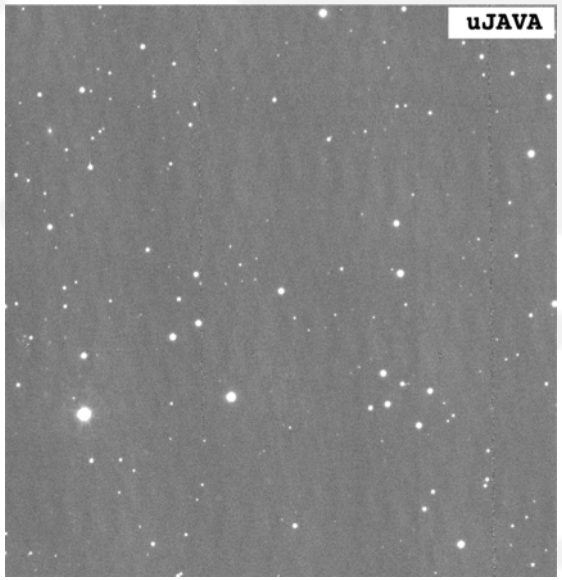
Mining the S-PLUS catalog to find chemically peculiar stars in the Galaxy

Vinicius Placco (NSF's NOIRLab)

+ S-PLUS Milky Way working group members



NSF's National Optical-Infrared Astronomy Research Laboratory

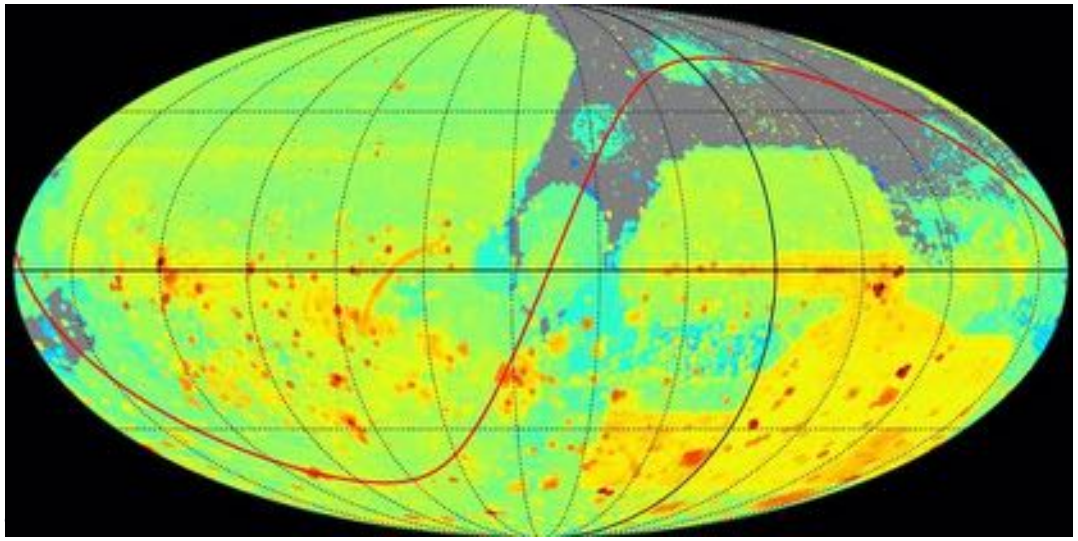
Gemini North (Mauna Kea – Hawaii)

SOAR (Cerro Pachón - Chile)

Gemini South (Cerro Pachón - Chile)

Kitt Peak National Observatory (Arizona/USA)

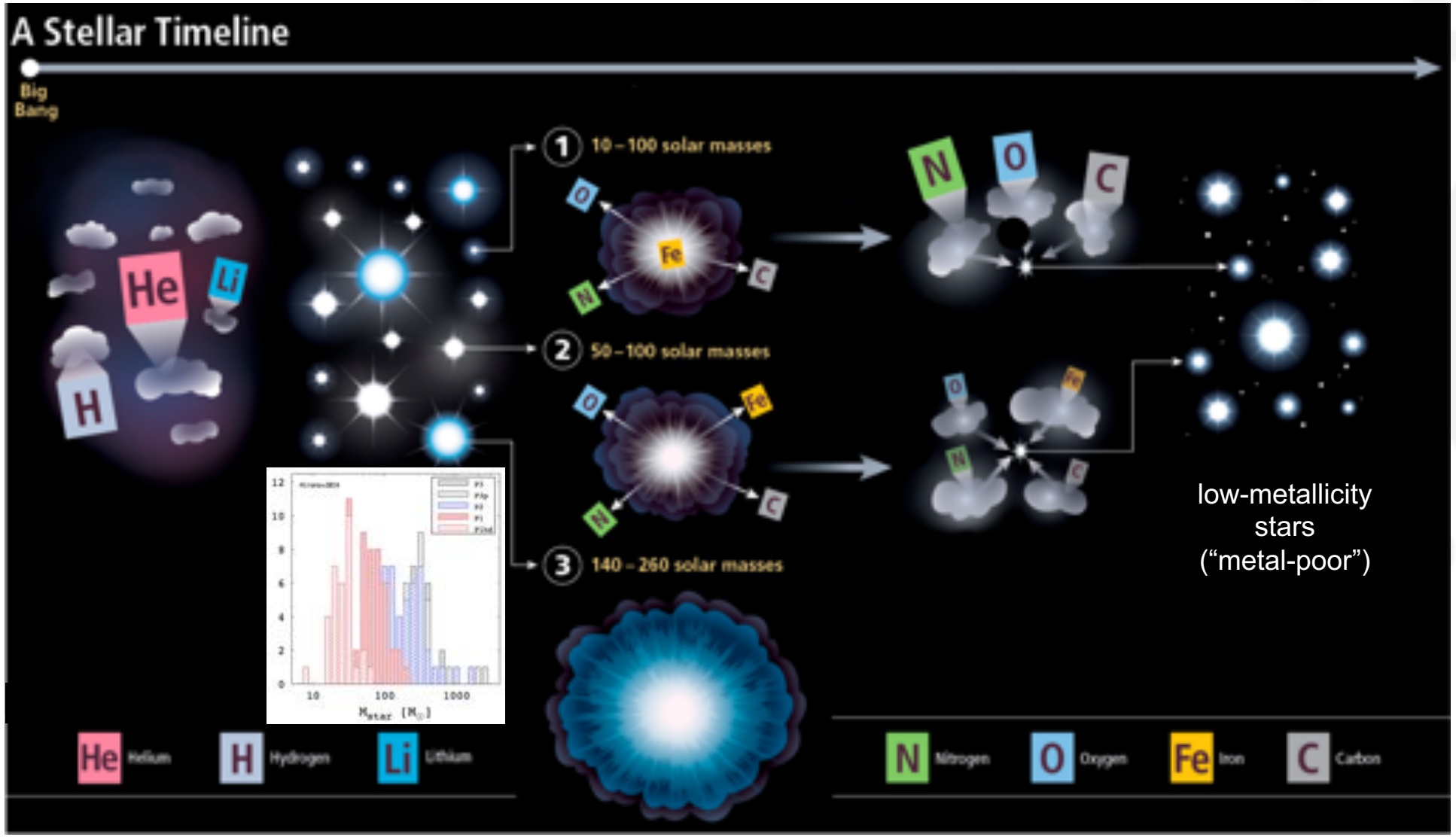
Community Science & Data Center



Vera Rubin Observatory (Cerro Pachón)

Cerro Tololo Interamerican Observatory

Stellar Archaeology and the First Stars

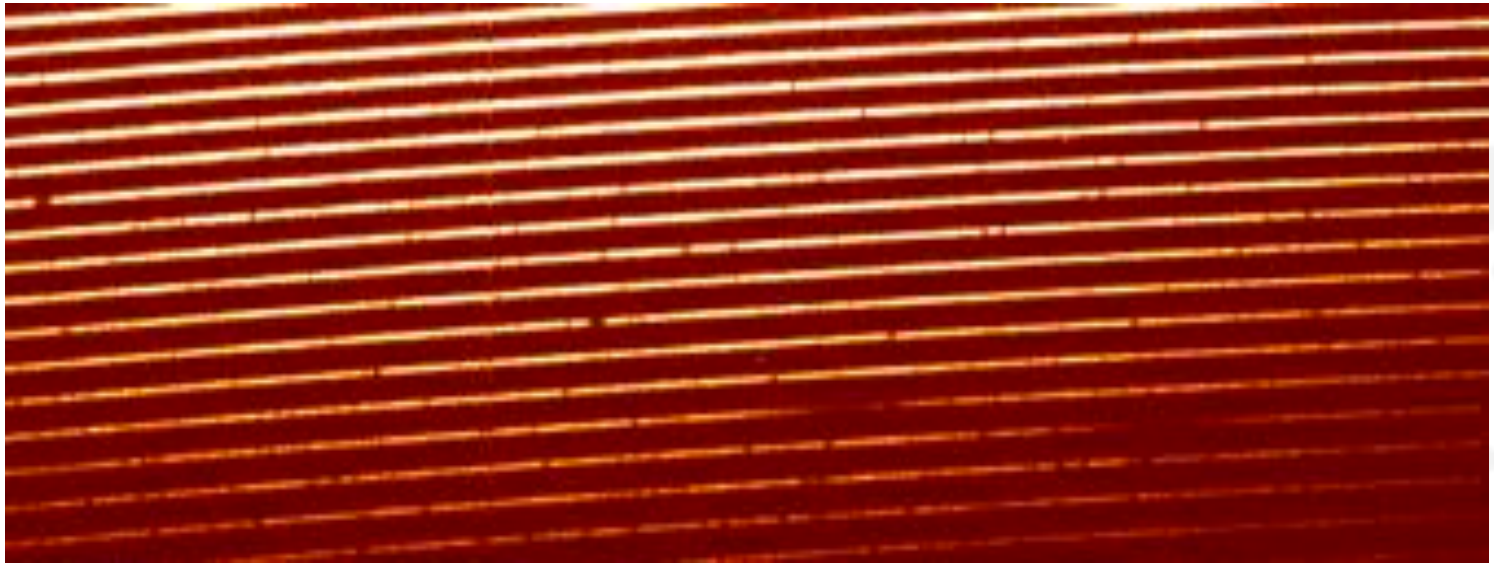


http://discovermagazine.com/~/media/Images/Issues/2015/Dec/stellar_timeline.jpg (edits by Elisa Arizono)

