

PROBING K DWARF AGES USING H β AND LI I SPECTRAL LINE ANALYSIS

Jacinda Byam^[1], Daniela García-Lara^[1], Hodari-Sadiki Hubbard-James^[1], Leonardo Paredes^[2], Sebastian C. Gaxiola^[3], Todd J. Henry^[4]

¹Agnes Scott College, ²University of Arizona, ³Georgia State University, ⁴RECONS Institute

Abstract

This research investigates how the H β line can be used to track the **aging process of mature (> 1 Gyr) K dwarf stars**. We obtained spectra for 51 K dwarf stars using CHIRON, a high-resolution spectrometer at Cerro Tololo Inter-American Observatory. We observed a progressive increase in a feature on the left side of the H β line as the Li I line depletes. This feature corresponds to a Fe I line, initially obscured by the H β line in young stars but becomes more visible as the H β line weakens with age. Our analysis revealed that this spectral change can effectively distinguish between younger and older K dwarfs.

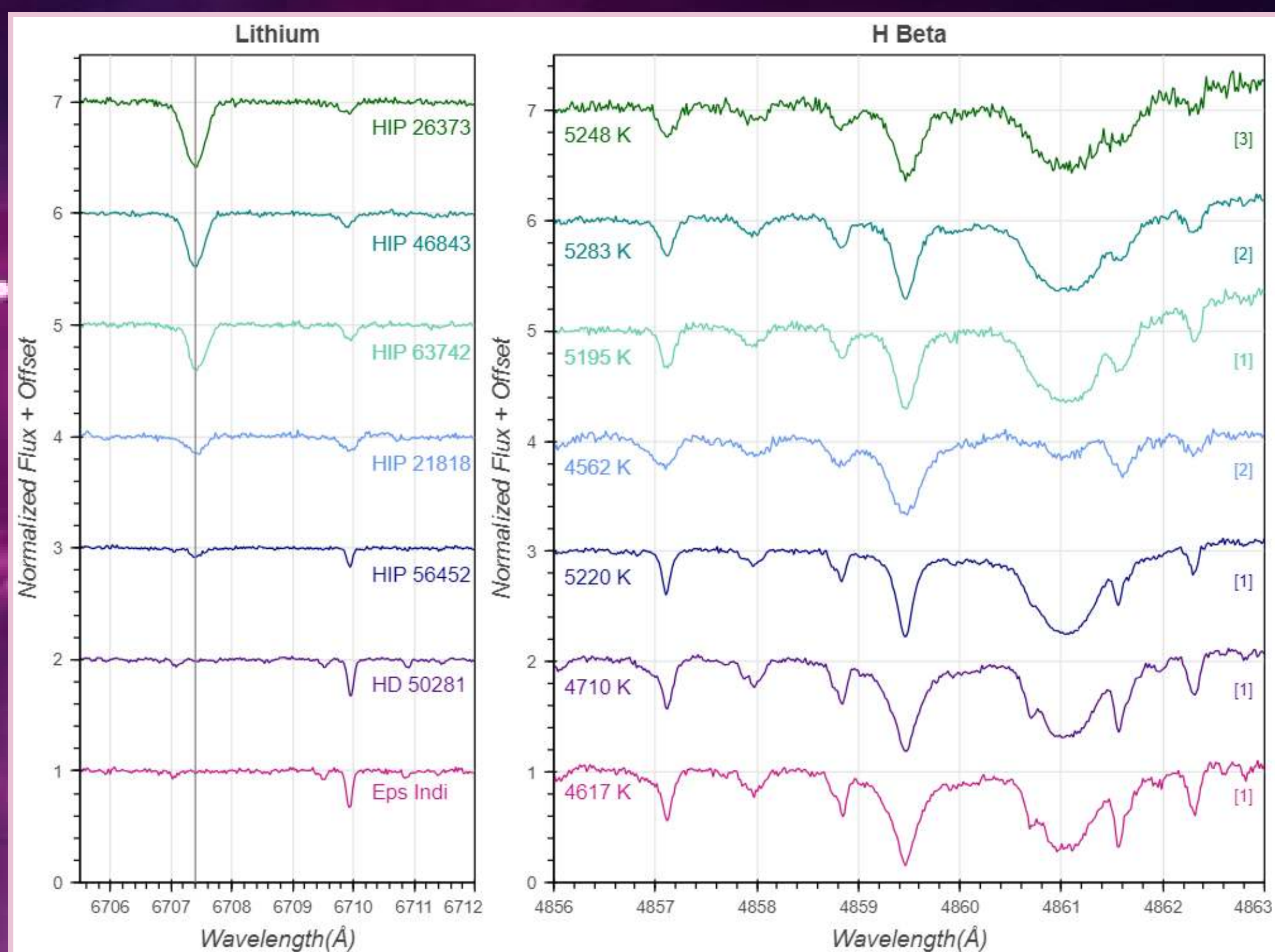


Figure 1

Testing the H β line

Figure 2: We identified HD 45088, a K dwarf previously miscategorized as mature using the Li I line, which showed characteristics of a younger star, due to the absence of the fragment on the H β line on the right plot and the presence on the lithium line on the left plot.

