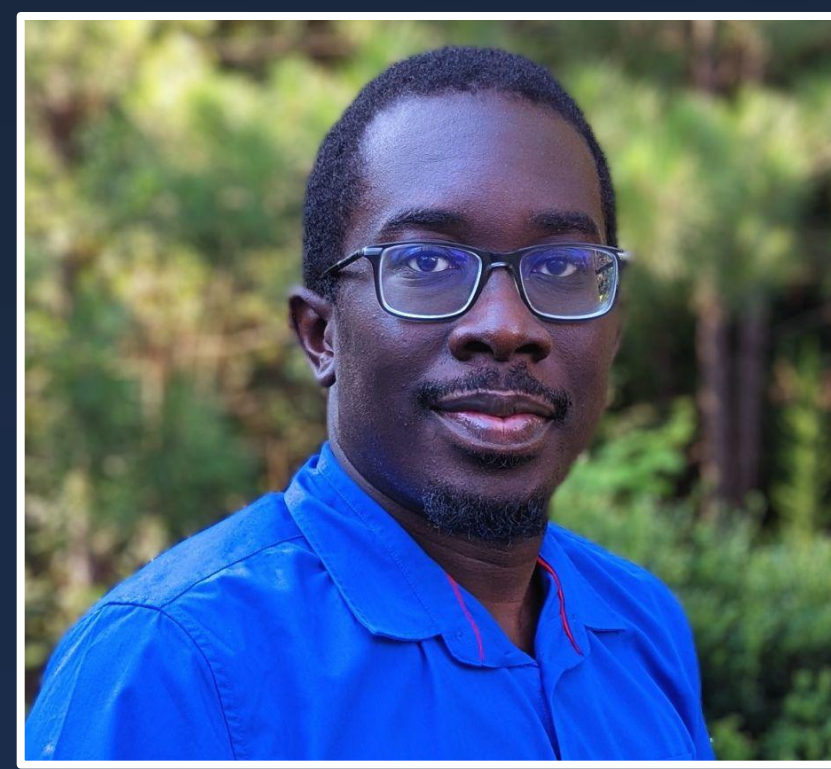




# Spectroscopic Identification of Young and Active K Dwarfs Within 25 Parsecs

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## Quick Hits

- 286 K dwarfs within 25 parsecs
- High resolution spectra from the CHIRON spectrograph
- Youth and Activity analysis using four spectral lines.
- 7% of K dwarfs young or active.
- Stellar Properties using Empirical SpecMatch
- 3% of K dwarfs metal poor  $[Fe/H] < -0.5$  dex
- Using our results current and future searches for life can exclude nearby K dwarfs that are young or active, and select others based on favorable stellar properties.
- Our sample identifies the best K dwarfs for future exoplanet habitability surveys.

## Abstract

We present the results of an ongoing spectroscopic study of the ages, activity levels, and stellar parameters of over 1,200 K dwarf stars within 40 parsecs and between declinations +30 degrees and -30 degrees. 286 K dwarfs within 25 parsecs have been observed with CHIRON and analyzed using a benchmark calibration set results. Surprisingly, as many as ~7% of these K dwarfs have spectroscopic features indicating that they are young and/or active.

In addition to the age/activity investigation, Empirical SpecMatch has been used to measure various stellar characteristics for all 286 K dwarfs: temperatures range from 3900–5300 K, metallicities range from  $-0.6 < [Fe/H] < +0.2$ , and rotational velocities ( $v \sin i$ ) range from less than 10 km/s to more than 50 km/s.