Finding low-metallicity stars

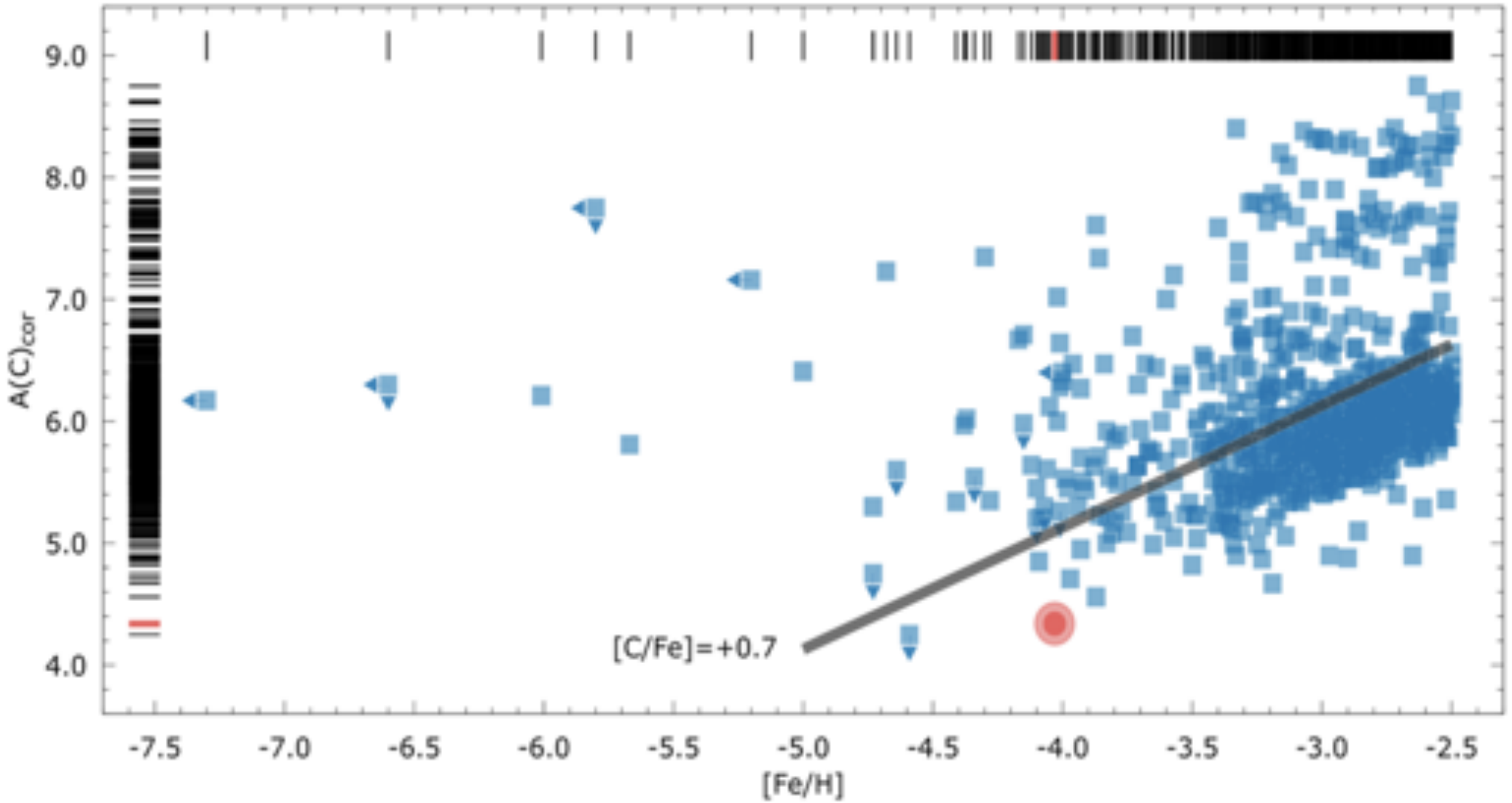
Solar type:
[Fe/H] ~ 0.0

Extremely
Metal-Poor:
[Fe/H] < -3.0



credit: E. Holmbeck

Stellar Archaeology and the First Stars



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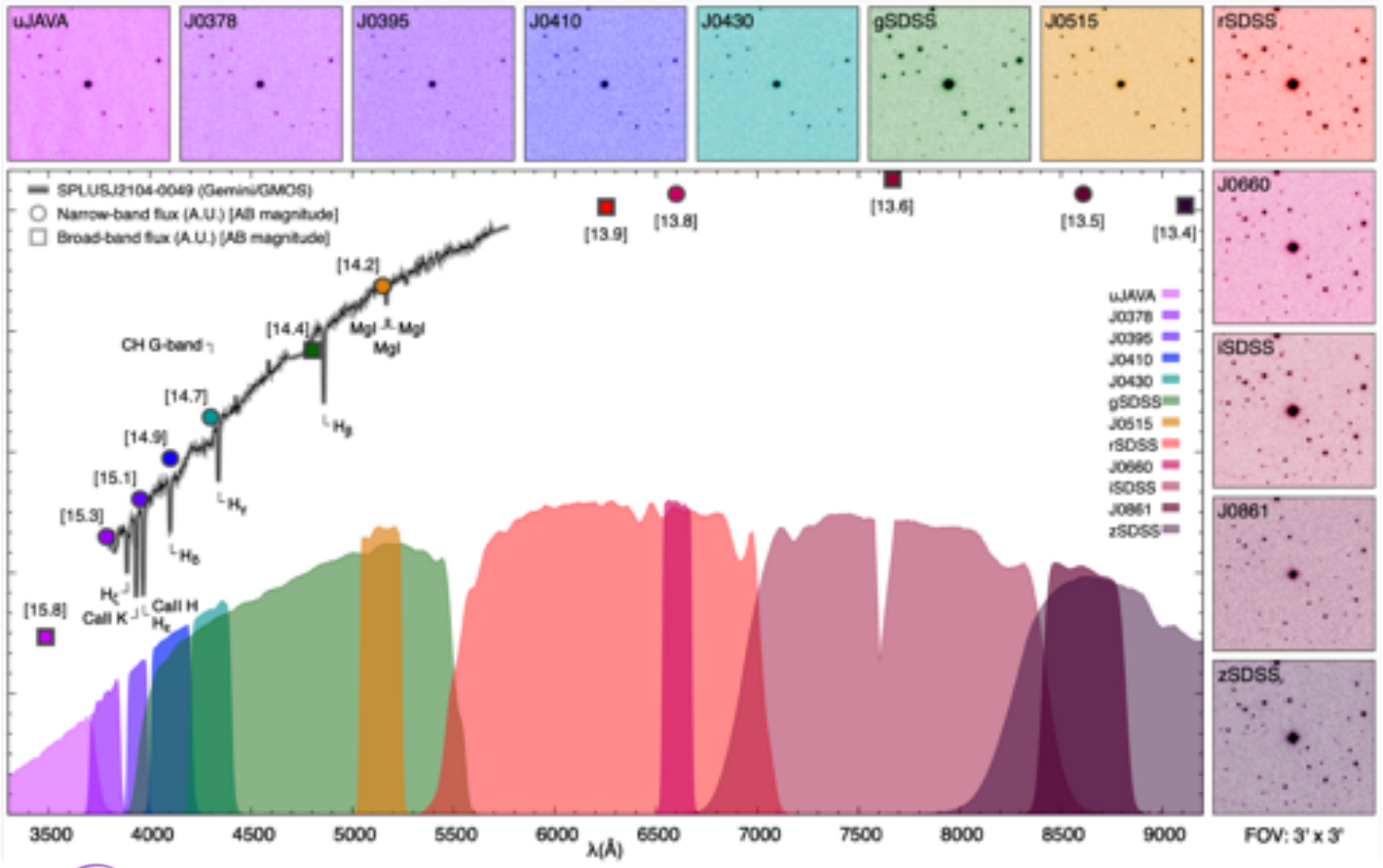
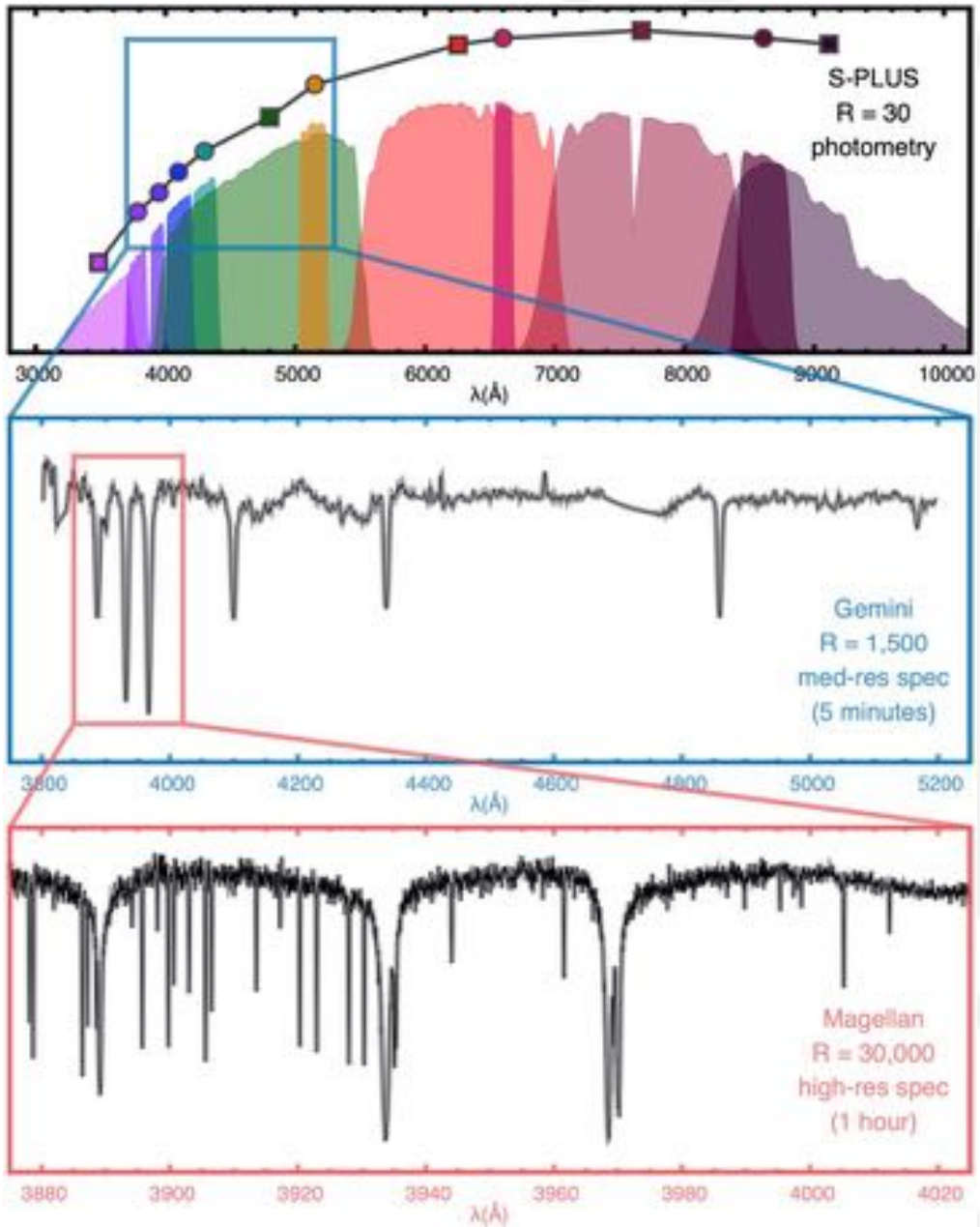
S-PLUS J210428.01-004934.2





