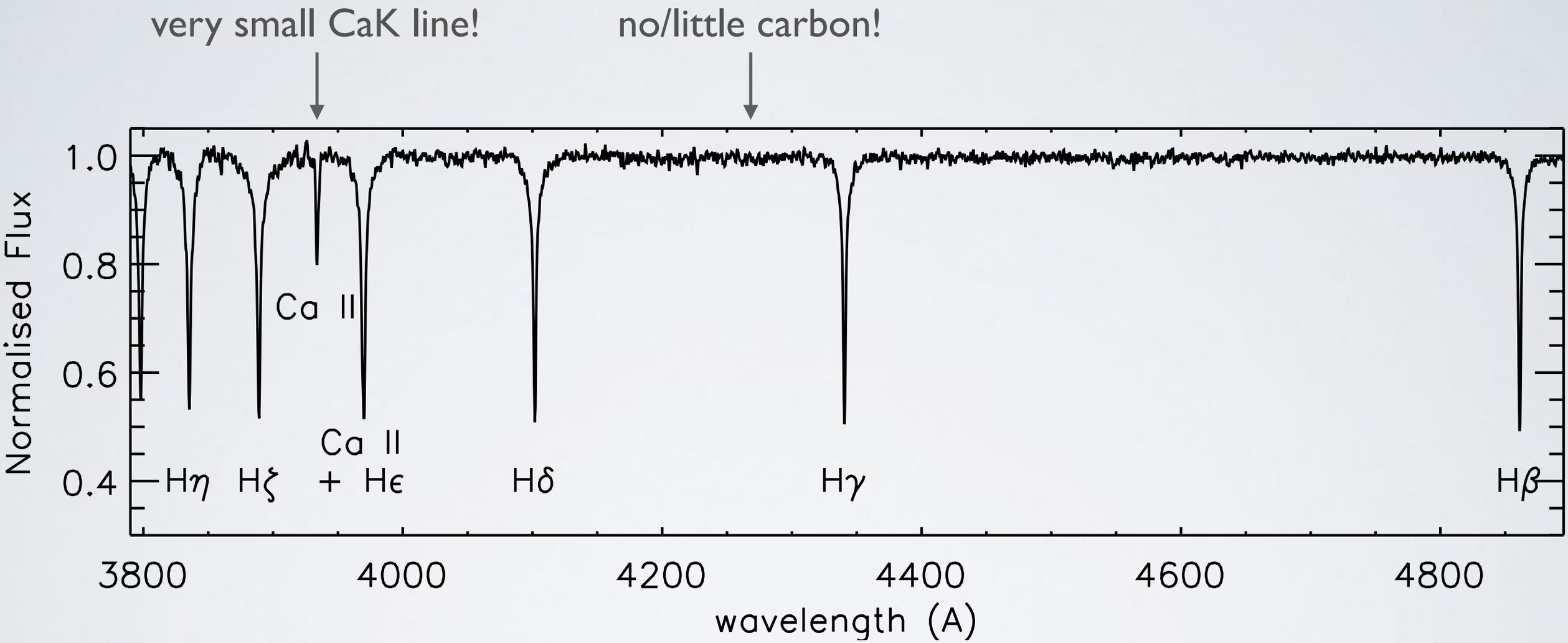
150+ nights on 2–4m telescopes; 1,200+ stars



20/80% success rate of selecting [Fe/H]<–3.0/–2.0

Probing the metallicity floor

Starkenburg et al. (2018)