## Why K Dwarfs

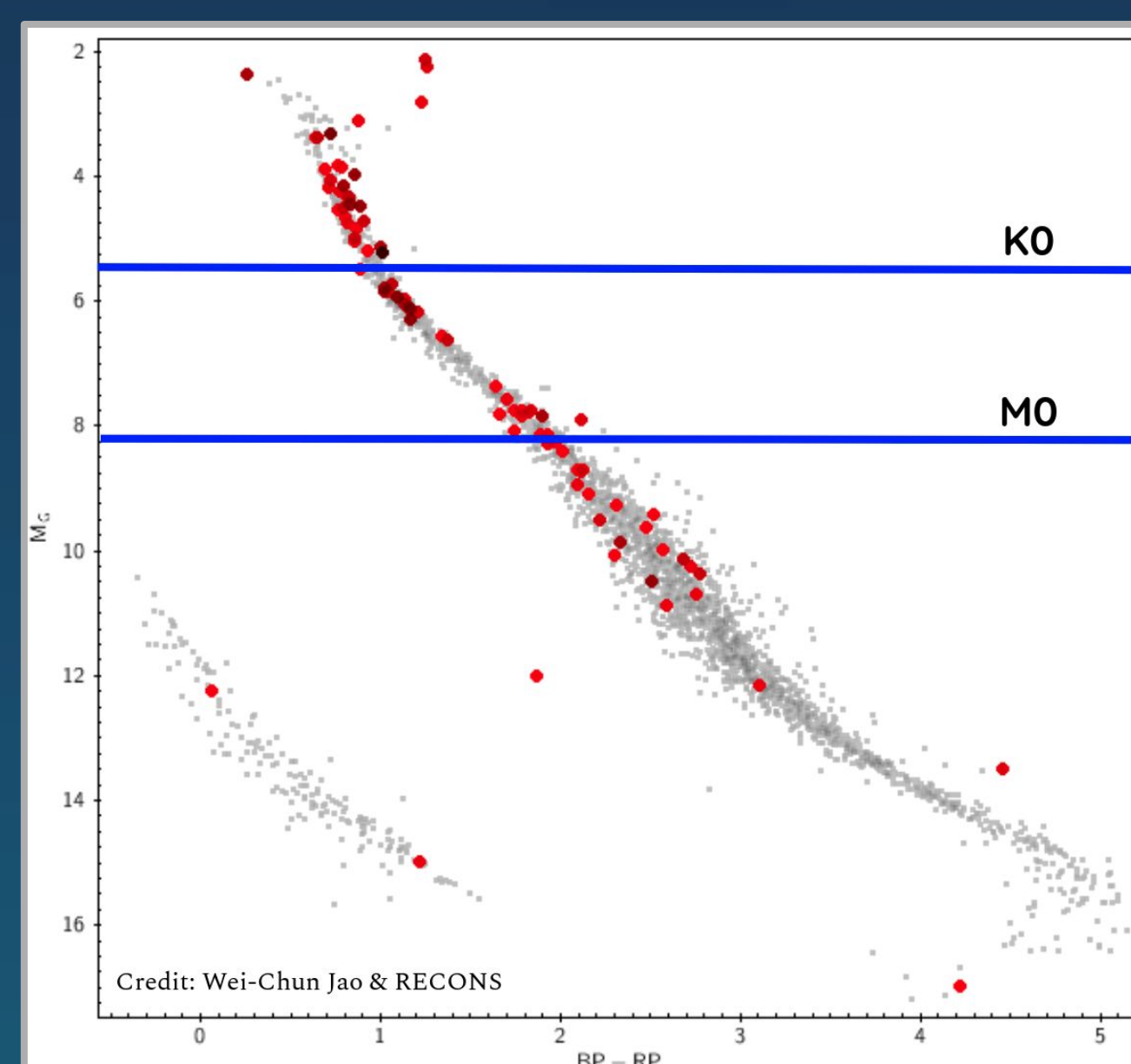


Figure 1: HR diagram of stars within 25 pc (RECONS sample) with confirmed host stars from the NASA Exoplanet Archive highlighted by red dots. The gap in confirmed planets seen from K2V-K7V shows that **K dwarfs are understudied compared to G and M dwarfs.**

K dwarfs provide longer main sequence lifetimes and a more significant population of stars within the solar neighborhood (~12%) than G dwarfs (~8%) and habitable zones further away from the host star when compared to M dwarf stars (Arney 2019).

## The Samples

K dwarfs identified as stars with Gaia absolute Bp ( $M_{Bp}$ ) = 5.5 – 10 mag, and Bp–K<sub>2MASS</sub> color = 2.0 – 4.0.