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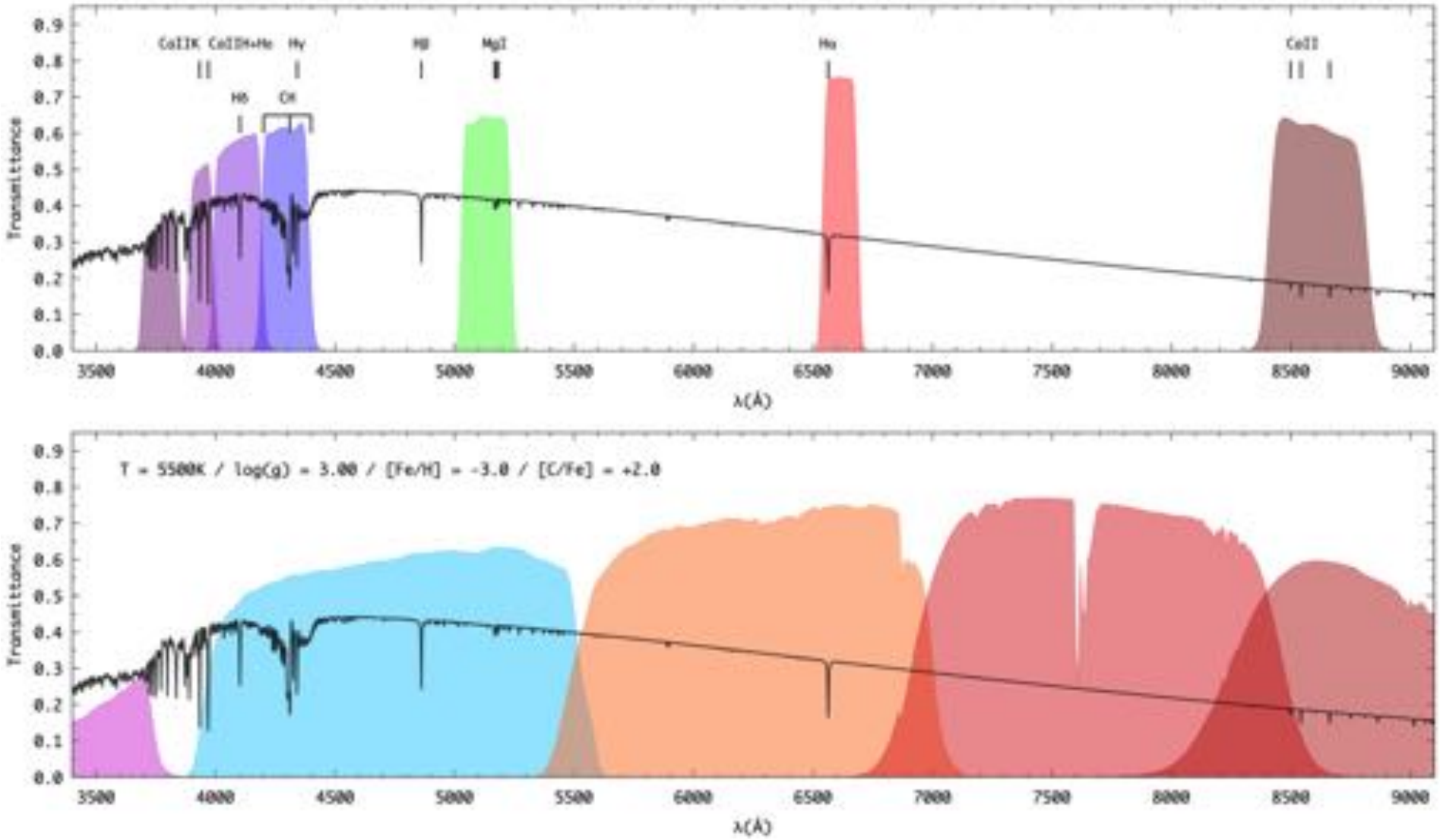
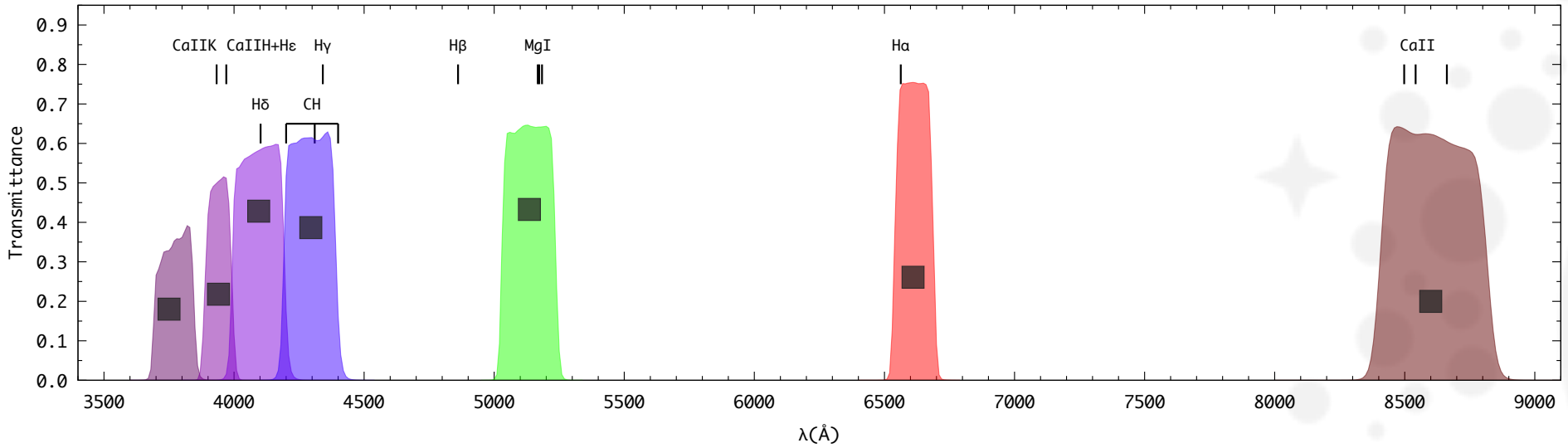
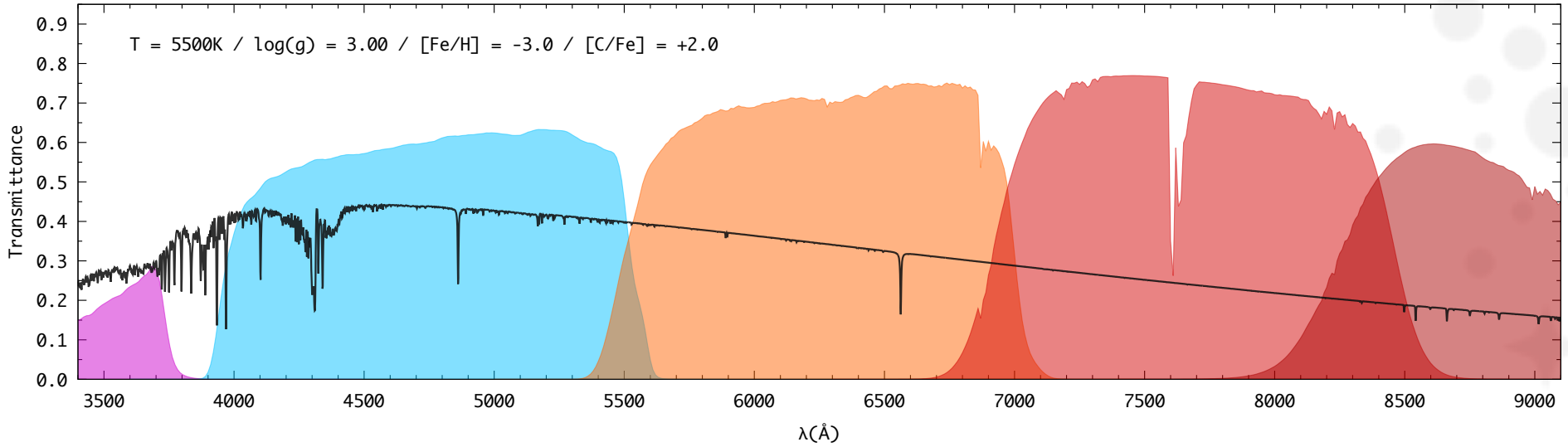
S-PLUS (Filter system)

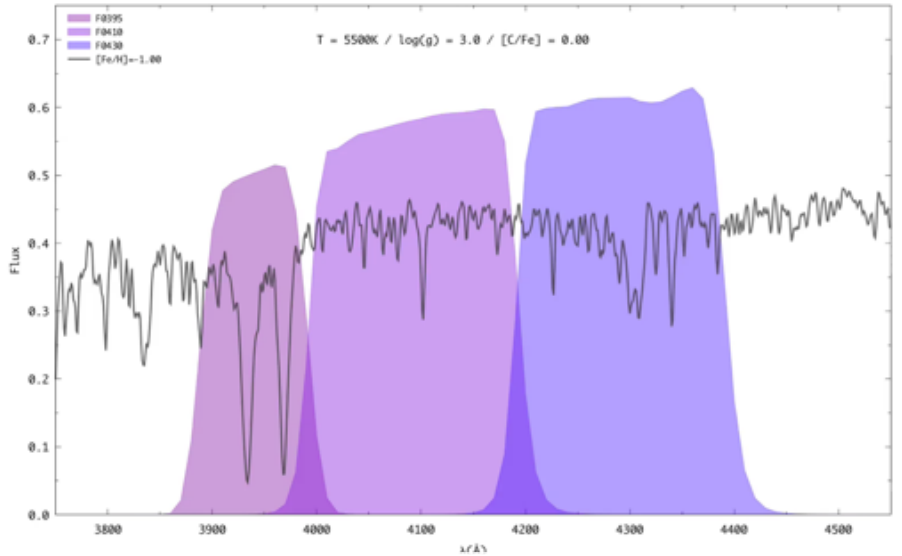


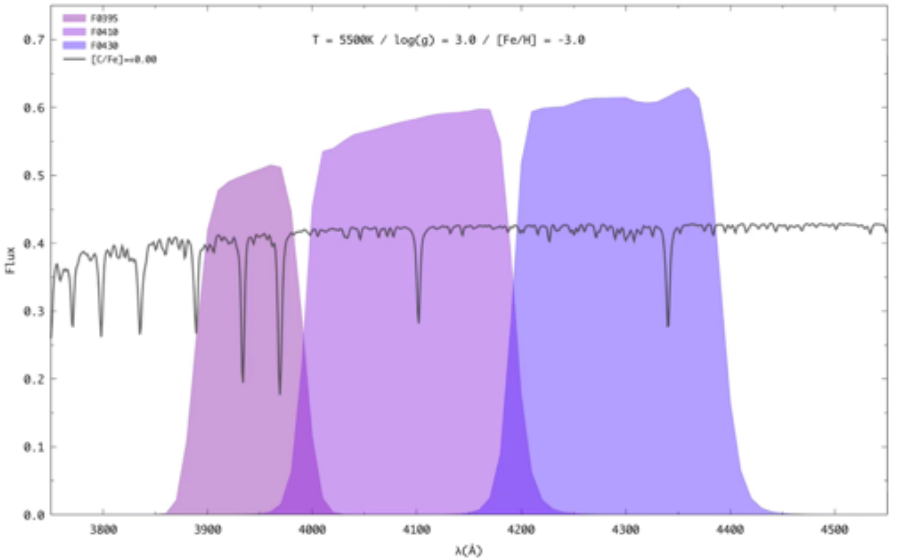
S-PLUS (Filter system)

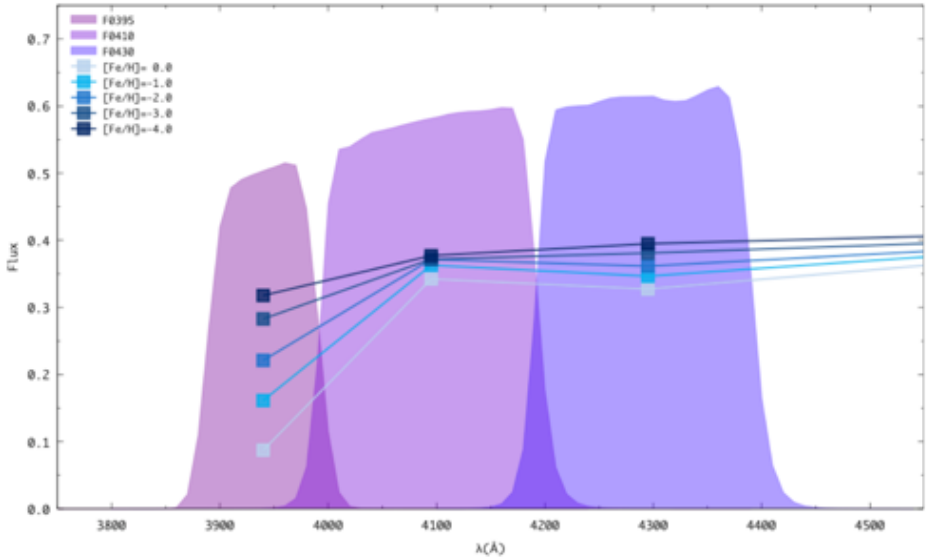


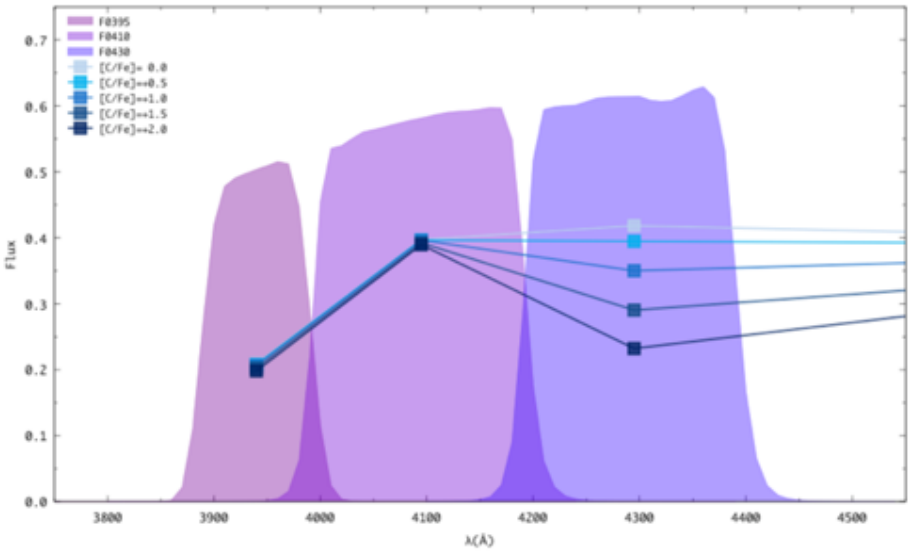


S-PLUS ([Fe/H] and A(C) indicators)

