



THE APO-K2 CATALOG

7,672 RED GIANTS WITH FUNDAMENTAL
STELLAR PARAMETERS FROM APOGEE
DR17 SPECTROSCOPY AND K2-GAP
ASTEROSEISMOLOGY



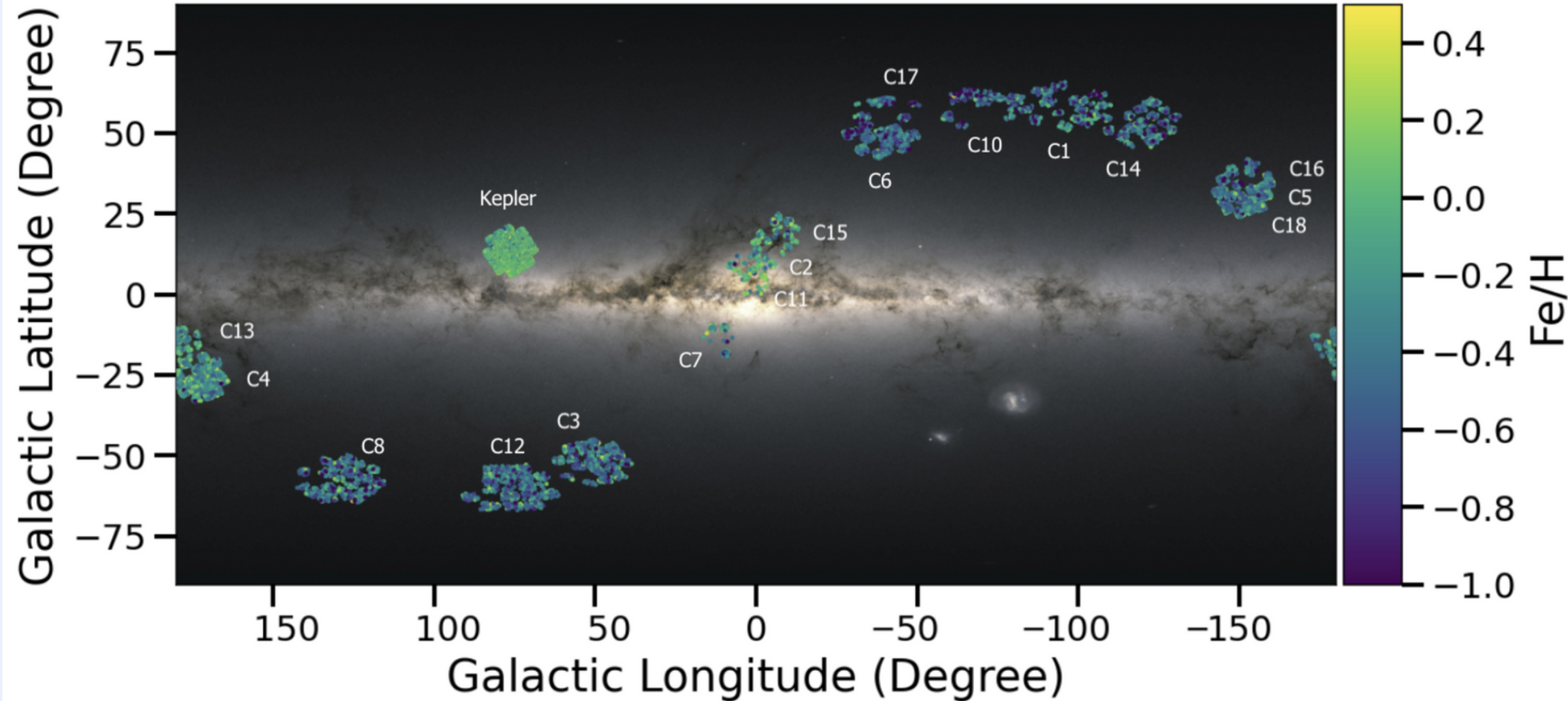
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Joel Zinn, Keivan Stassun (Thesis Advisor), Marc Pinsonneault, Jennifer Johnson, Jack Warfield, Dennis Stello, Yvonne Elsworth, Rafael Garcia, Savita Marthur, Beniot Mosser, Jamie Tayar, Guy Stringfellow, Rachael Beaton, Henrik Jonsson, & Dante Minniti.

THE APO-K2 CATALOG

Great for Galactic Archaeology

1. Precise measures from multiple methods
2. Red giants can be seen to great distances,
3. Sample covers many areas of the Galaxy (disk, bulge, **halo**).
4. And a well-understood selection function.



Schonhut-Stasik et al. (2023b) (in submission)

K2

- EPIC ID
- Campaign number
- Asteroseismic masses
- Asteroseismic radii
- Asteroseismic mass and radii coefficients
- Numax
- Dnu
- Fdnu
- **Jmag***, **Kmag*** & Vmag
- J - K

APOGEE

- APOGEE ID
- M/H
- Fe/H
- Alpha/M
- Alpha flags
- Evolutionary States
- Log(g)
- Effective Temperature