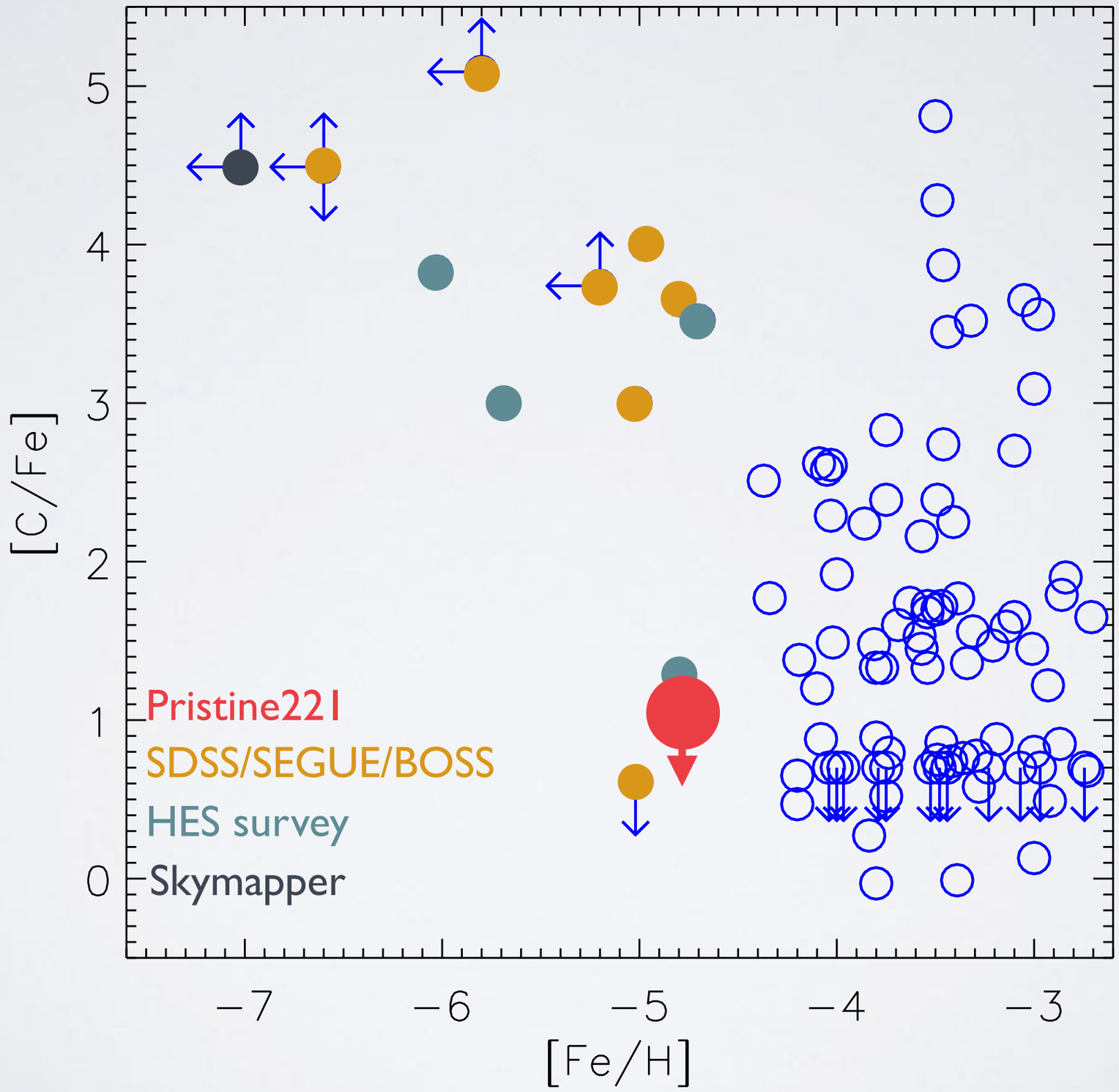


Pristine221: $[Fe/H] = -4.7$ $[C/Fe] < 1.0$

Second most metal-poor star ever found?