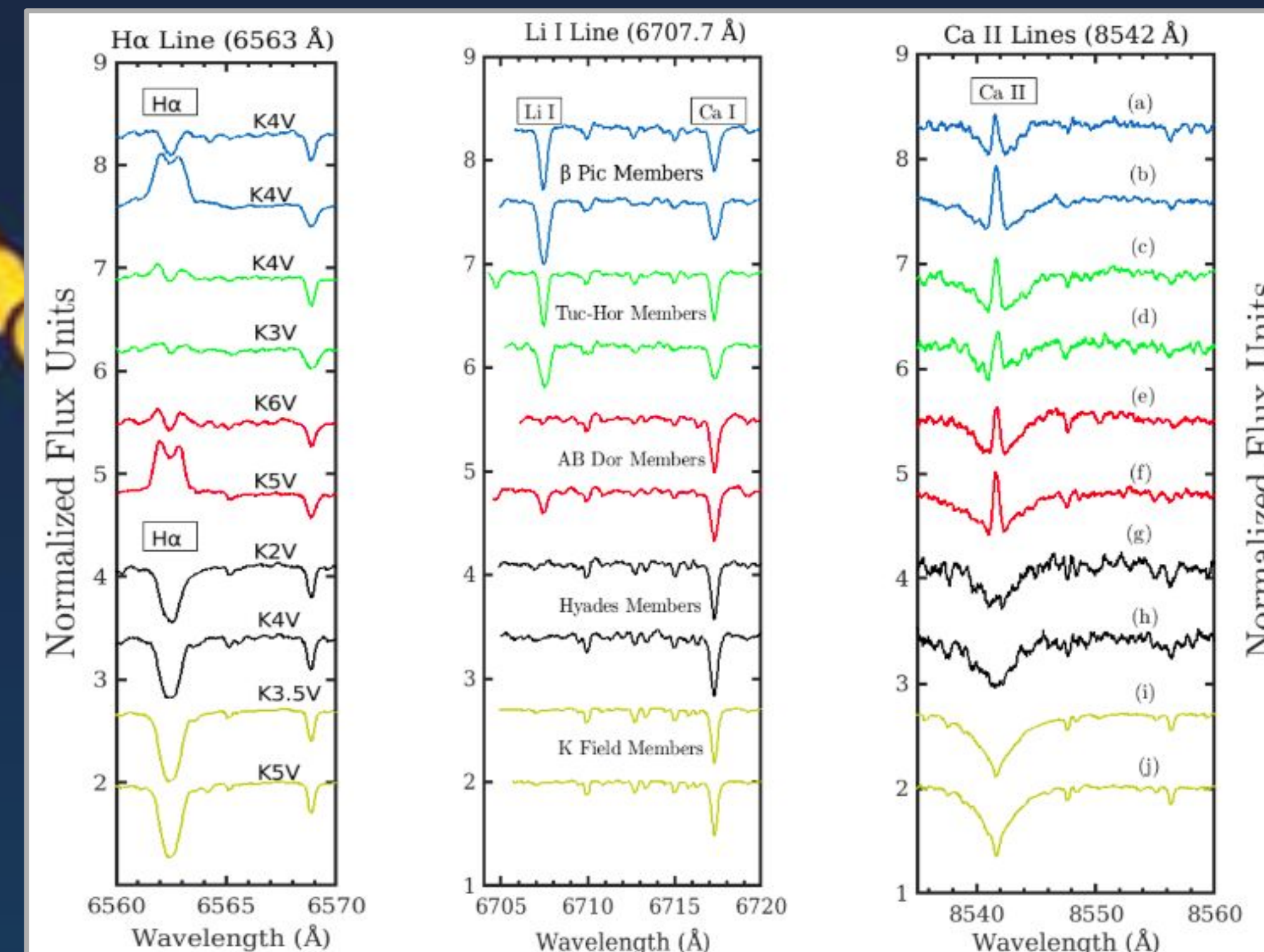
### Main Sample:

- Within 40 pc (Gaia DR2/3 Parallax)
- Equatorial (+30° and -30° Dec)
- K dwarf is the primary star in the system.
- 286 K dwarfs within 25 pc
- 1,217 K dwarfs within 40 pc

### Benchmark Sample:

- 35 K dwarfs from moving groups, open clusters and the field with known ages (Gagne et. al. 2018).

## CHIRON



All spectra used for this study were acquired using the CHIRON High Resolution (R~80,000 in slicer mode) Echelle Spectrograph, which has a spectral range 4150–8800 Å, and is mounted on the SMARTS/CTIO's 1.5m telescope (Paredes et al. 2021).

Figure 2: Plots showing a compilation of ten K dwarf spectra from the five age groups that make up the Benchmark sample. Left plot shows the Hα Line 6562.8 Å line, the Middle plot presents the Li I feature at 6707.9 Å, and the Right plot displays the Ca II line at 8542.0 Å.

**Key Results:** Hα line in emission for young and active K dwarfs. Li I absorption line present for K dwarfs from young moving groups. Ca II line shows core emission for younger K dwarfs.