GAIA

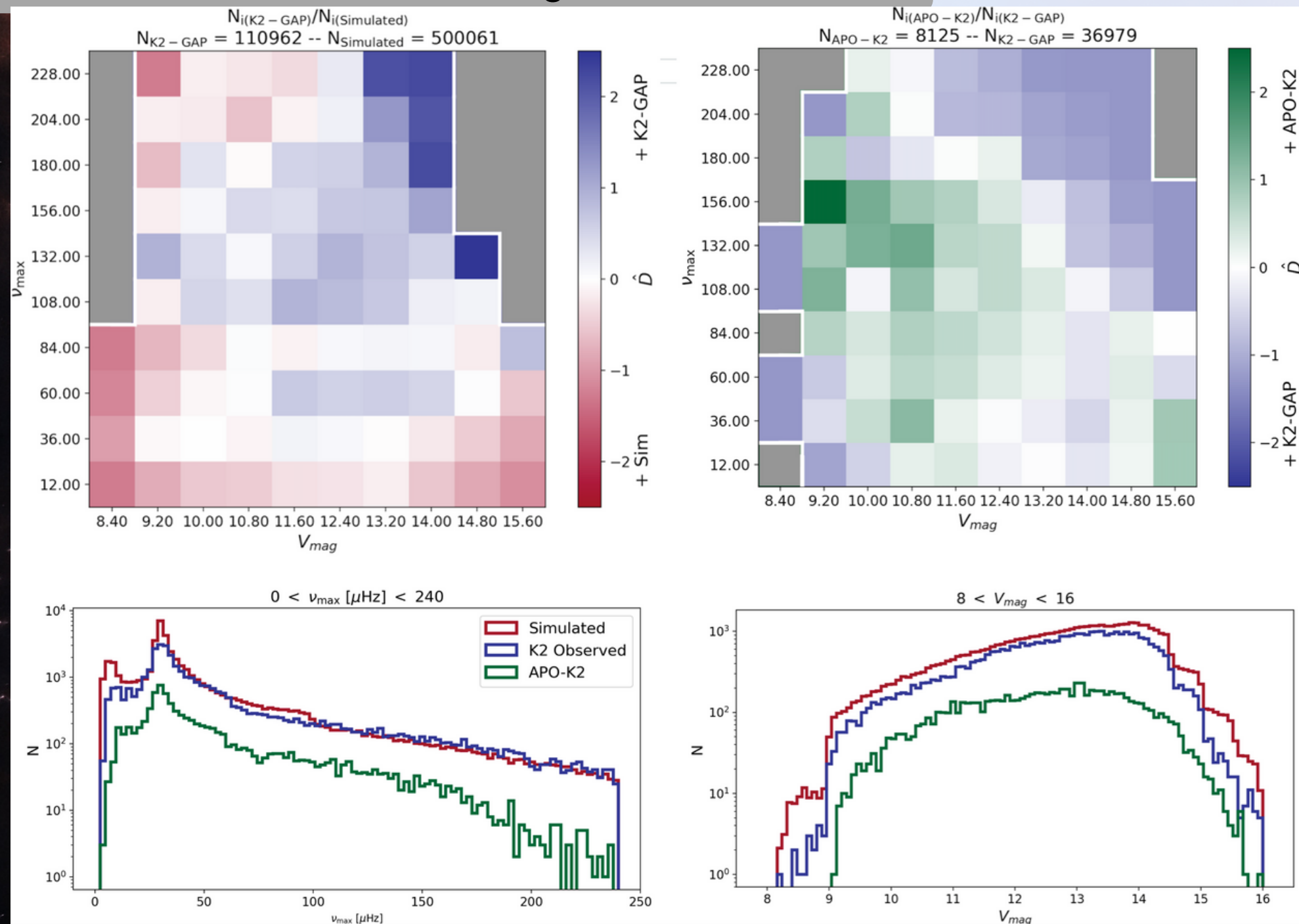
- **Gaia EDR3 source ID ***
- Galactic eccentricity
- Orbital angular momentum
- Total orbital energy
- **Binary flag ***
- **Corrected parallax ***
- Galactic Latitude + Galactic Longitude

* New after review.

A WELL-UNDERSTOOD SELECTION FUNCTION

Understanding the completeness of our sample in the context of the red giants in the Galaxy allows others to use our data to draw inferences about stellar populations.

Schonhut-Stasik et al. (2023b) (in submission)

