Understanding K Dwarf Evolution: Linking the Hα Spectral Feature to UV and X-Ray Activity

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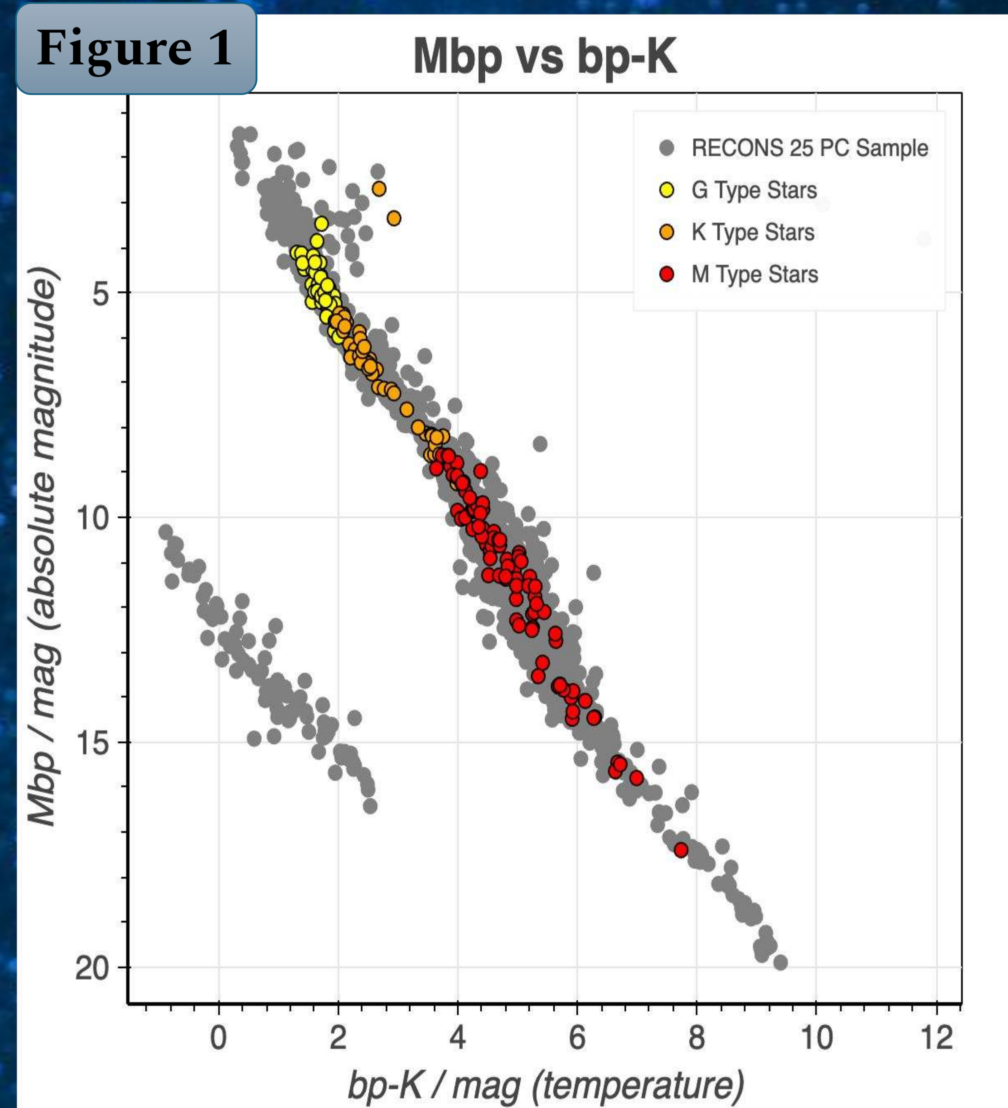
Abstract

This project explores the spectral analysis of K dwarf stars using optical, UV, and X-ray data to understand their activity levels and potential to support habitable planets. K dwarf stars have long, stable lifespans, making them promising targets for habitability studies. We used archival spectra from Hubbard-James et al. (2024) and cross-referenced our findings with Hinkel et al. (2017), which provides NUV, FUV, and X-ray activity data. Optical data, especially the Hα line's equivalent width, was analyzed to predict UV and X-ray activity. This approach offers a less resource-intensive way to study a star's chromospheric activity. To better understand how activity changes over time, we examined UV data, though its strong correlation with temperature made it challenging to determine activity levels accurately.