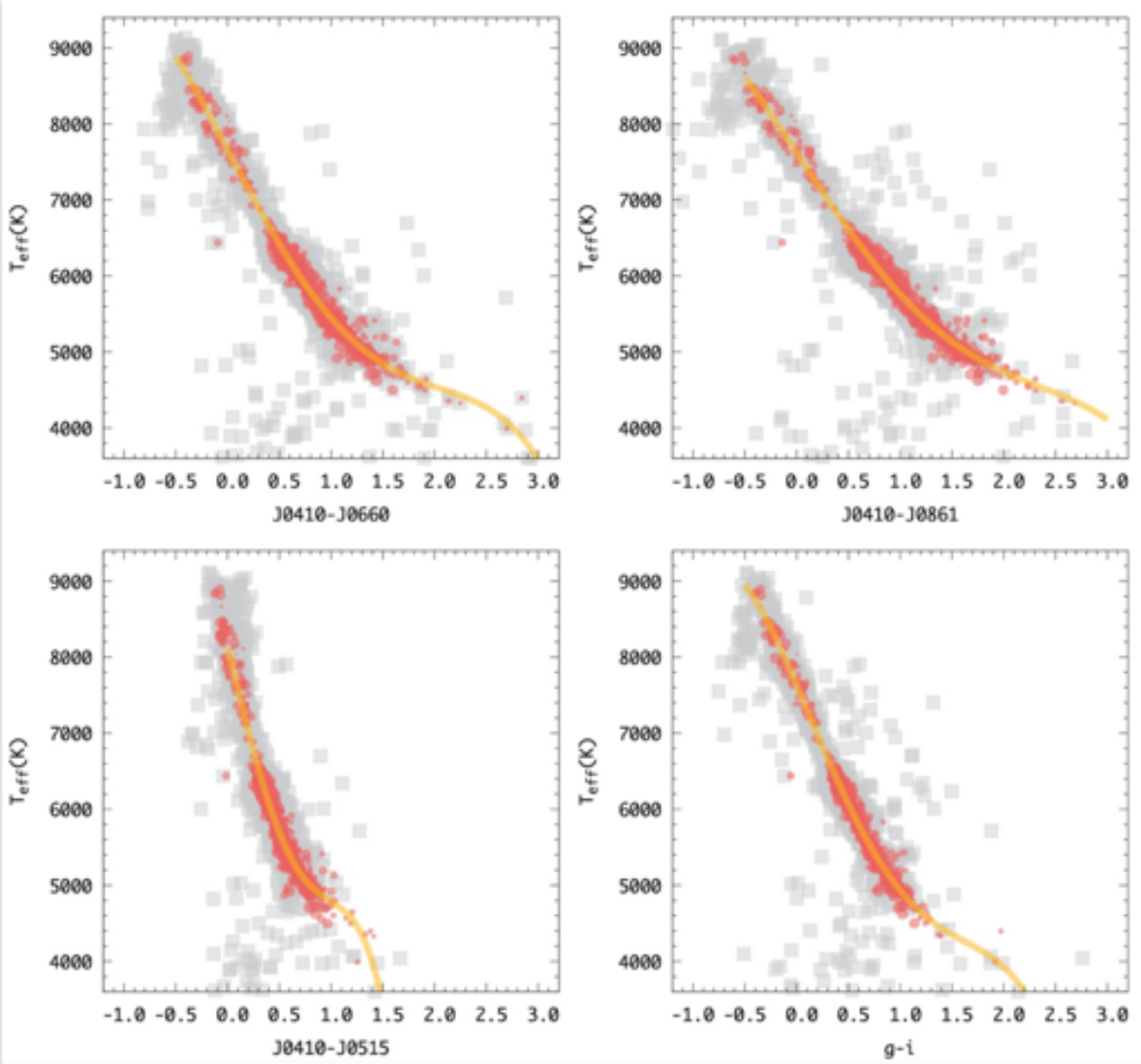


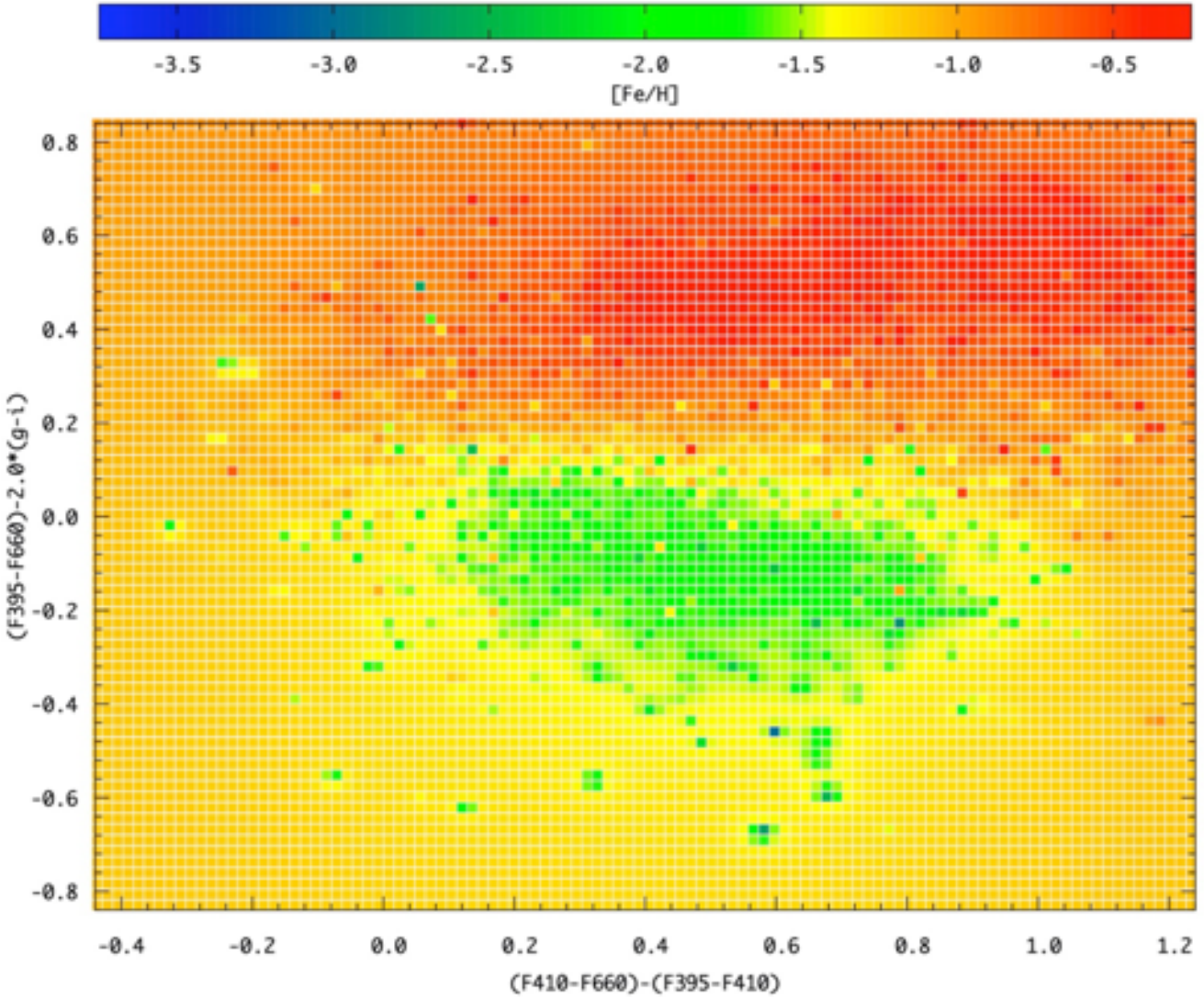




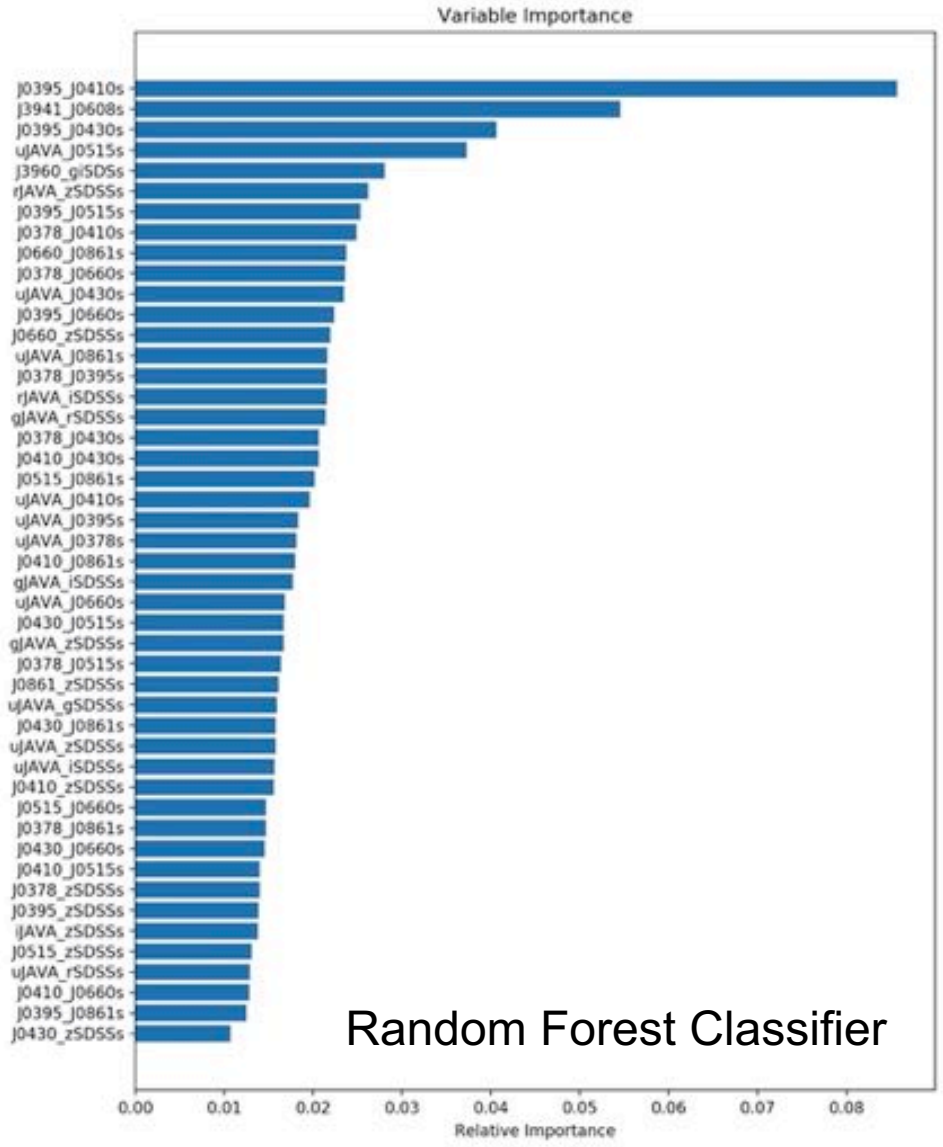


S-PLUS (color dependencies)