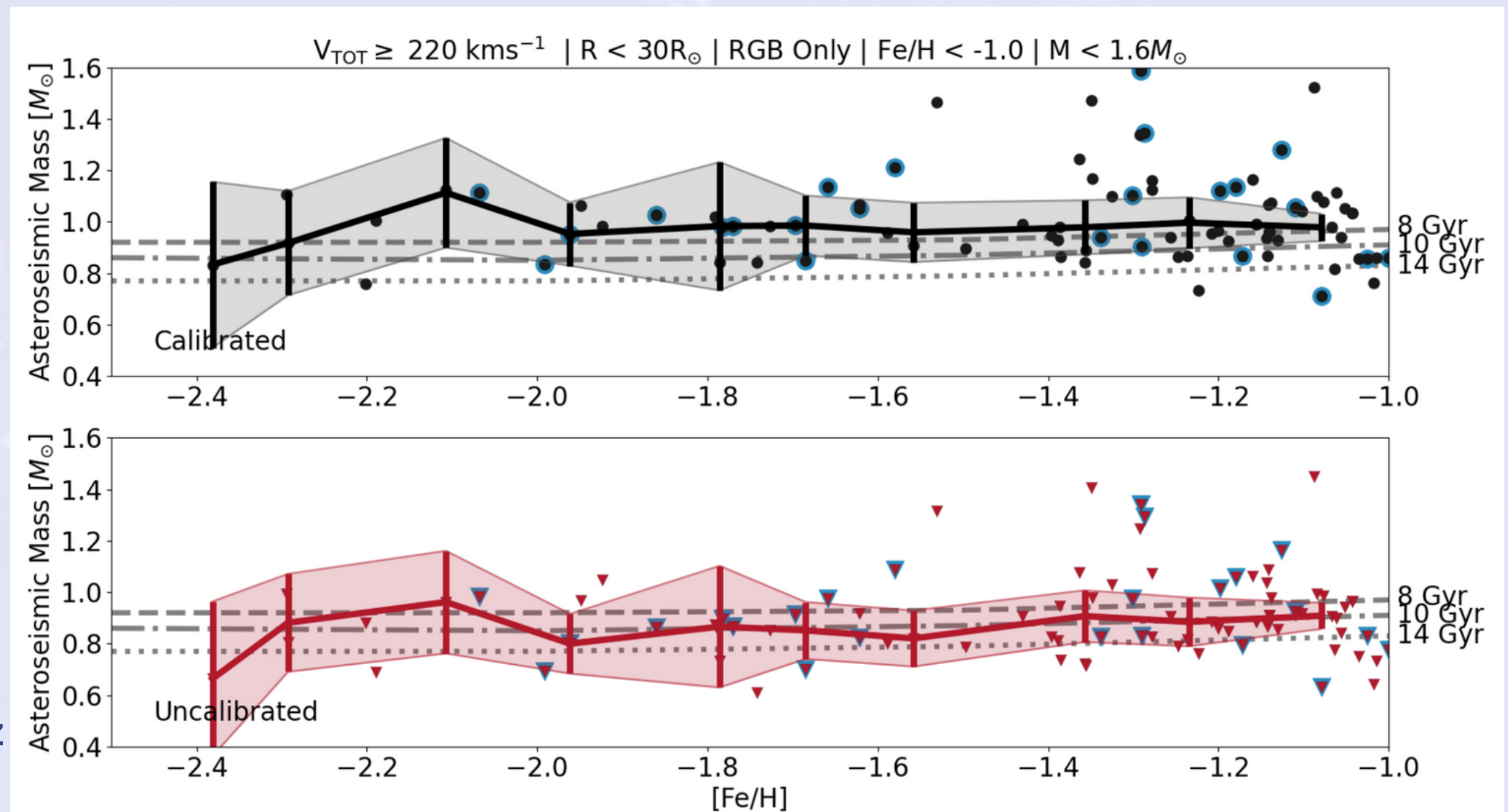


- Selection function derived in **Sharma+ (2016)**.
- The relative density of stars in each campaign (and combined) in various parameter spaces are available on the paper's GitHub.
- Parameter spaces:
 - v_{\max} vs. V-band magnitude
 - V-band magnitude vs. J-K color
 - $[M/H]$ vs. asteroseismic mass
 - Asteroseismic radius vs. asteroseismic mass

METAL-POOR ASTEROSEISMOLOGY

An example of the power of multiple methods and independent measurements for Galactic Archaeology.

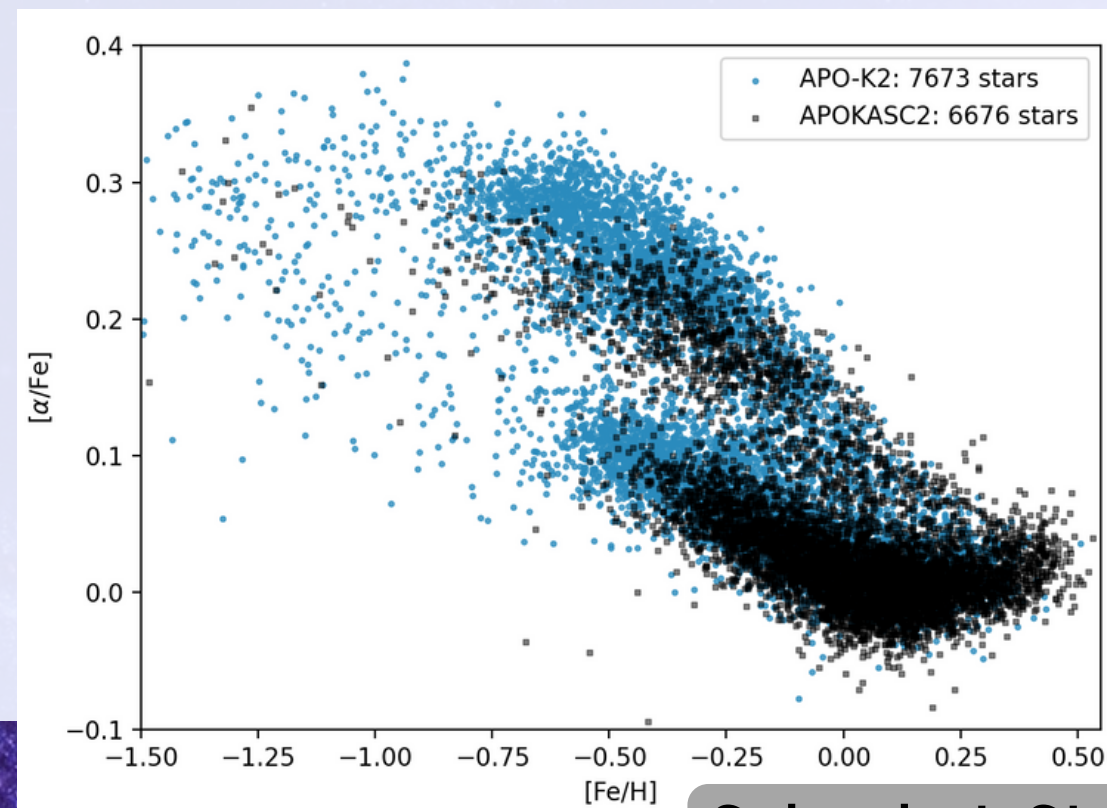
- **Epstein+ (2014)** found overestimated asteroseismic masses in low-metallicity halo stars.
- Some later papers do not find this same overmassive problem: (**Miglio+ 2016**, **Sharma+ 2016**, **Valentini+ 2019**, **Matsuno+ 2021**, **Tailo+ 2022**, **Howell+ 2022**).
- We found overestimated masses, but only when using the APOGEE calibrated temperature scale (**González Hernández & Bonifacio 2009**).



