

The K Dwarf Advantage: The Ultraviolet Imperative for Assessing the Habitability of Planets

Tyler Richey-Yowell

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ExoPAG 25 – January 10, 2022

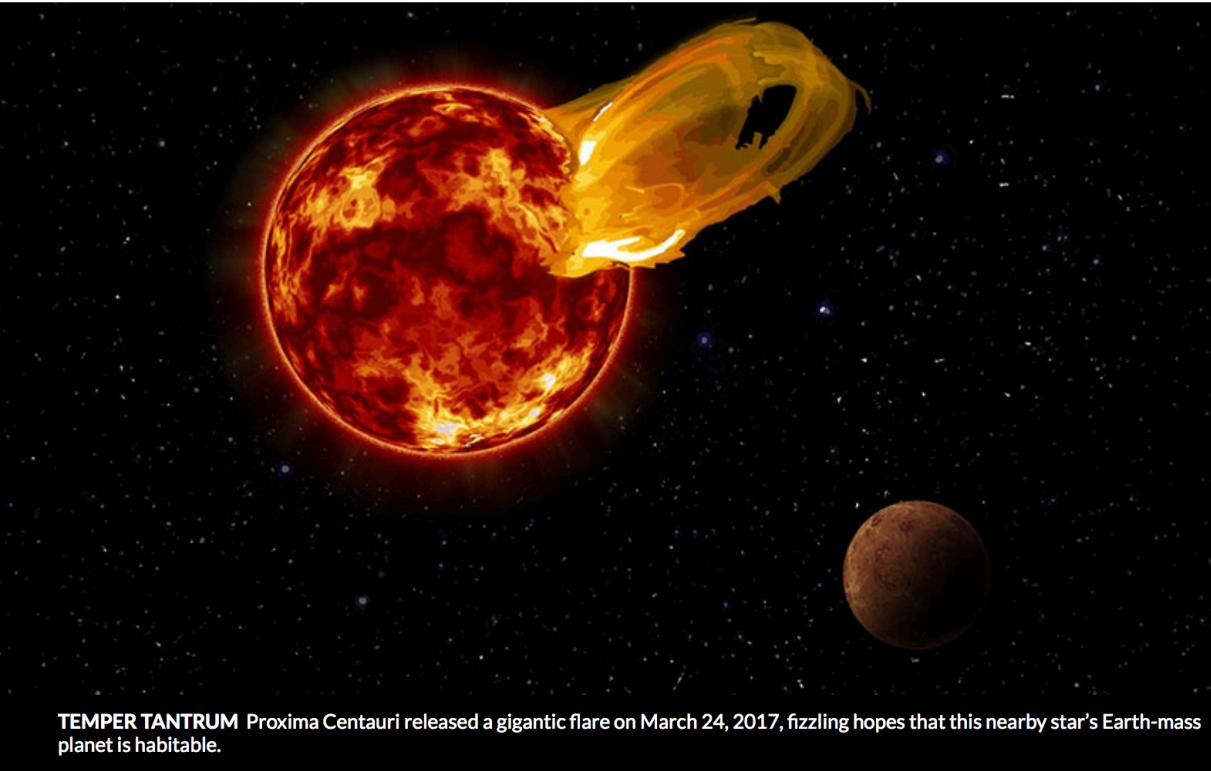


Know Thy Star, Know Thy Planet

Massive stellar flare may have fried Earth's nearest exoplanet

The radiation explosion from Proxima Centauri has scorched hopes for habitability nearby

BY LISA GROSSMAN 7:00AM, MARCH 5, 2018



TEMPER TANTRUM Proxima Centauri released a gigantic flare on March 24, 2017, fizzling hopes that this nearby star's Earth-mass planet is habitable.