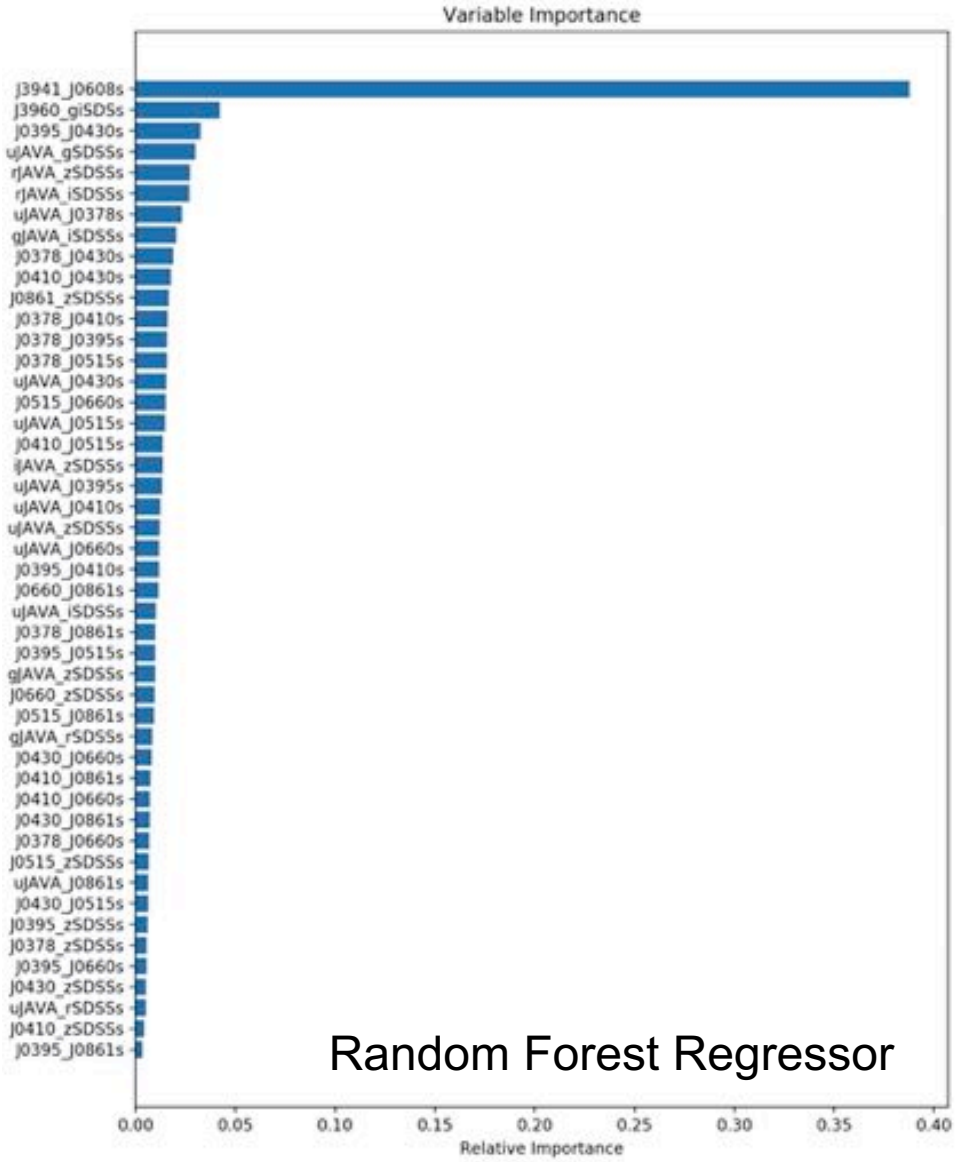




S-PLUS (random forest for [Fe/H])



Random Forest Classifier

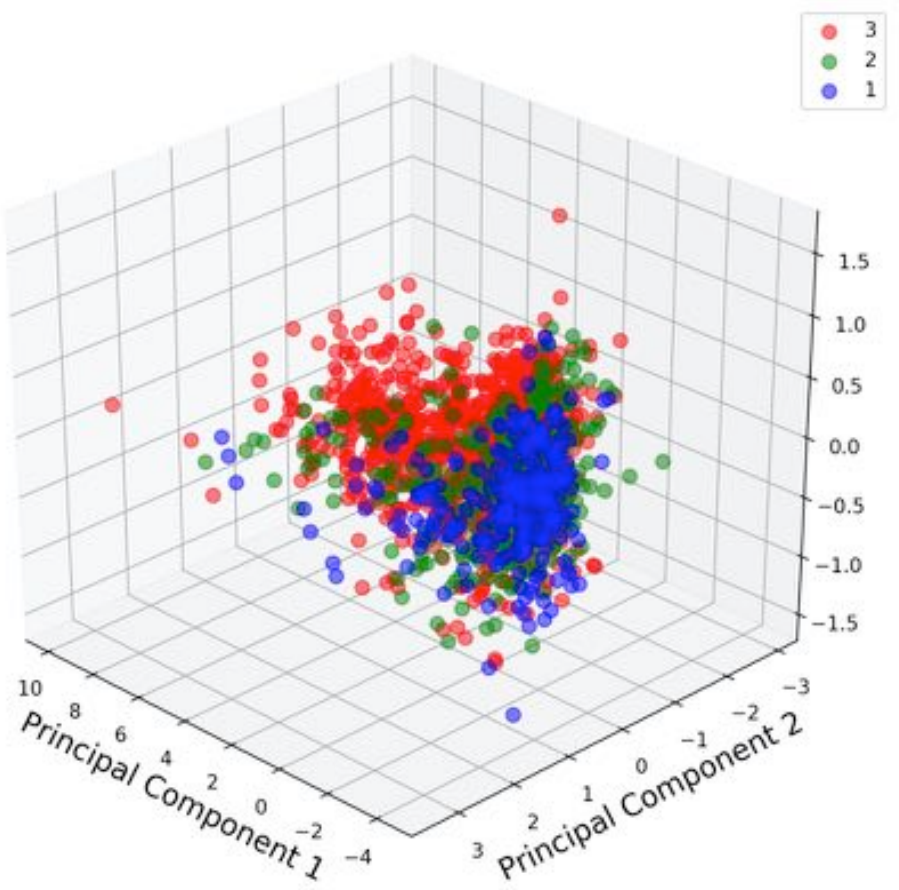


Random Forest Regressor

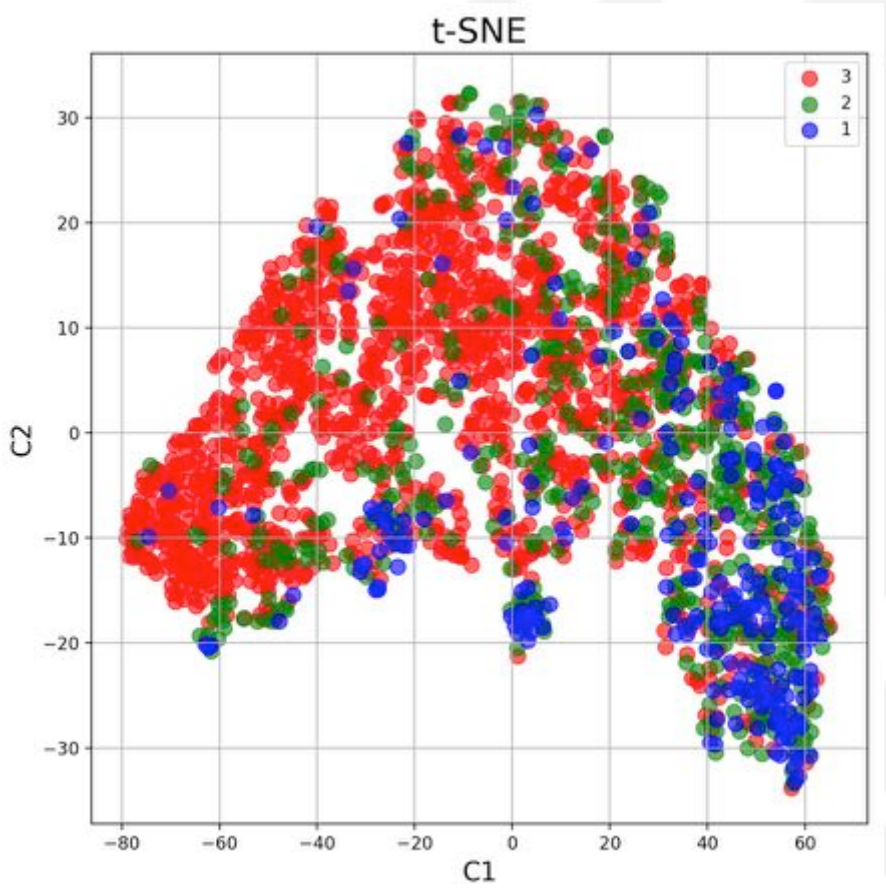
S-PLUS (ML and dimensionality reduction)

- [Fe/H]>-1.6
- -2.2<[Fe/H]<=-1.6
- [Fe/H]<=-2.2

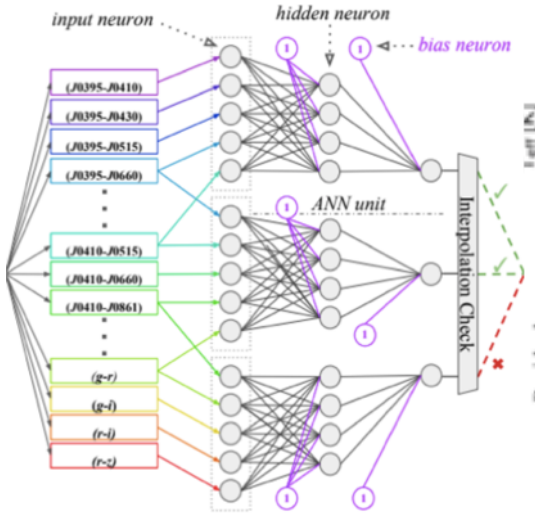
Principal Component Analysis

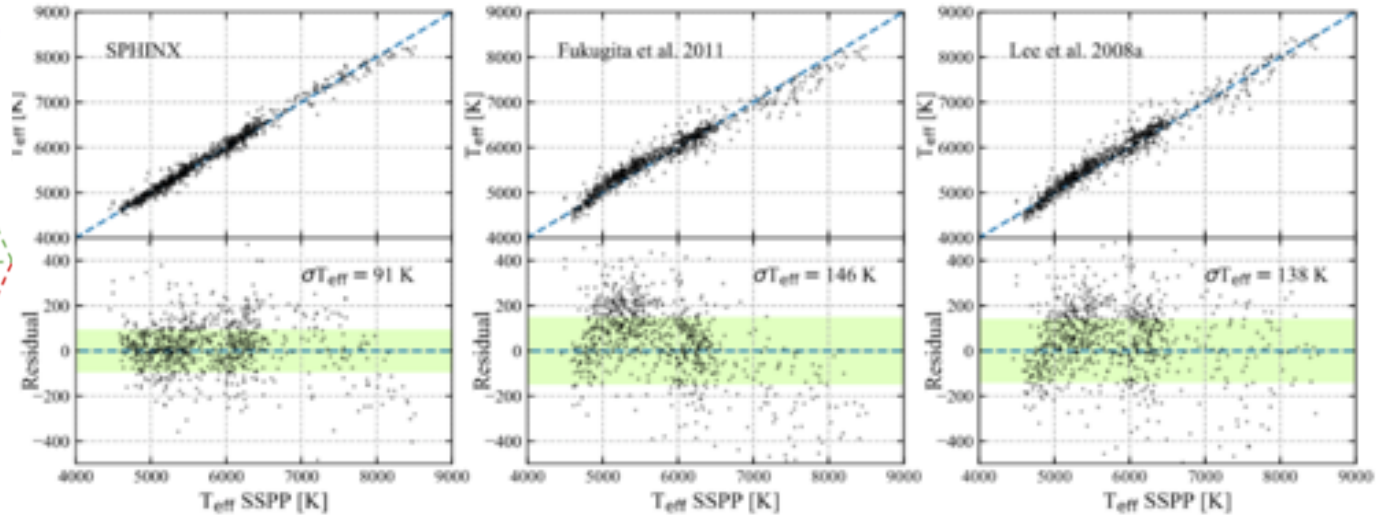


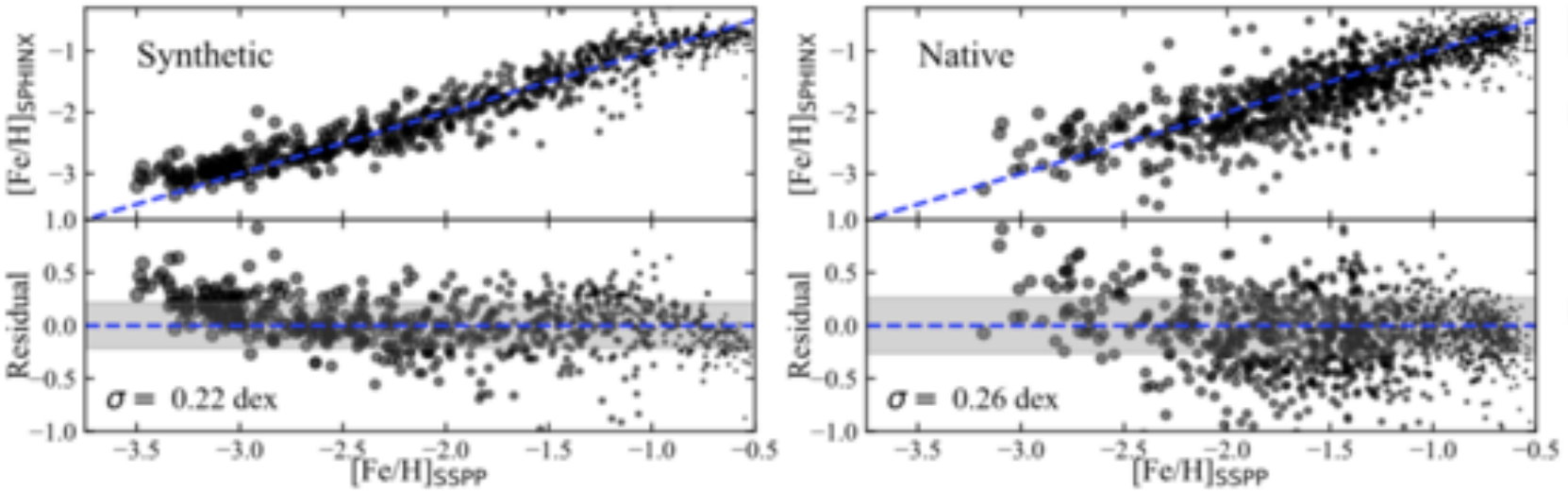
t-distributed stochastic neighbor embedding