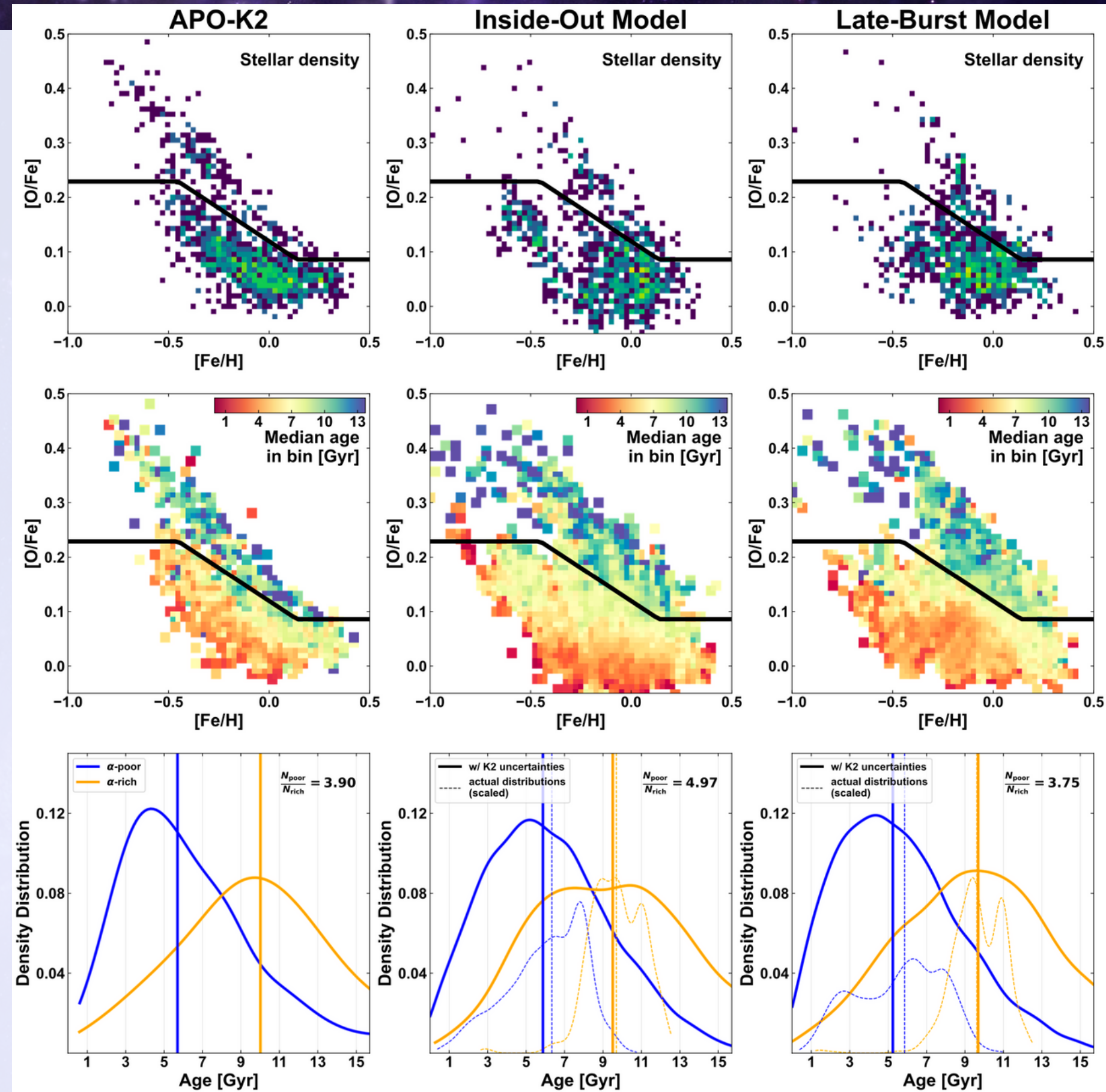
WHAT ABOUT AGES?

Ages will be added to the catalog in an upcoming paper (Warfield et al.), and used to test models of the α -bimodality.

- The quantity of stars has increased since the APOKASC catalogs (Pinsonneault+ 2014, 2018), opening up new areas of exploration.
- Precise ages from asteroseismology can be used to test models of Milky Way formation (Johnson+ 2021).
- Many more thick disk stars to work with!



Schonhut-Stasik et al. (2023b) (in submission)



Warfield et al. (in prep.)

STELLAR COMPANIONS WORK

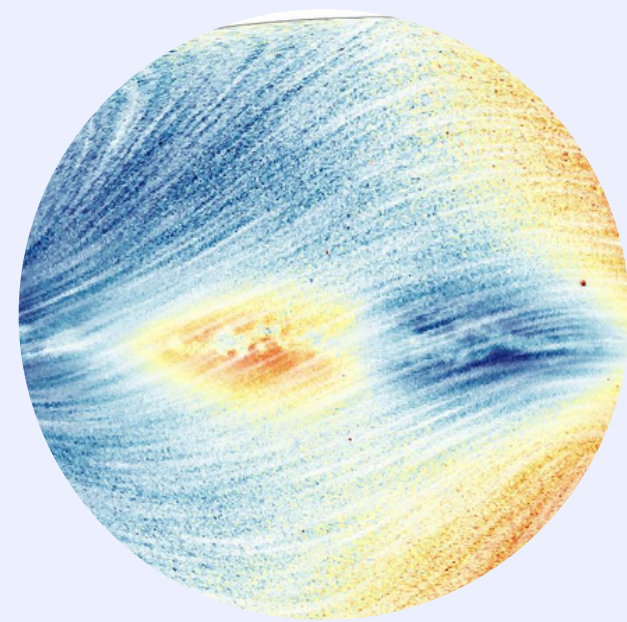
The APO-K2 catalog allows us to draw conclusions about the distribution of binary stars and multiple systems for red giants in the Milky Way.



GAIA

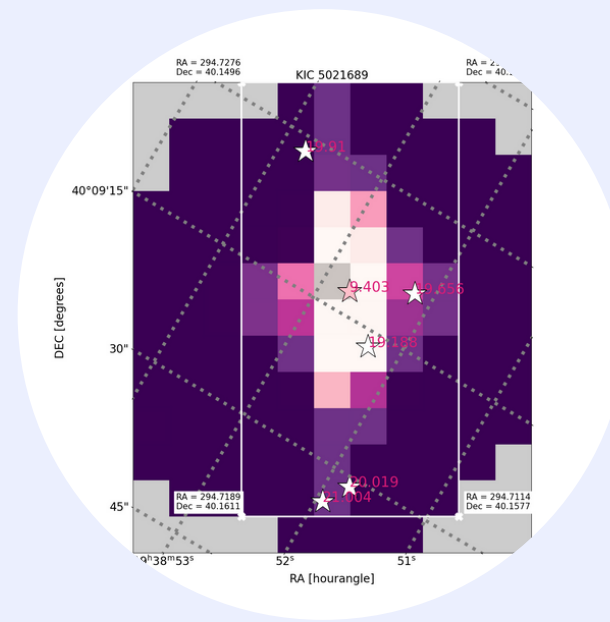
ASTROMETRICS

Using Gaia astrometric errors, radial searches and available tables we can find both visual pairs and the likelihood of close bound stars.