What are K Dwarfs

Figure 1



Samples

Figure 1, we utilized the NASA Exoplanet Archive to identify K dwarfs with confirmed exoplanets, currently totaling 44 confirmed exoplanets.

Additionally, we cross-correlated our data with Hinkel 2017, which includes NUV, FUV, and X-ray activity data.

1. NUV (Near Ultraviolet): 3000 to 4000 angstroms.
2. FUV (Far Ultraviolet): 1220 to 2000 angstroms.
3. X-ray: 0.1 to 100 angstroms.

CHIRON

Left: The 1.5 m CTIO telescope housing the CHIRON spectrograph for high-resolution stellar observations.

Why UV & X-Ray

Cross-referenced Hinkel's 2017 data to incorporate FUV (Figure 2), NUV (Figure 3), and X-ray activity alongside analyzing the Hα line, which are crucial for indicating chromospheric activity. This comprehensive approach helps us better understand the radiation environment of K dwarf stars.

By correlating optical data with UV and X-ray data, we can predict high-energy radiation levels efficiently, enhancing our study's effectiveness without the need for resource-intensive observations.

Best Measure

In contrast, X-ray data, Figure 4, provided a clearer way to distinguish young, active stars from older, inactive ones. Our results found that the Hα line's equivalent width relates to X-ray activity, which is important since higher stellar activity can break apart planetary atmospheres, affecting their ability to support life.

Future Work: will involve cross-checking with other UV and X-ray catalogs and exploring the relationship between other optical lines and stellar activity.