Figure 3: We then reinforced the fact that HD 45088 was young based on its ROSAT X-ray data. The marked orange point in Figure 3 is above the defined line of young and active stars, indicating the H β line was accurate in categorizing the age of K dwarfs.

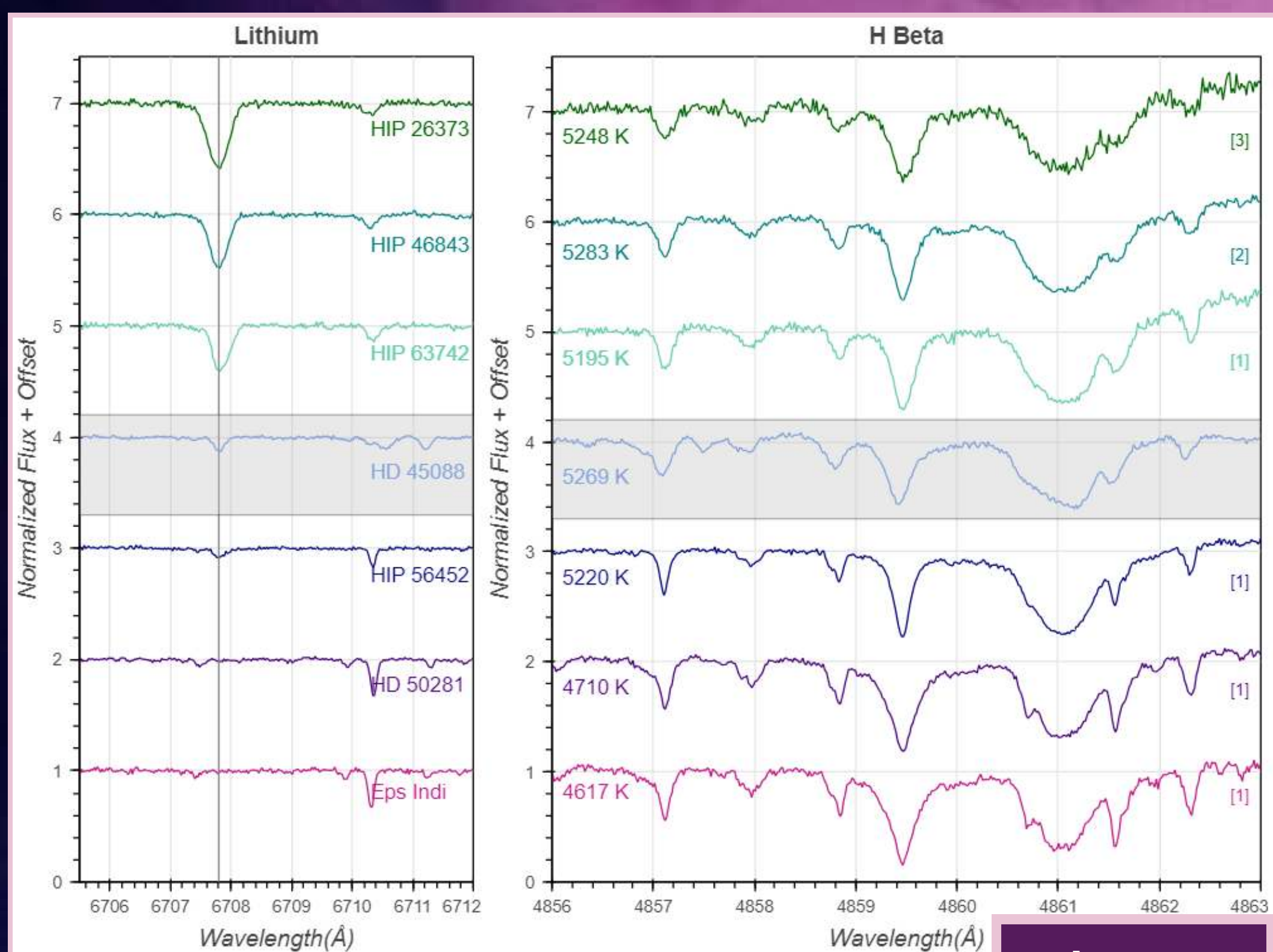


Figure 2

Li I line vs H β line

Figure 1: Comparison of the Li I line (6707 Å) on the left plot to the H β absorption line (4861 Å) on the right plot for a benchmark set of seven K dwarfs from known age groups—four younger than 200 Myr and three older than 500 Myr. As the lithium line grows the **fragment on the left side of the H β line becomes more pronounced**. The star categories are as follows: [3] is a part of the AB Dor moving group, [2] are known rv variable young/active stars, and [1] are field stars. The three [1] stars on the bottom are known mature and inactive field stars and HIP 63742, the other [1] star, is a known young star.