RVS

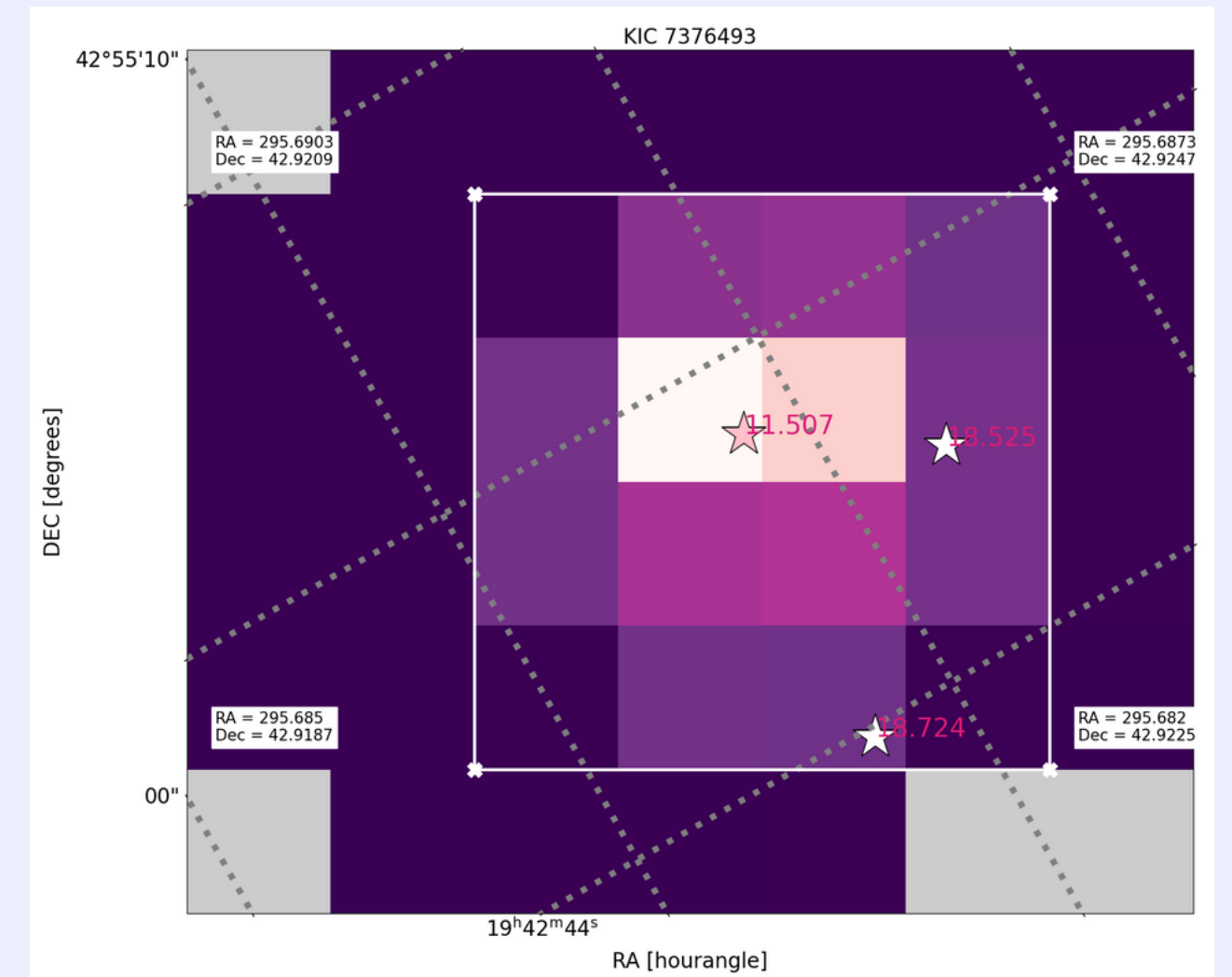
Using radial velocities from both Gaia and APOGEE we can identify and confirm stars with close bound companions.



K2 TPFS

Using FluxCT we will search for companions that fall within the light curve aperture, which may not be picked up by other methods.

(Schonhut-Stasik & Stassun 2023a).





CONTACT INFO

Upcoming APO-K2 Work:

- APO-K2 with ages! **Warfield et al. (in prep)**
- APO-K2 stellar companions. **Schonhut-Stasik et al. (in prep)**
- Futher work into abundances and possible interacting binaries.

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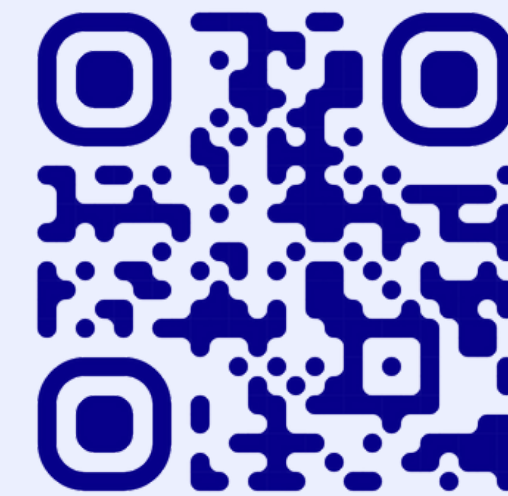
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FluxCT



APO-K2 Catalog
& Paper



AstronomerAND
Podcast

HAWAI'I

This presentation was created on the Big Island of Hawai'i. I am an immigrant on this 'āina and now call Volcano Village my home and I am of European descent. I would like to begin by acknowledging that the 'āina on which this presentation was written, is part of the larger territory recognized by Indigenous Hawaiians as their ancestral grandmother, Papahānaumoku. I recognize that each moment I am in Hawai'i she nourishes and gifts me with the opportunity to breathe her air, eat from her soils, drink from her waters, bathe in her sun, swim in her oceans, be kissed by her rains, and be embraced by her winds. I further recognize that generations of Indigenous Hawaiians and their knowledge systems shaped Hawai'i in sustainable ways that allow me to enjoy these gifts today.

LAND ACKNOWLEDGEMENTS

NASHVILLE, TN

I acknowledge that the location of this presentation occupies the ancestral hunting and traditional Lands of the Cherokee, Shawnee, Choctaw, Chickasaw, and Creek peoples. Today, these people have nation boundaries in Oklahoma, North Carolina, and Mississippi, after the Indian Removal Act of 1830 led to the forced removal of southern tribes west of the Mississippi River. I recognize, support, and advocate for the Indigenous individuals and communities who live here now, and for those forcibly removed from their Homelands.