## Young & Active Stars

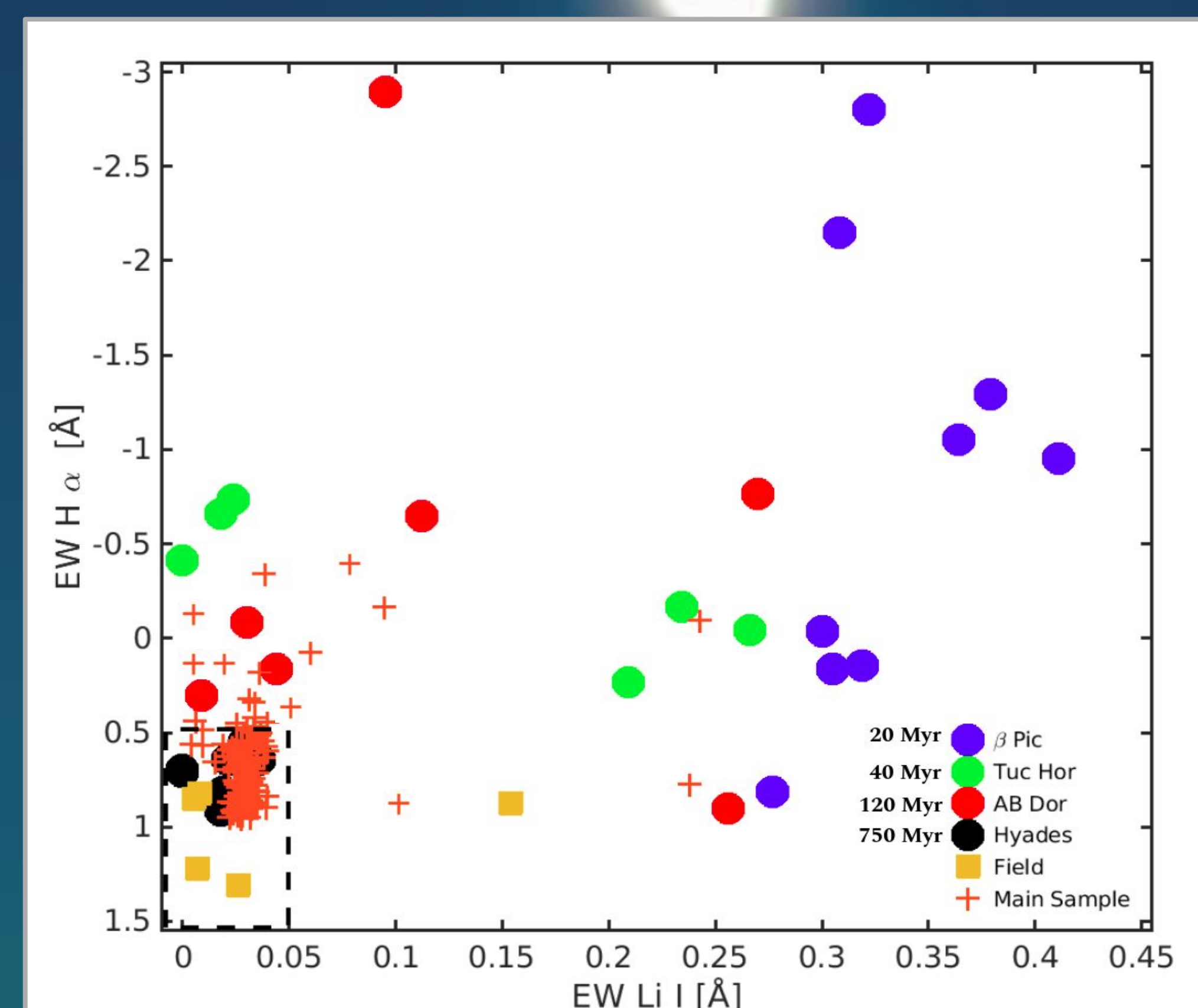
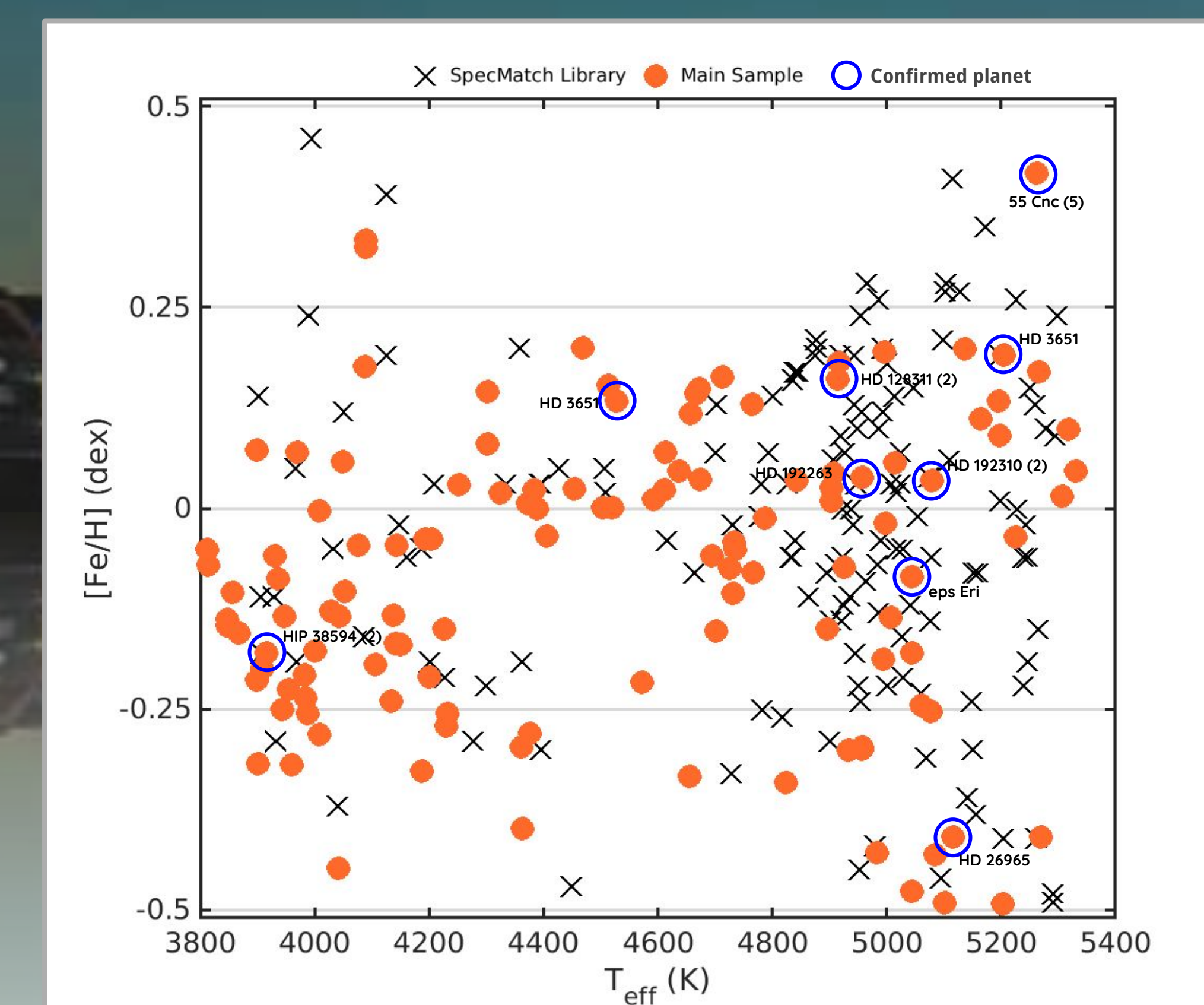