UV Data & Hα

Figure 2

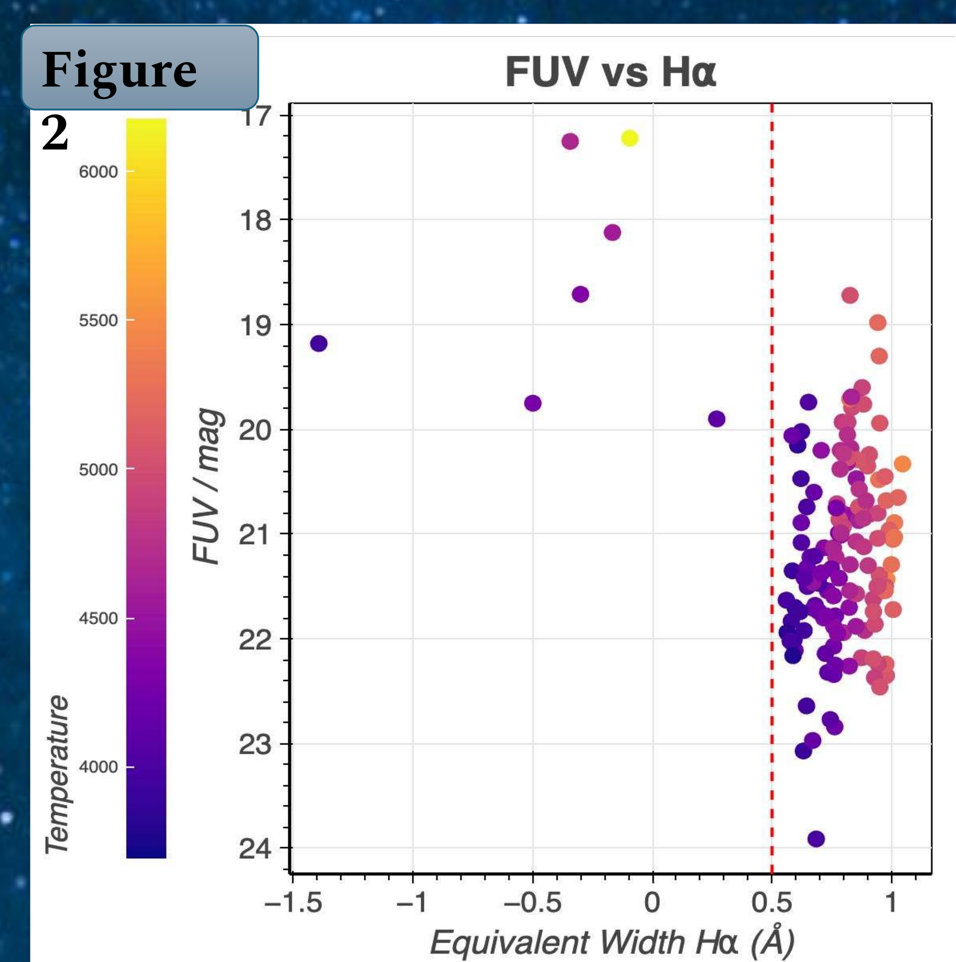
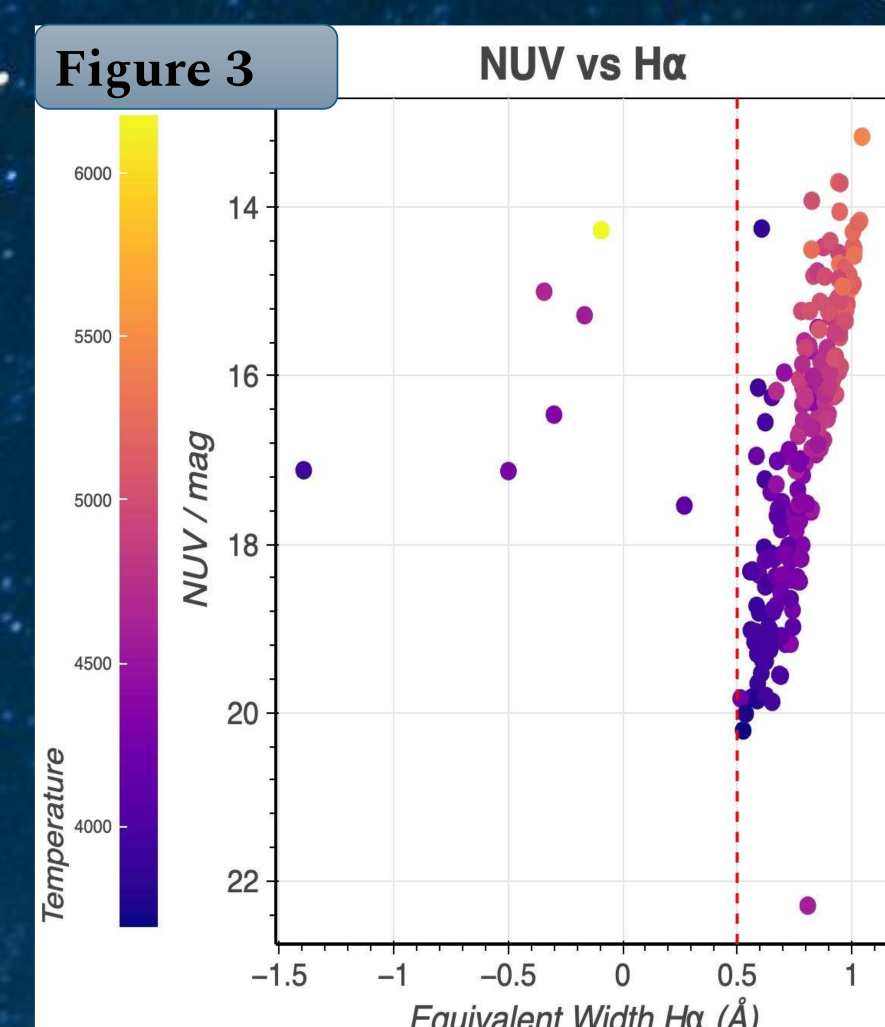