Likely the first of many

Probing the metallicity floor



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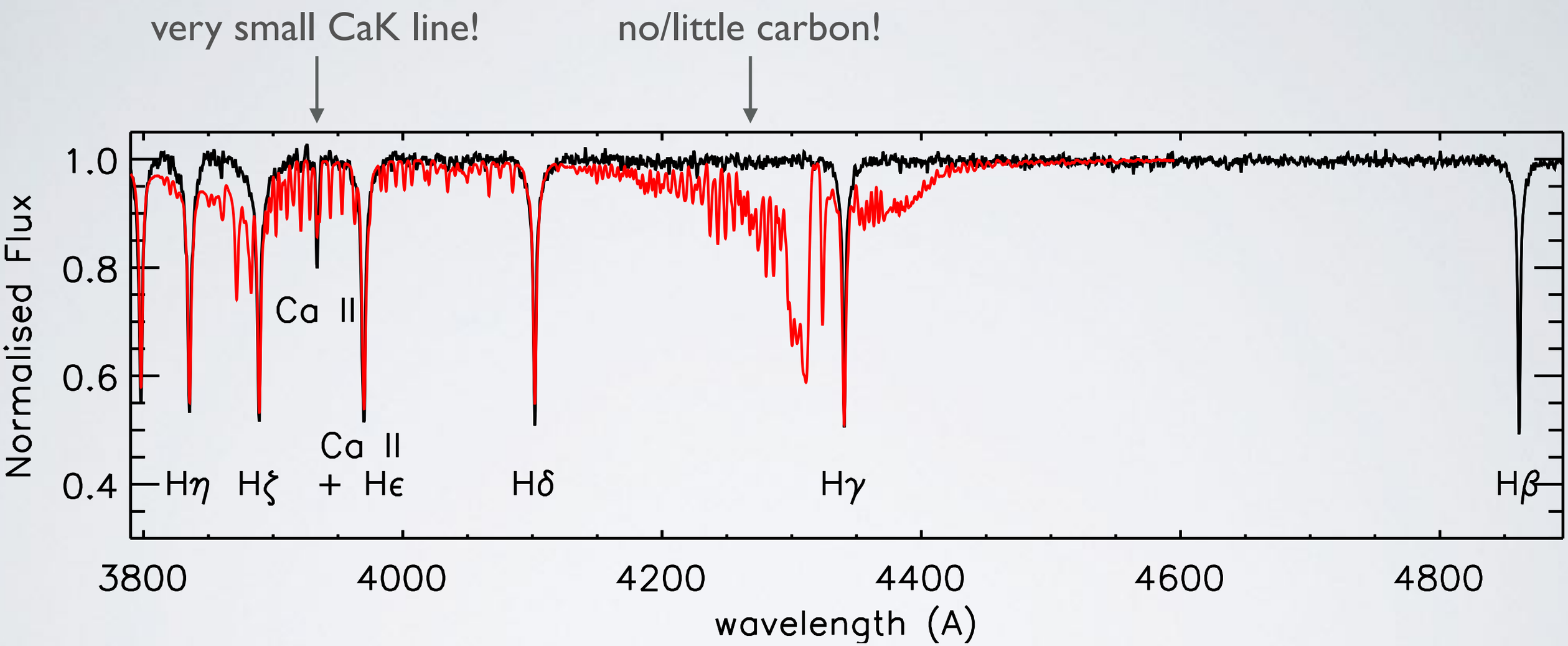