Figure 3: Plot of EW[Hα] vs. EW[LiI], where the dashed black box in the bottom left encloses older (>750 MYR) K dwarfs from the Hyades and the field in an old locus (Hubbard-James et al. 2022). The numbers of stars in each group are β Pic (n=9), Tuc-Hor (n=6), AB Dor (n=7), Hyades (n=8), and field K dwarf (n=5). Orange crosses indicate the 286 K dwarfs from the 25 pc sample.

**Key Result:** 7% of our 25 pc sample were identified as young or active by virtue of falling outside the old locus defined by the Benchmark Sample.

Background Credit: Robert Sparks

## Stellar Parameters



Empirical SpecMatch (Yee et. al. 2017) was used to measure  $T_{eff}$  and  $[Fe/H]$  for all 286 K dwarfs.

Figure 4:  $[Fe/H]$  plotted against  $T_{eff}$  for K dwarfs (orange dots) in our sample, with confirmed host stars from the NASA Exoplanet Archive circled (blue circle), and SpecMatch library stars (black x's) shown in the background.

**Key Result:** Temperatures range from 3900–5300 K, metallicities range from  $-0.6 < [Fe/H] < +0.2$ . Rotational velocities ( $v \sin i$ ) also measured and range from less than 10 km/s to 50 km/s.

## References:

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