Artificial Neural Networks – J-PLUS DR1

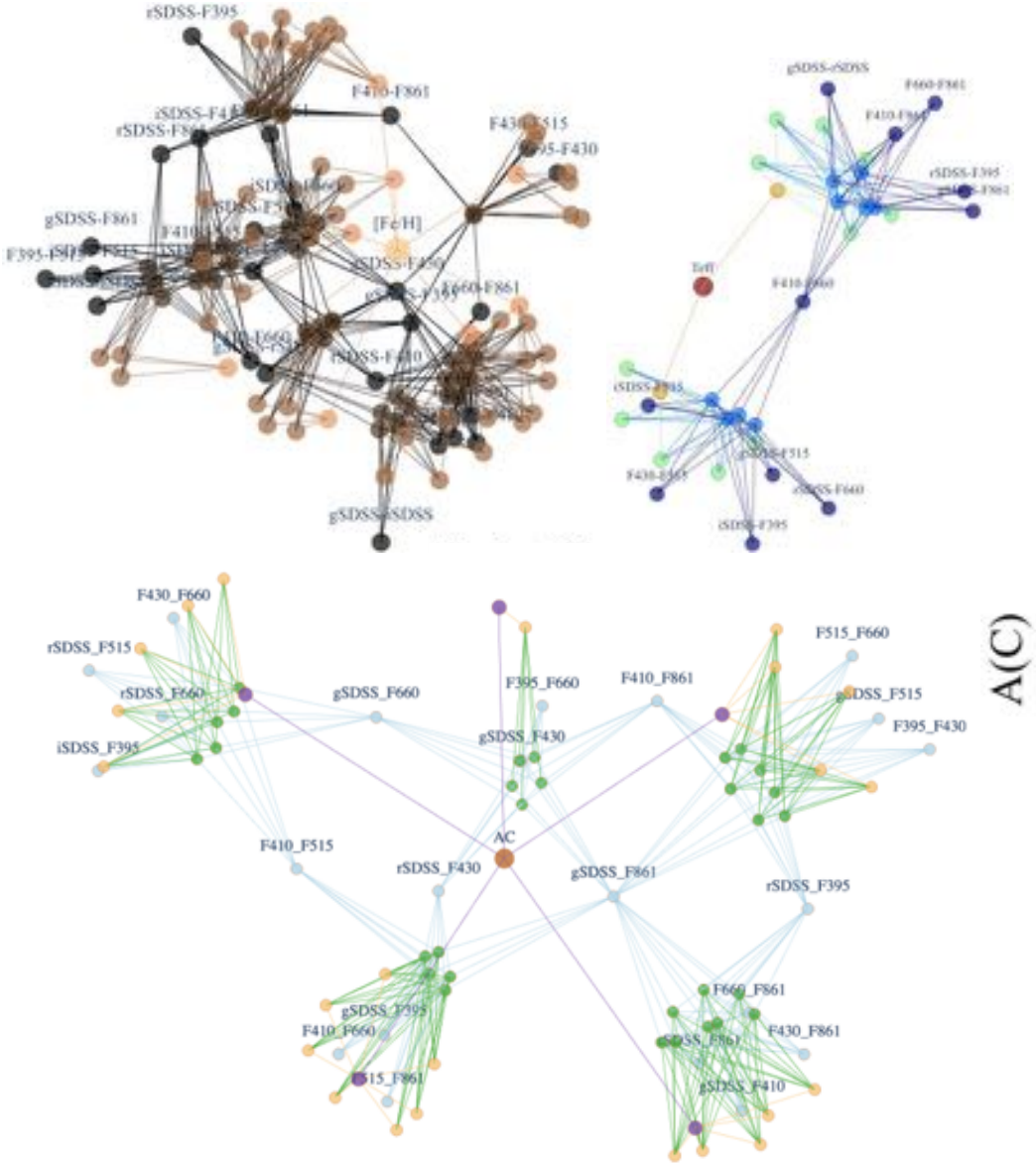




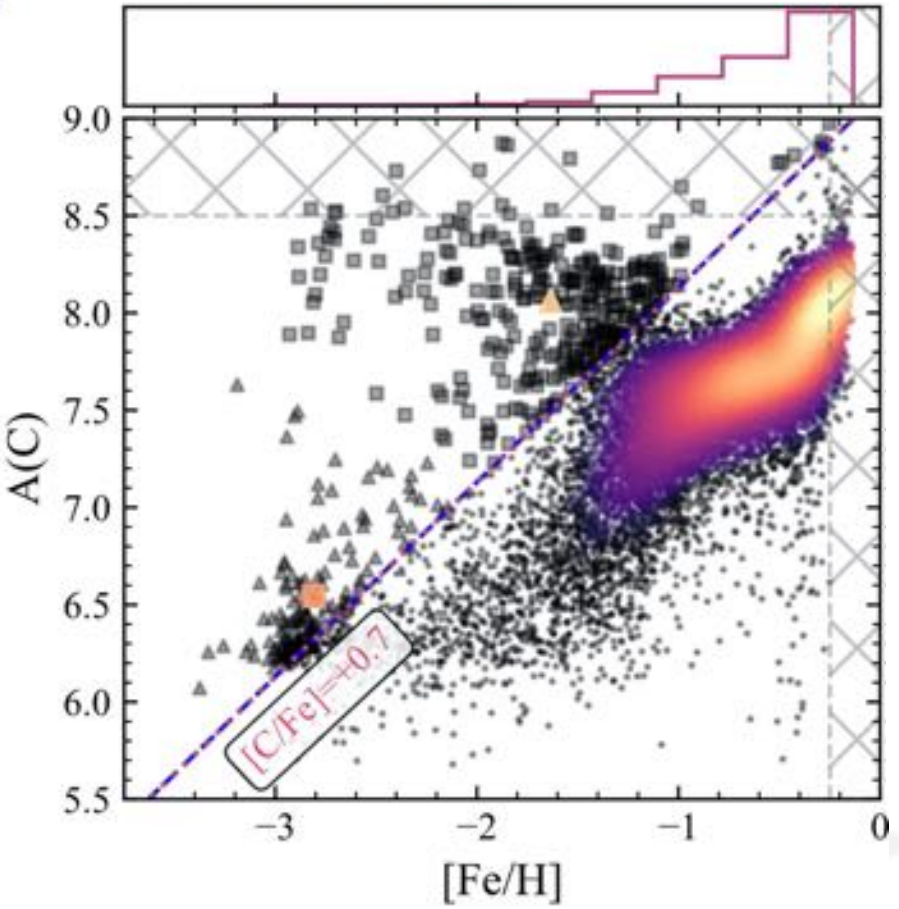


Whitten, Placco+2019

Artificial Neural Networks – S-PLUS Stripe 82



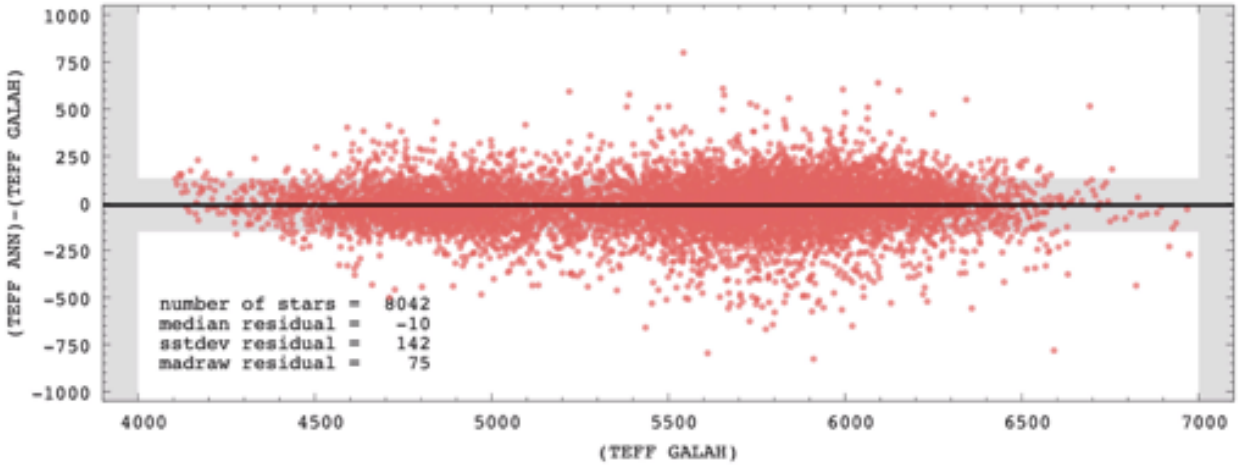
First photometric A (C) vs. [Fe/H] diagram!

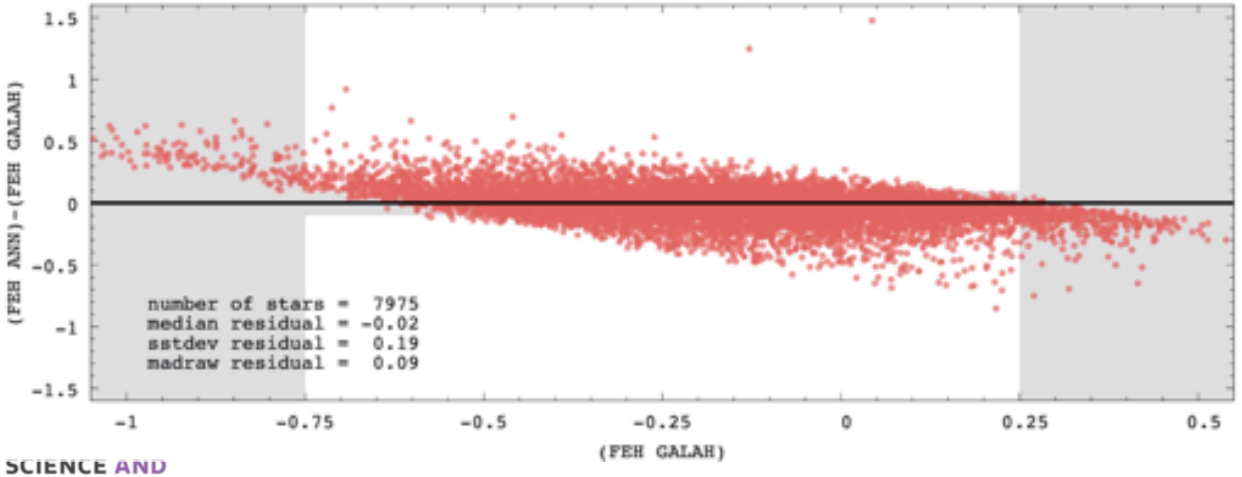


Whitten, Placco, SPLUS Collab+2021

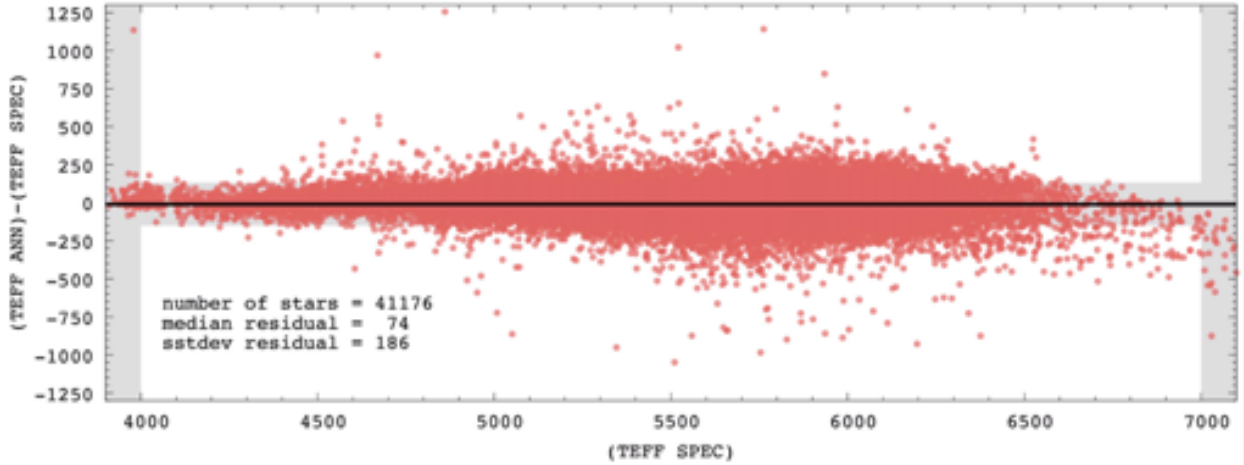
Artificial Neural Networks – S-PLUS iDR3