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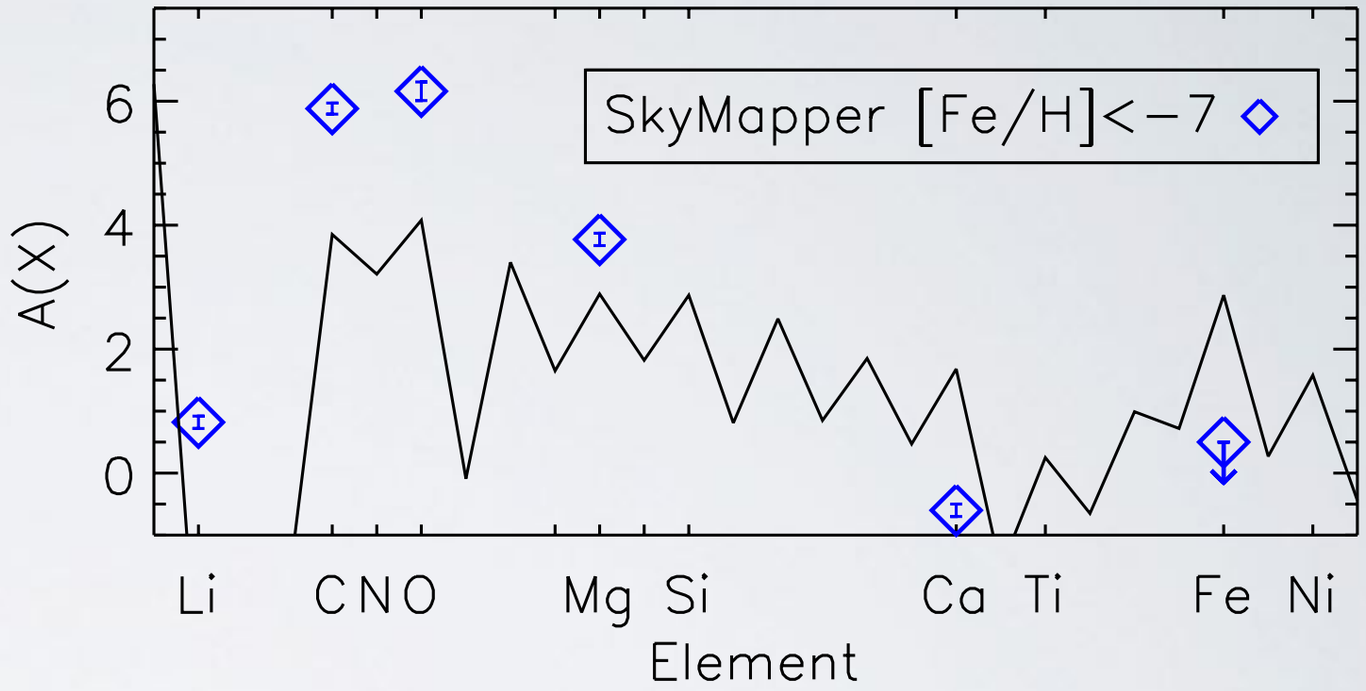
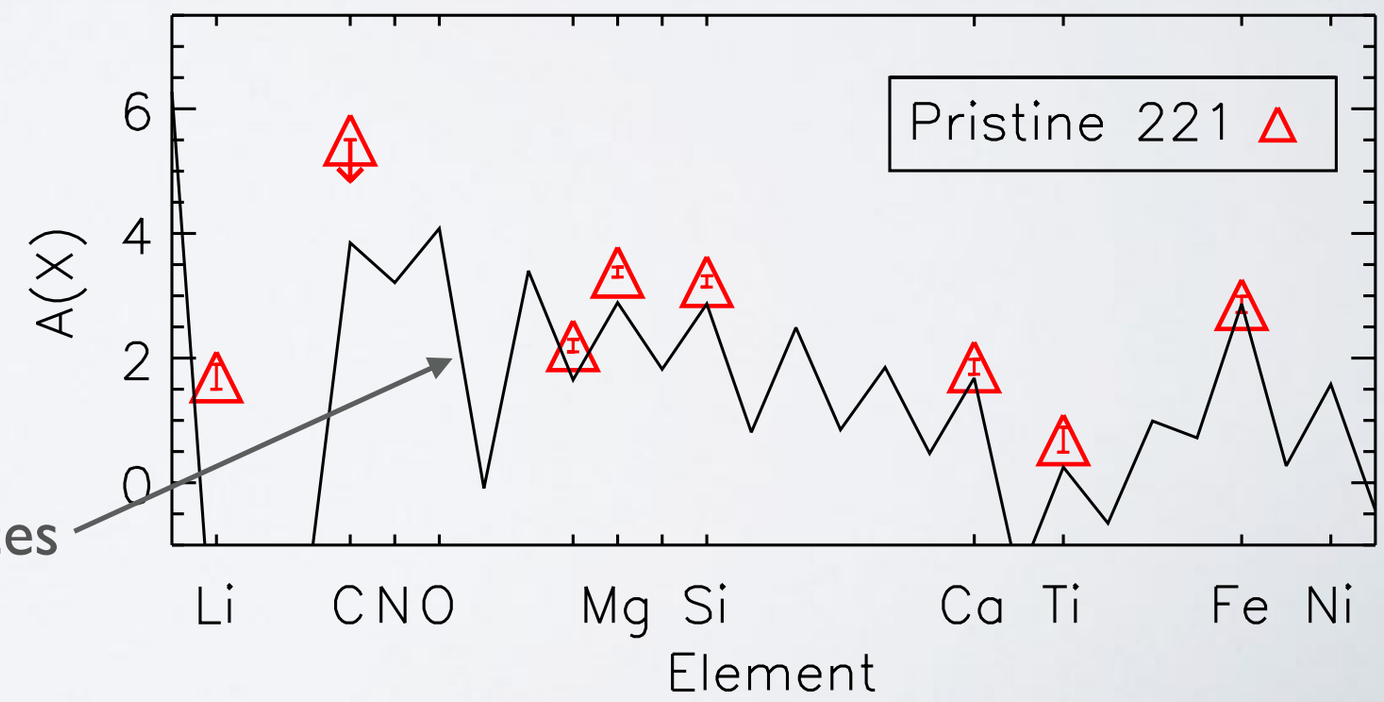
Are these stars probing early star formation?