ROBERTO MOLAR CANDANOSA/CARNEGIE INSTITUTION FOR SCIENCE, SDO/NASA

Loyd+ 18

Red Dwarf Star's Mighty 'Hazflare' Could Be Bad News for Alien Life

By Mike Wall, Space.com Senior Writer | October 19, 2018 07:00am ET

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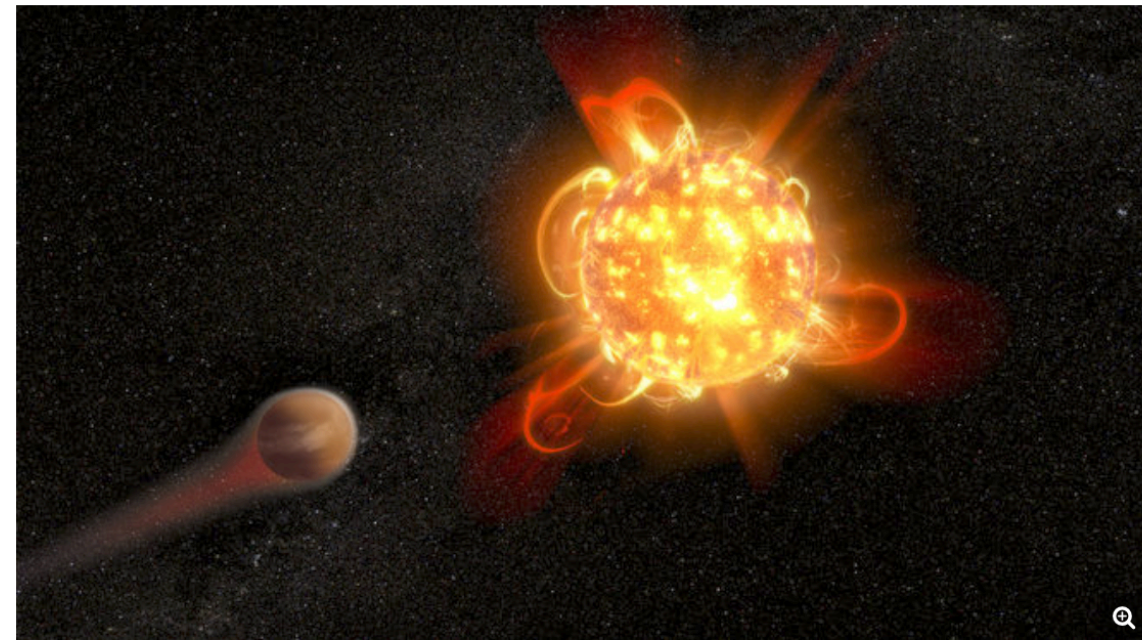
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Artist's illustration of a flaring red dwarf stripping away the atmosphere of an orbiting planet.

Credit: D. Player (STScI)/NASA/ESA

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The UV drives photochemistry and thermal escape