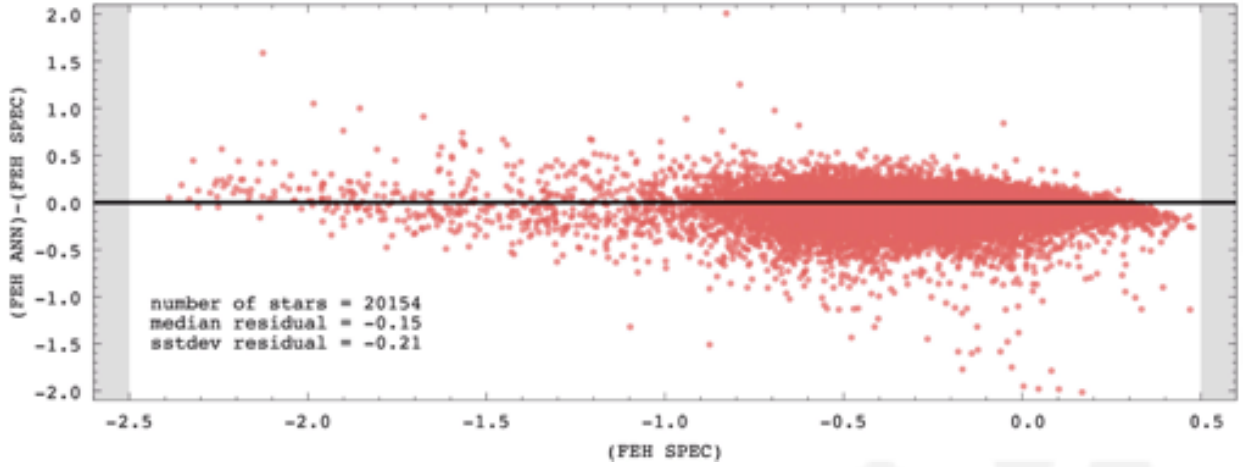
Sanity check #1 → GALAH survey





Sanity check #2 → LAMOST+SDSS





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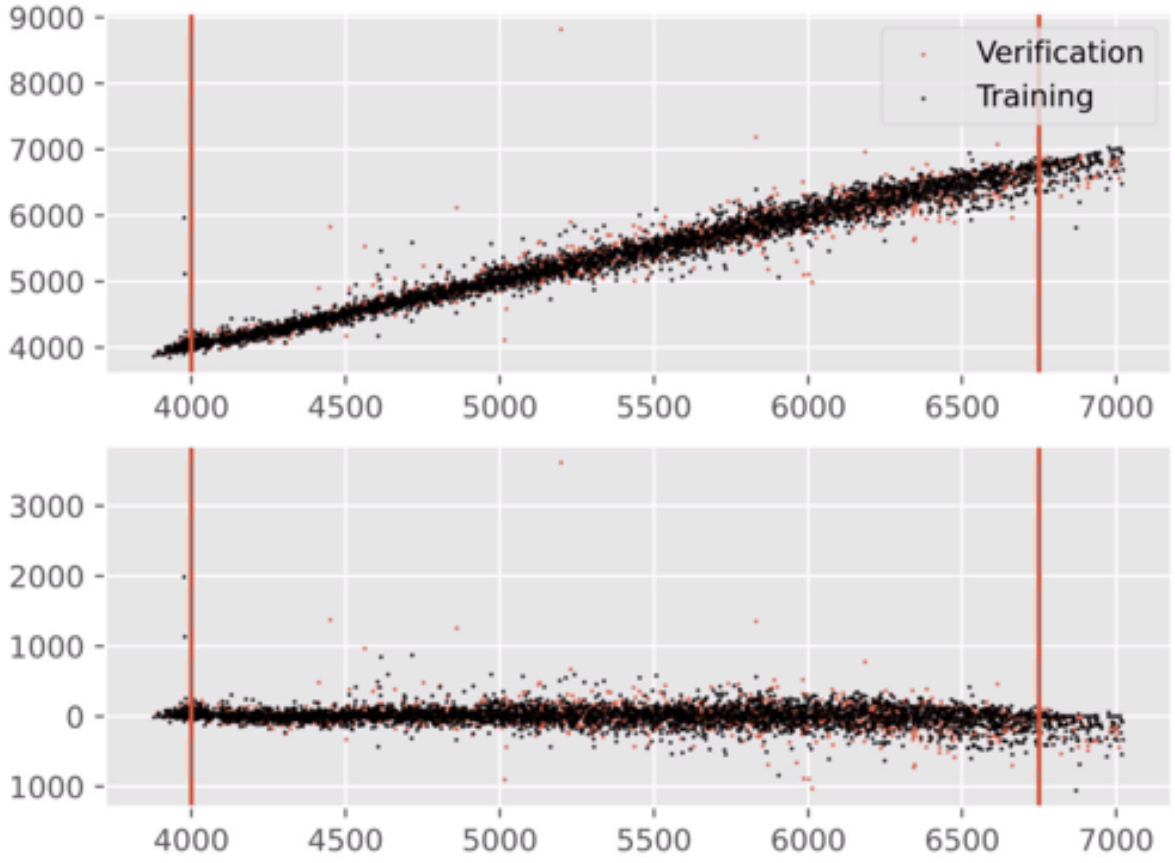
*thanks to Guilherme Limberg for doing the x-matches and providing the catalogs!