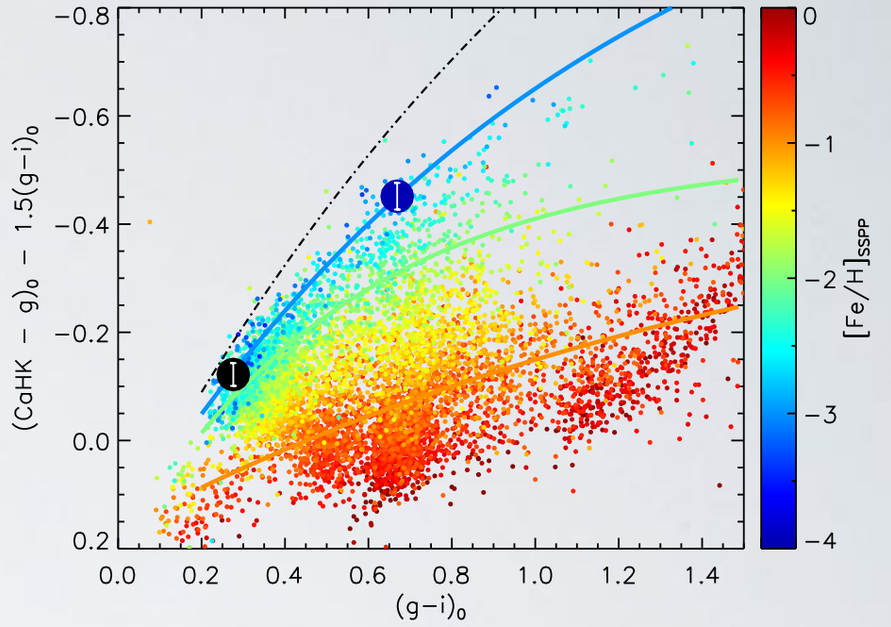
- Important to study their full abundance patterns
- Some very unusual stars: imprints from the First Stars?
- *Need more statistics!*



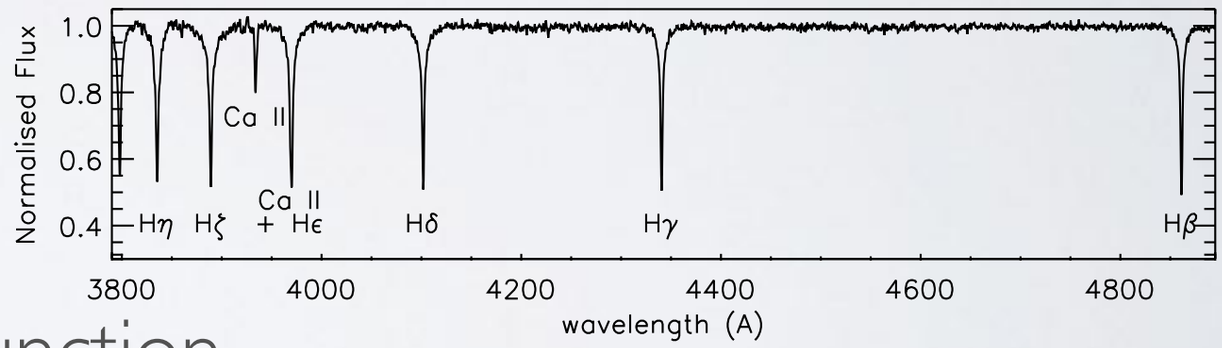


Pristine

- ***Oldest/most metal-poor stars***
  - Already new discoveries [Fe/H]<–4.0
  - *MoU with WEAVE survey (~20–30k spectra)*
  - *Building largest sample of EMP stars*



- ***Galactic archaeology of MW***
  - *Gaia for distances, orbits*
  - Comparison with models
  - Large statistics, known selection function



- ***A thorough study of (very) faint MW satellites***
  - Systematic survey of all northern faint satellites (Longeard, Martin *et al.* 2018 & 2019)

Pristine Publications

1. The Pristine Survey – I. Mining the Galaxy for the most metal-poor stars (Starkenburg, Martin et al. 2017)
2. The Pristine Survey – II. A sample of bright stars observed with FEROS (Caffau et al. 2017)
3. The Pristine Survey – III. Spectroscopic confirmation of an efficient search for extremely metal-poor stars (Youakim et al. 2017)
4. The Pristine Survey – IV. Approaching the Galactic metallicity floor with the discovery of an ultra metal-poor star (Starkenburg et al. 2018)
5. The Pristine Survey – V. A bright star sample observed with SOPHIE (Bonifacio et al. 2019)
6. **The Pristine Survey – VI. A uniquely clean view of the Galactic outer halo using blue horizontal using blue horizontal branch stars (Starkenburg et al., submitted)**
7. The Pristine Survey – VII. The first three years of medium resolution follow-up spectroscopy of Pristine EMP candidate (Aguado et al., to be submitted soon)
8. **Pristine Dwarf Galaxy Survey – I. A detailed photometric and spectroscopic study of the metal-poor Draco II satellite (Longeard, Martin et al. 2018)**
9. **Pristine Dwarf Galaxy Survey – II. In-depth observational study of the faint Milky Way satellite Sagittarius II (Longeard, Martin et al., submitted)**
10. The Pristine Inner Galaxy Survey (PIGS) – I. Kinematics of metal-poor stars in the inner Galaxy (Arentsen et al., to be submitted)
11. The Pristine Inner Galaxy Survey (PIGS) – II. Introduction the survey (Arentsen et al., to be submitted)