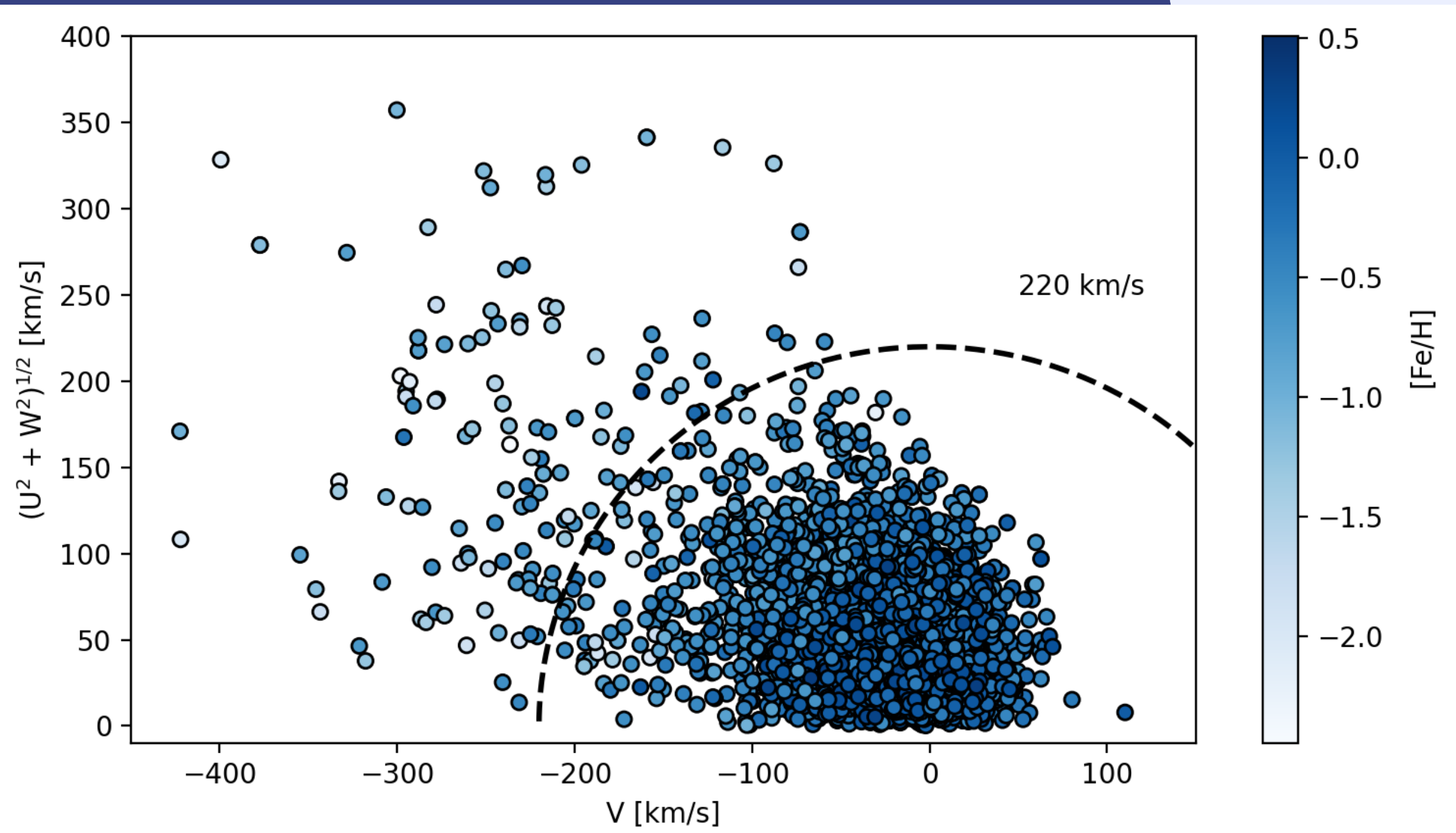


MAHALO NUI LOA

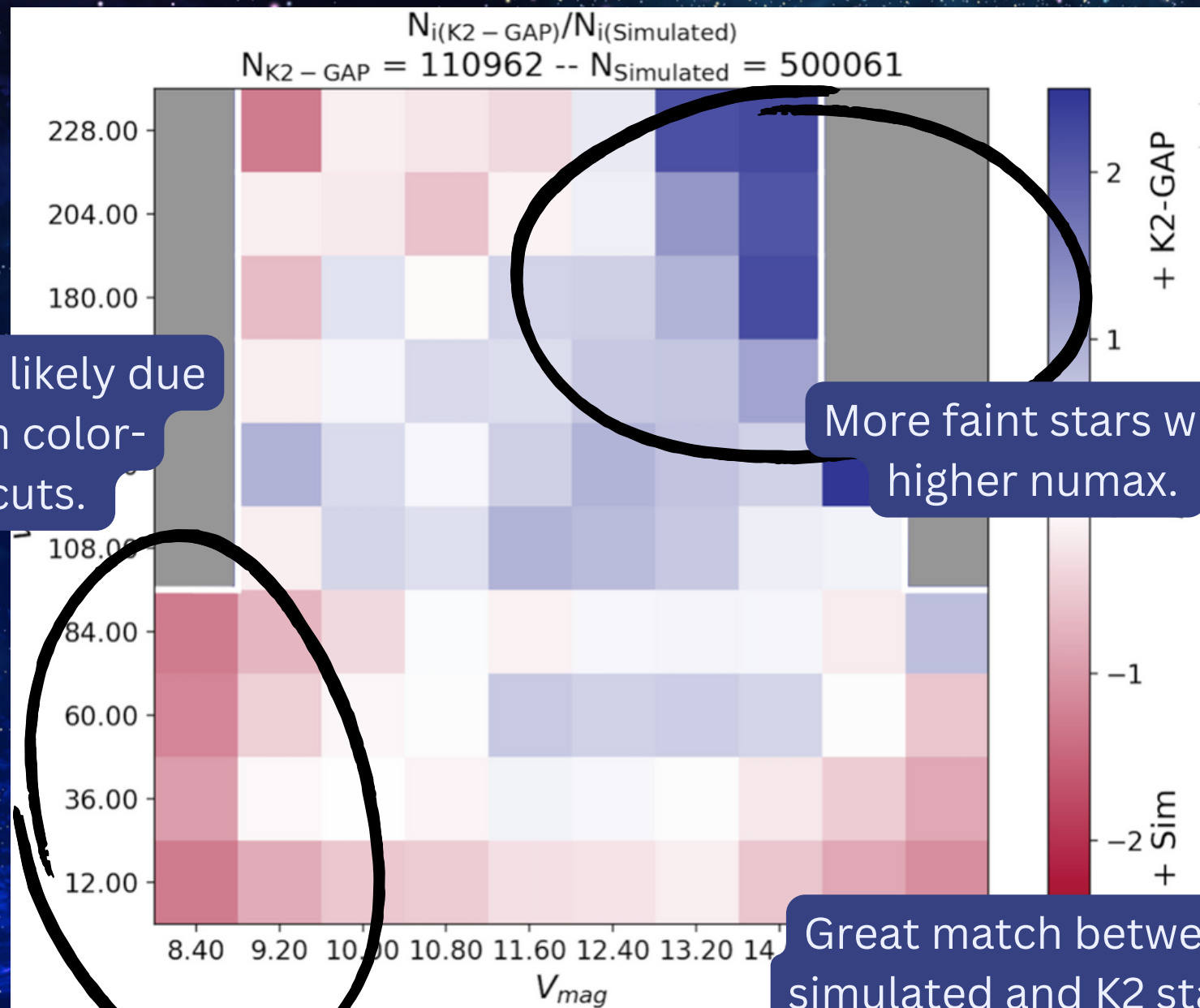


QUESTIONS?

IDENTIFYING HALO STARS

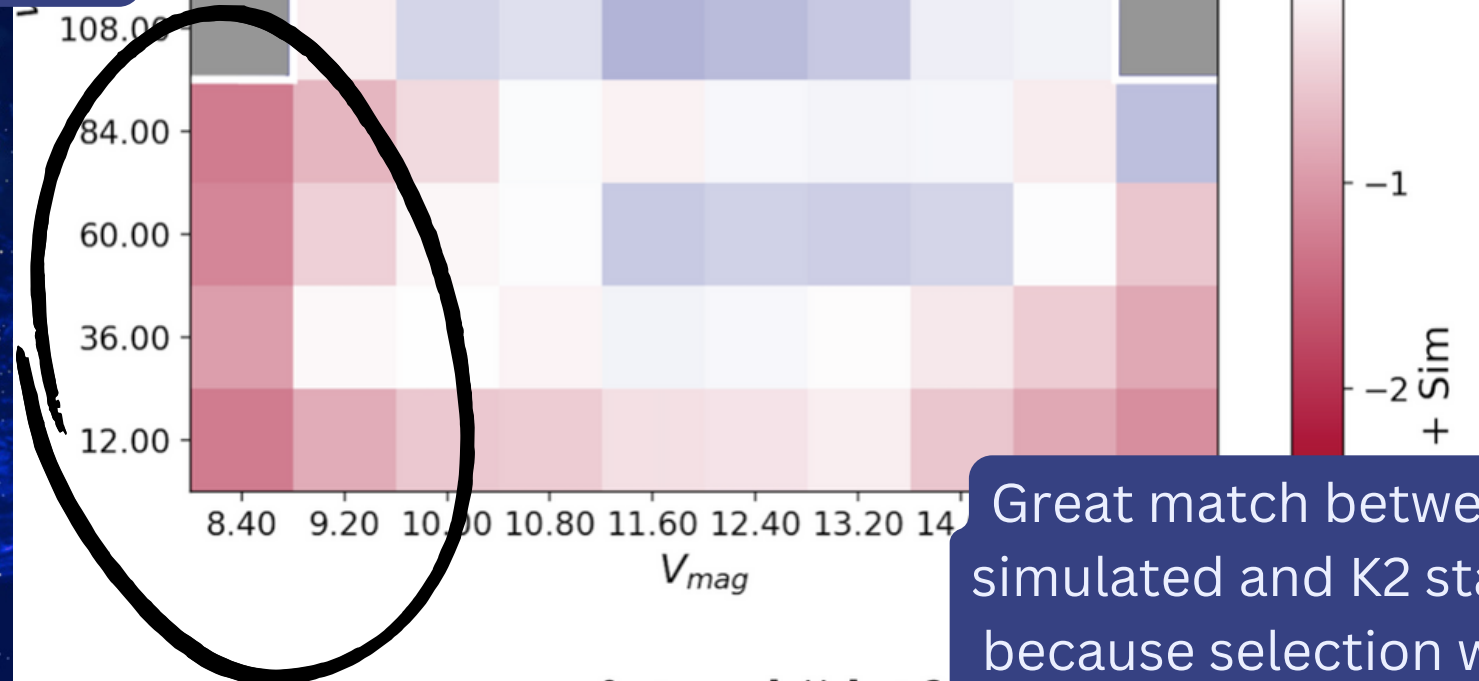


- Halo stars in APO-K2 are defined as those with a stellar velocity > 220 km/s when compared to the local standard of rest.
- These are computed using a combination of Gaia DR3 measurements, and the Python modules Gala and pyia.