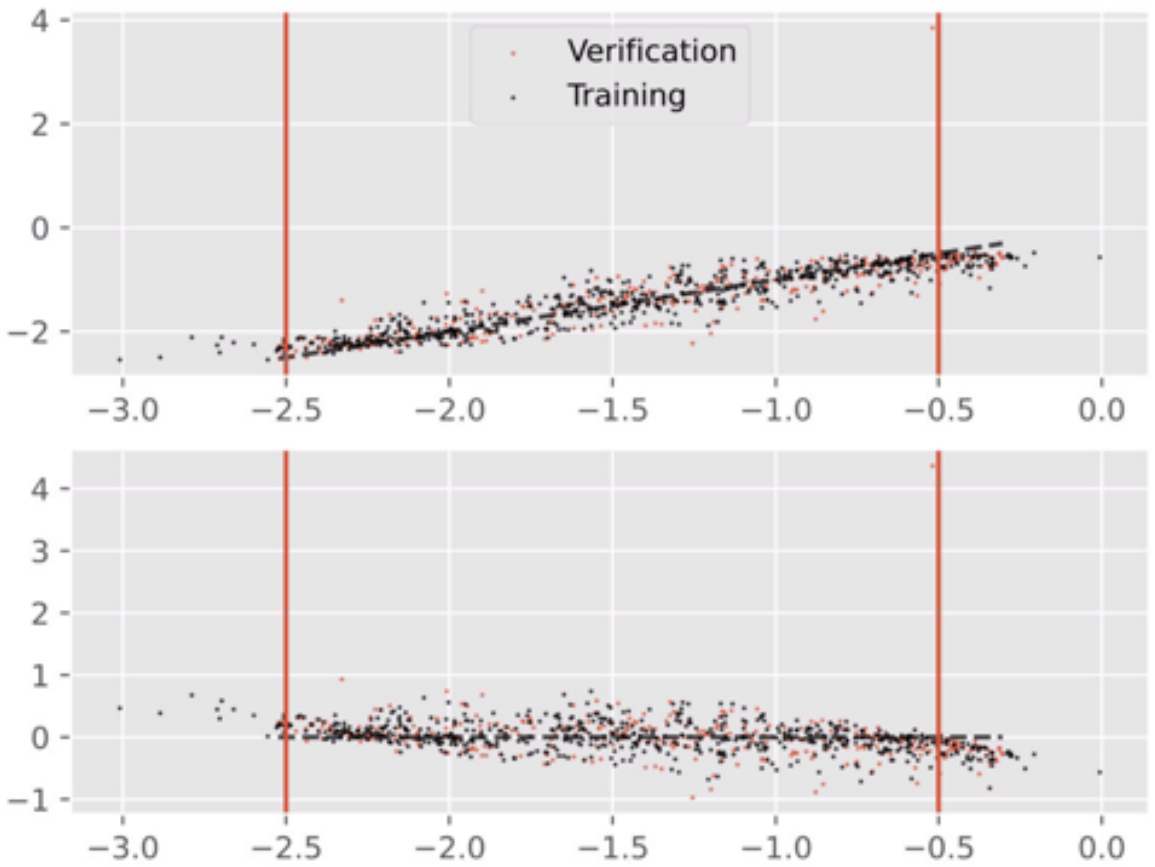
ANN applied to S-PLUS iDR3

Training on LAMOST+SDSS

Temperature

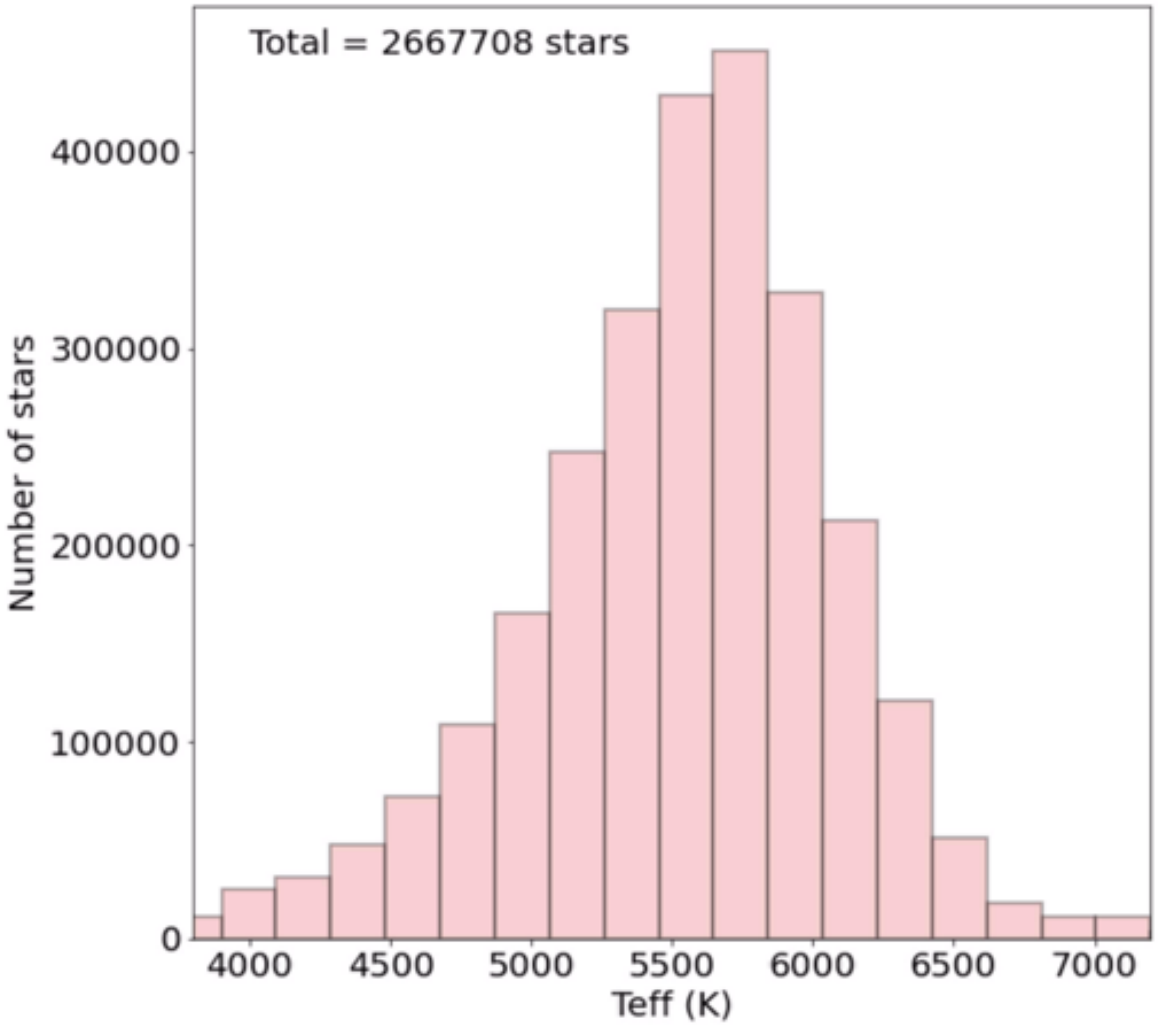


Metallicity

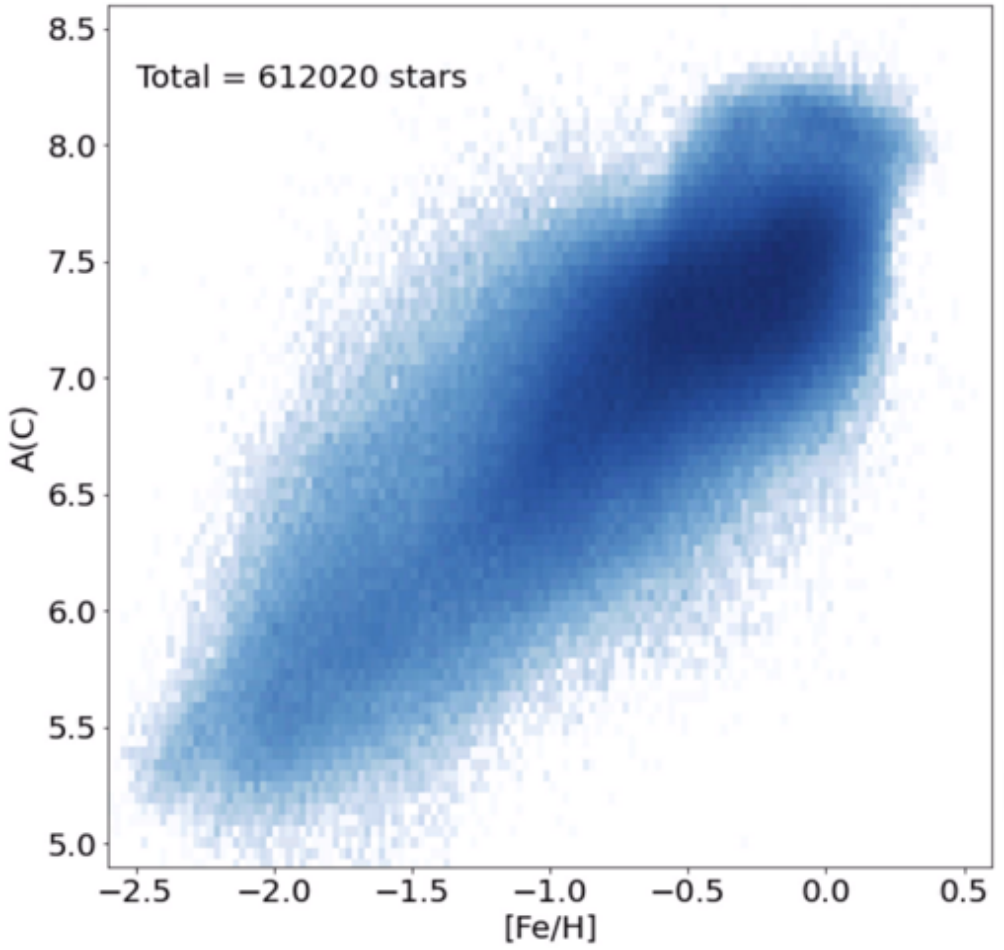


ANN applied to S-PLUS iDR3

Temperature

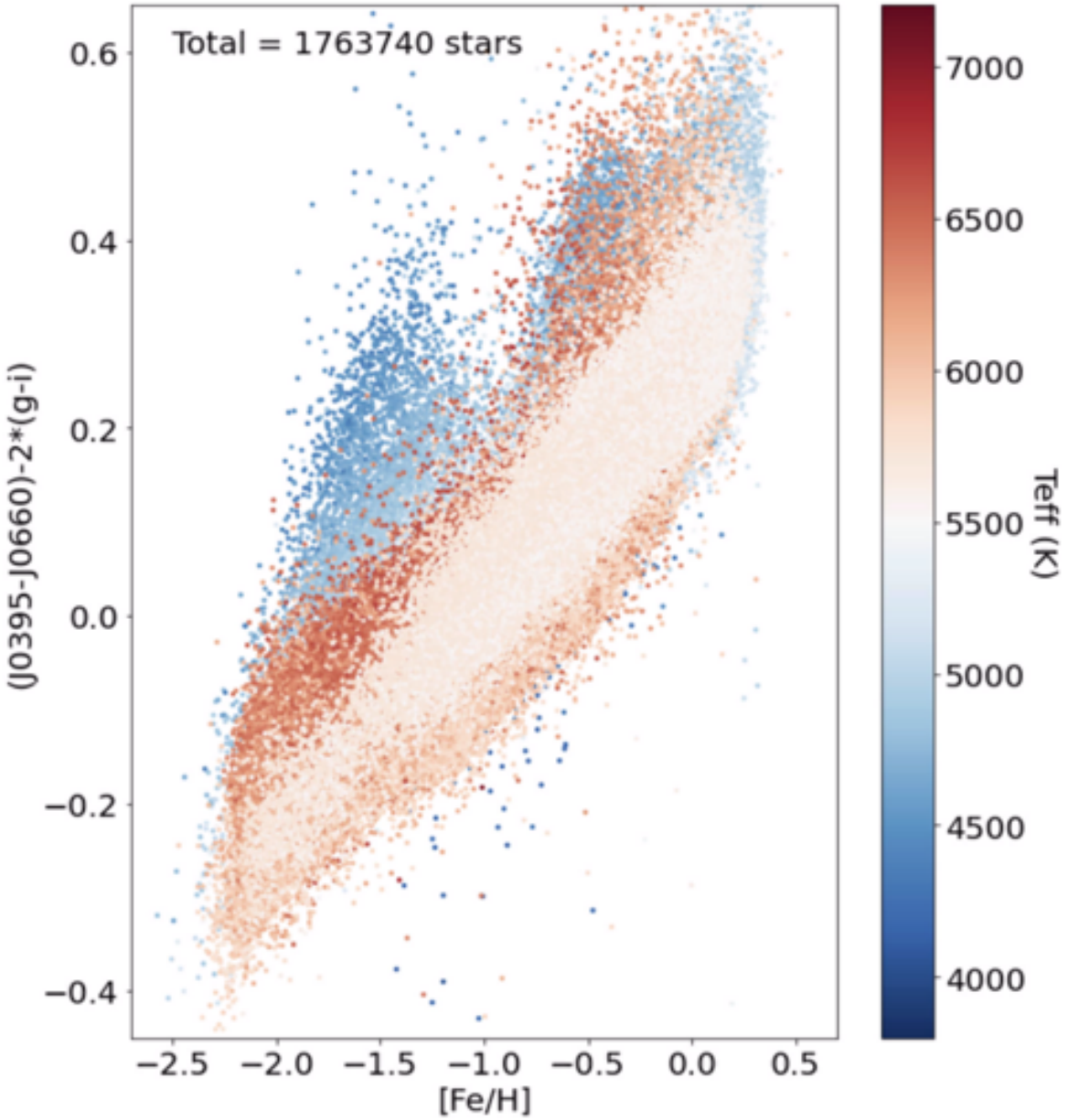


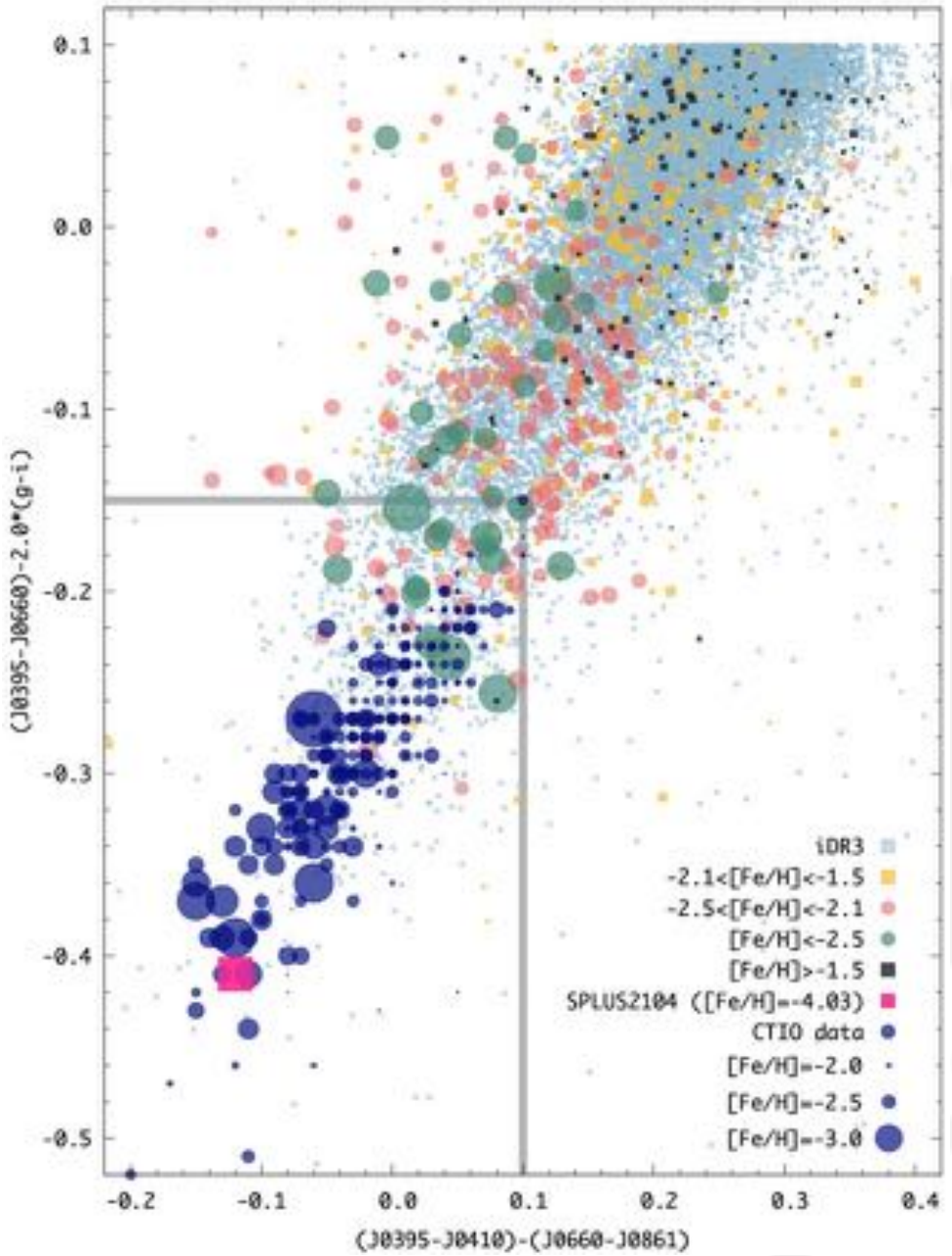
Metallicity and Carbon*



*network needs to be re-trained

ANN applied to S-PLUS iDR3





Placco+ in prep.

Conclusions and Perspectives

Main takeaways:

- There are many ways to approach a problem, and all *should* converge to a common answer
- Technical developments should *not* come on the expense of time spent doing science
  - These are the “means to an end”.
- S-PLUS reached its “tipping point”!

Low-metallicity stars:

- Addressing first-star nucleosynthesis
- Constrain the primordial IMF

Narrow-band photometry:

- Accurate Teff, logg (maybe?), and [Fe/H]
- Selected chemical abundances (C, Mg, Ca, N, Si…)

Stellar parameters and abundances:

- Statistics on metal-poor stars (10^7 stars)
- Conduct detailed chemical studies