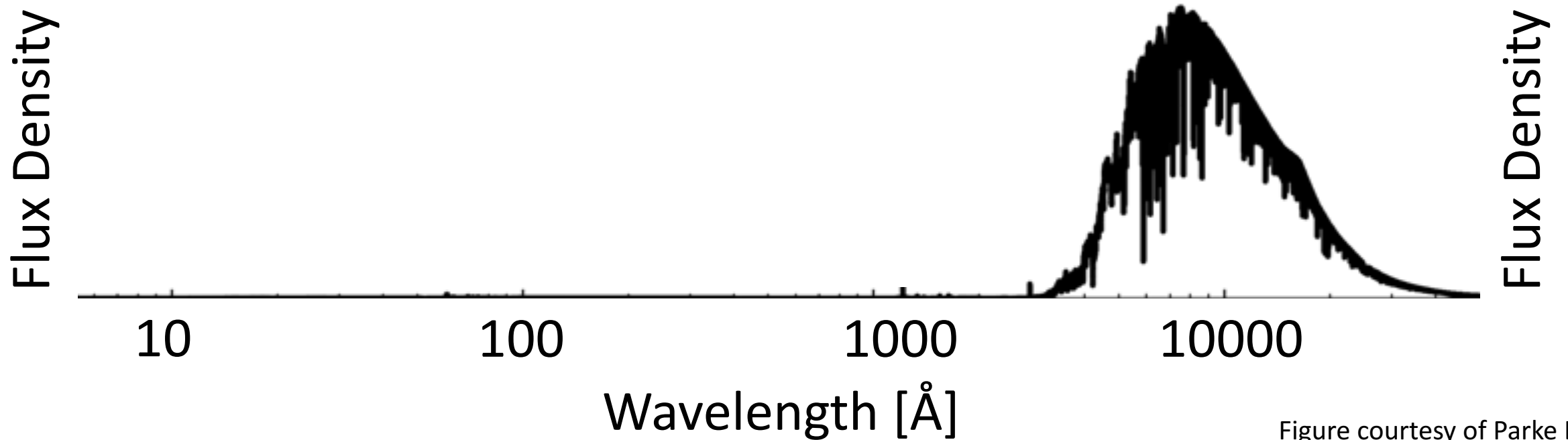


Figure courtesy of Parke Loyd

The UV drives photochemistry and thermal escape

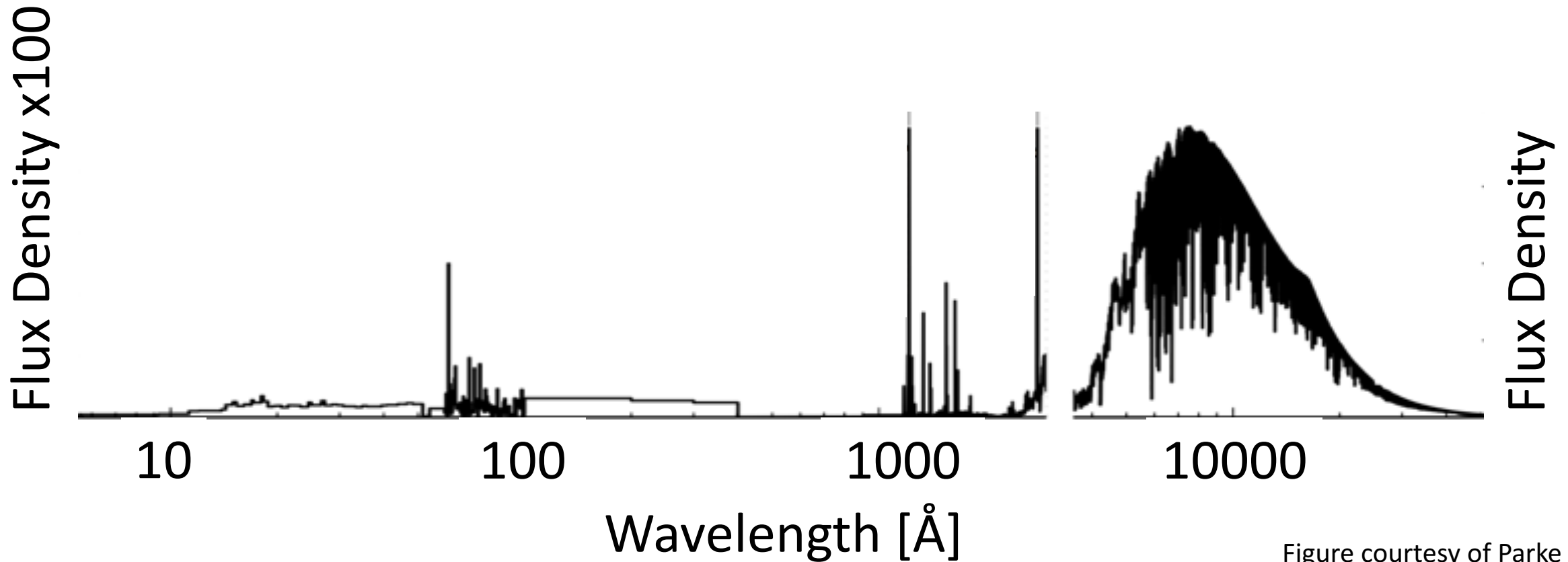


Figure courtesy of Parke Loyd