Figure 3



X-Ray Data & Hα

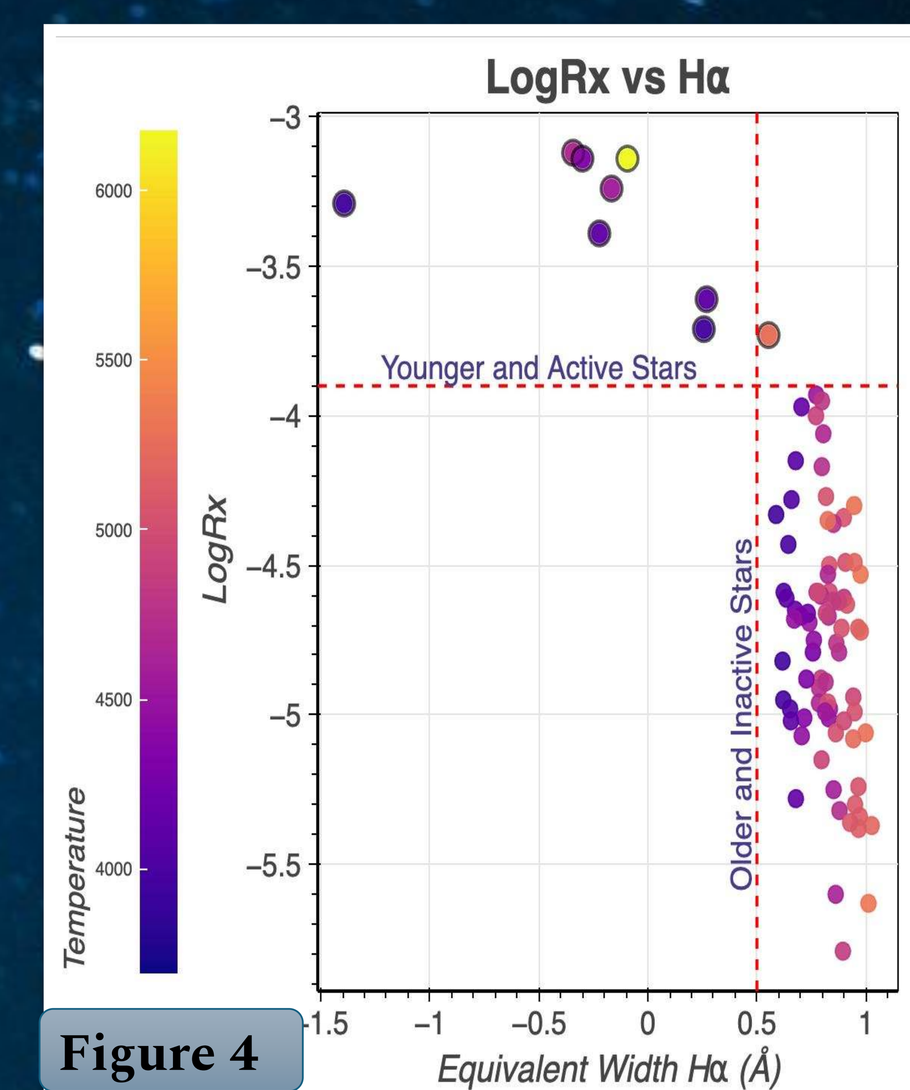


Figure 4

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References

[1] Cuntz, M. & Guinan, E.~F., 2016, apj, 827, 79. doi:10.3847
[2] Hinkel, N.~R. & Burger, D., 2017, arXiv:1712.04944. doi:10.48550
[3] Hubbard-James, H.-S., Lesley, D.~X., et al., 2022, aj, 164, 174. doi:10.3847
[4] Melbourne, K., Youngblood, A., France, K., et al., 2020, aj, 160, 269. doi:10.3847

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