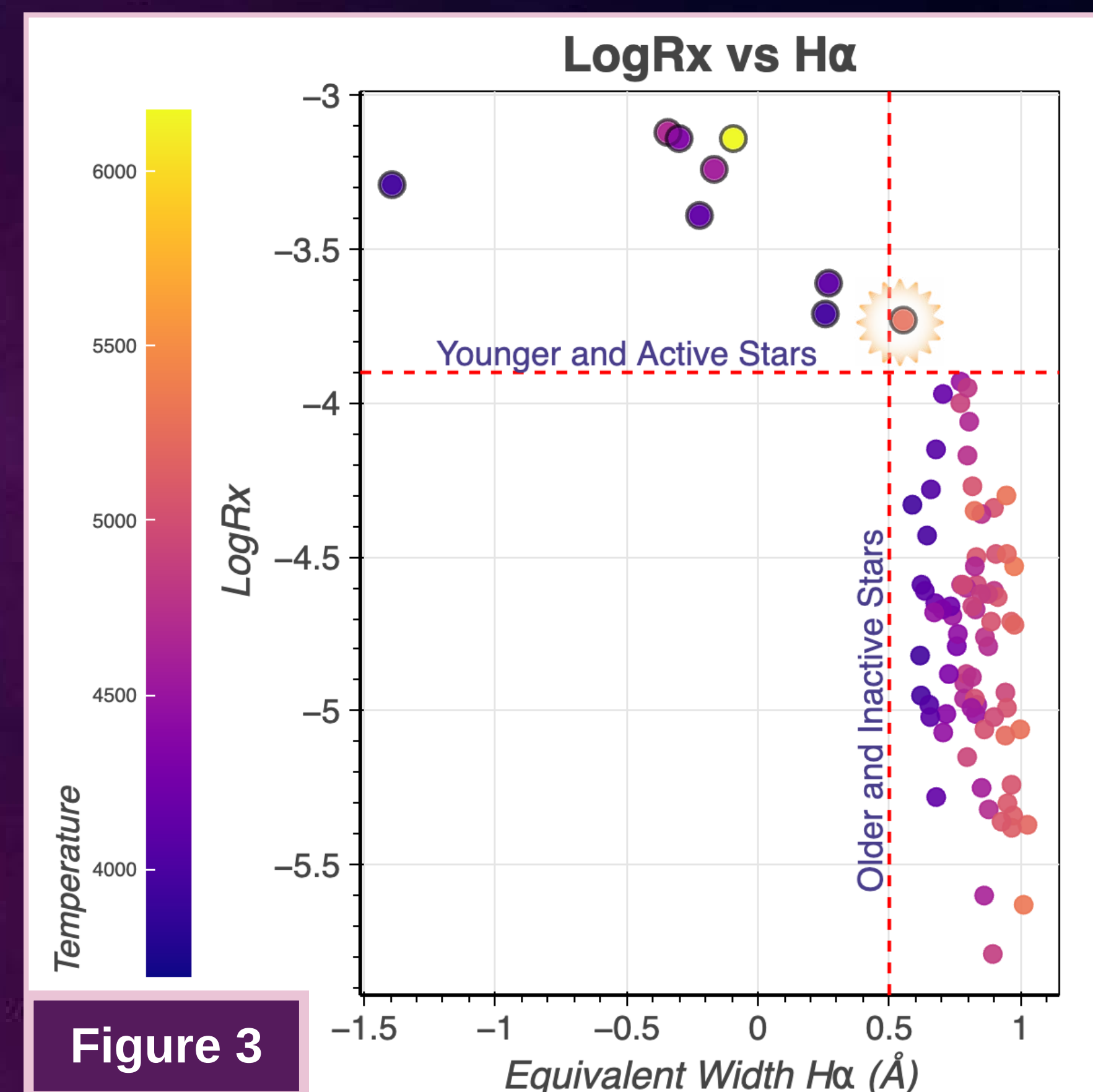


Figure 3

The Importance of K dwarfs Age

By refining our understanding of spectral age indicators, we can better identify which K dwarfs and their exoplanets are likely to be at the right stage in their timeline for life to potentially evolve. Since K dwarfs' main sequence lifetimes are 4 times longer than G dwarfs', ranging up to 40 billion years, there is more time for life to develop. Furthermore, K dwarfs have the most promising habitable zones after G dwarfs, due to the K dwarfs' greater habitable zone size than M dwarfs. Our future work includes measuring the equivalent length of the H β line to quantify the stellar age of K dwarfs.



Contact Me:



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