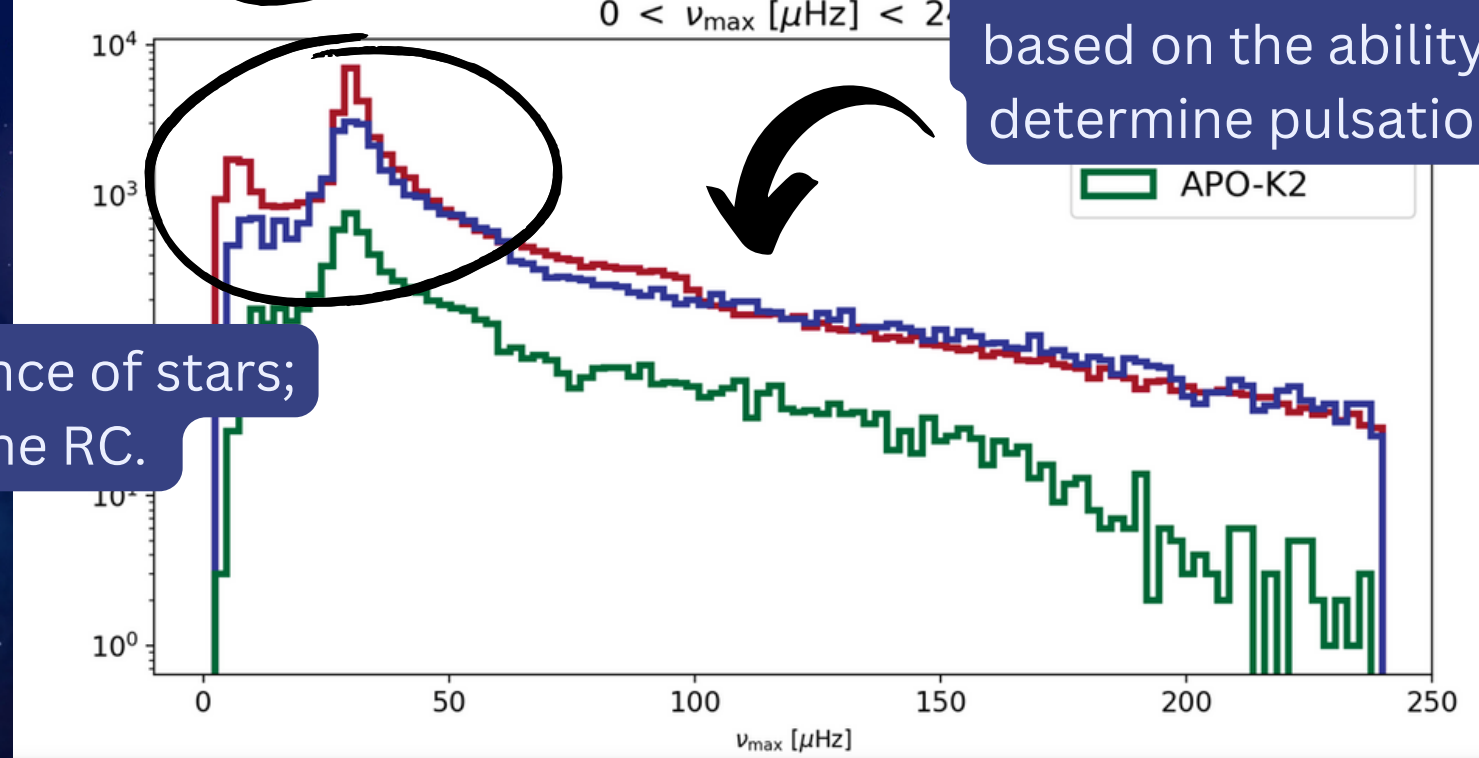


Fewer bright star likely due to targeting on color-magnitude cuts.

More faint stars with higher numax.

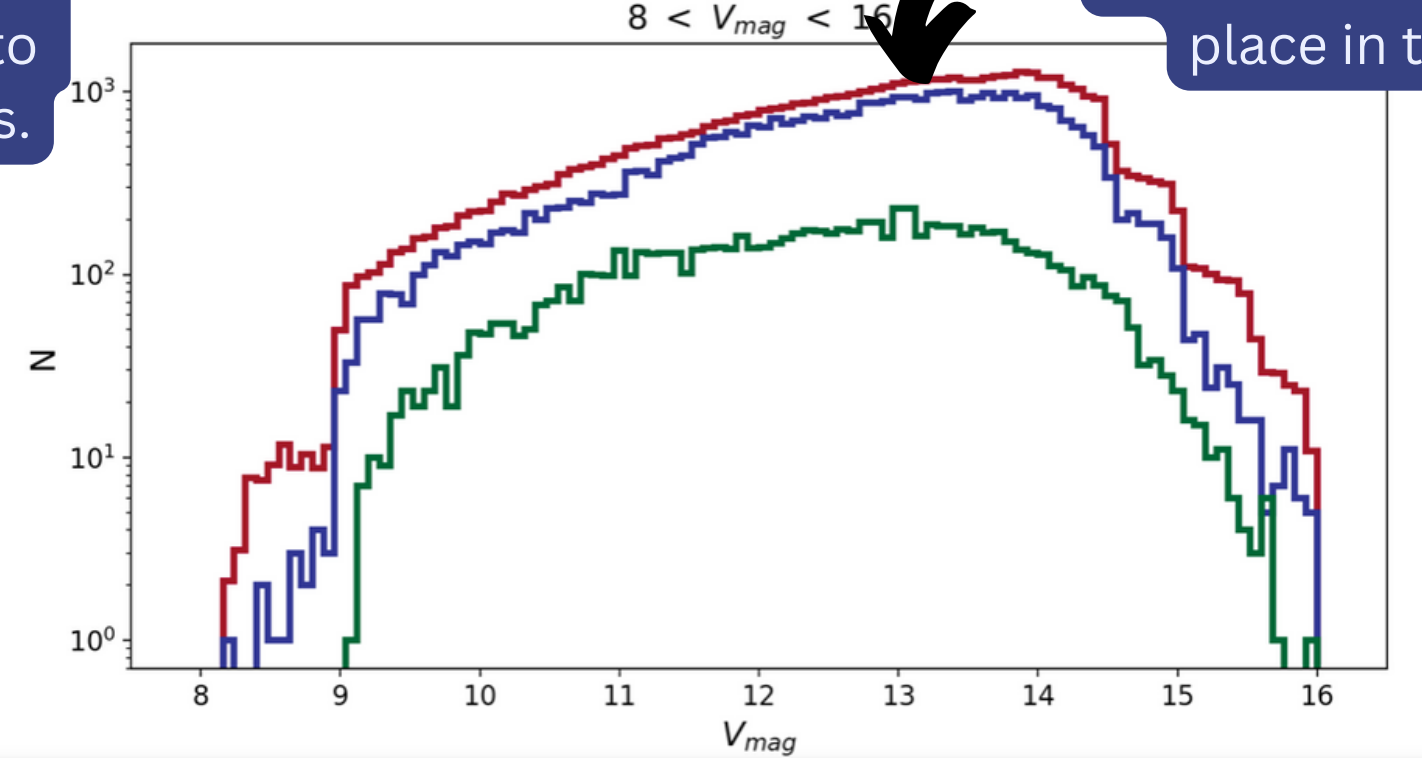


Fewer of the seismically low SNR stars.



Overabundance of stars; this is the RC.

Great match between simulated and K2 stars, because selection was based on the ability to determine pulsations.



Close match between simulated and K2 because the selection function took place in the V band.