The UV drives photochemistry and thermal escape

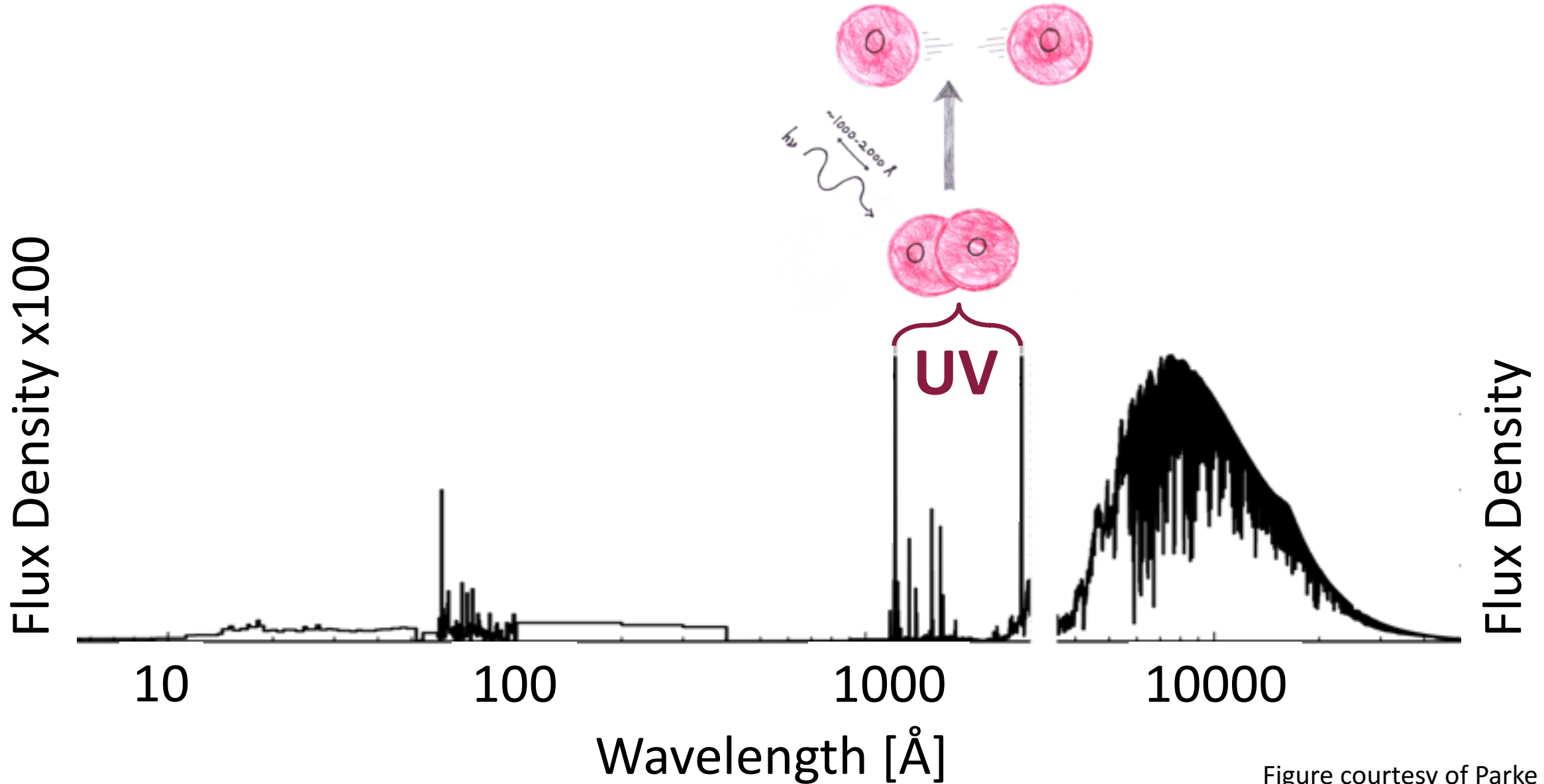


Figure courtesy of Parke Loyd

The UV drives photochemistry and thermal escape

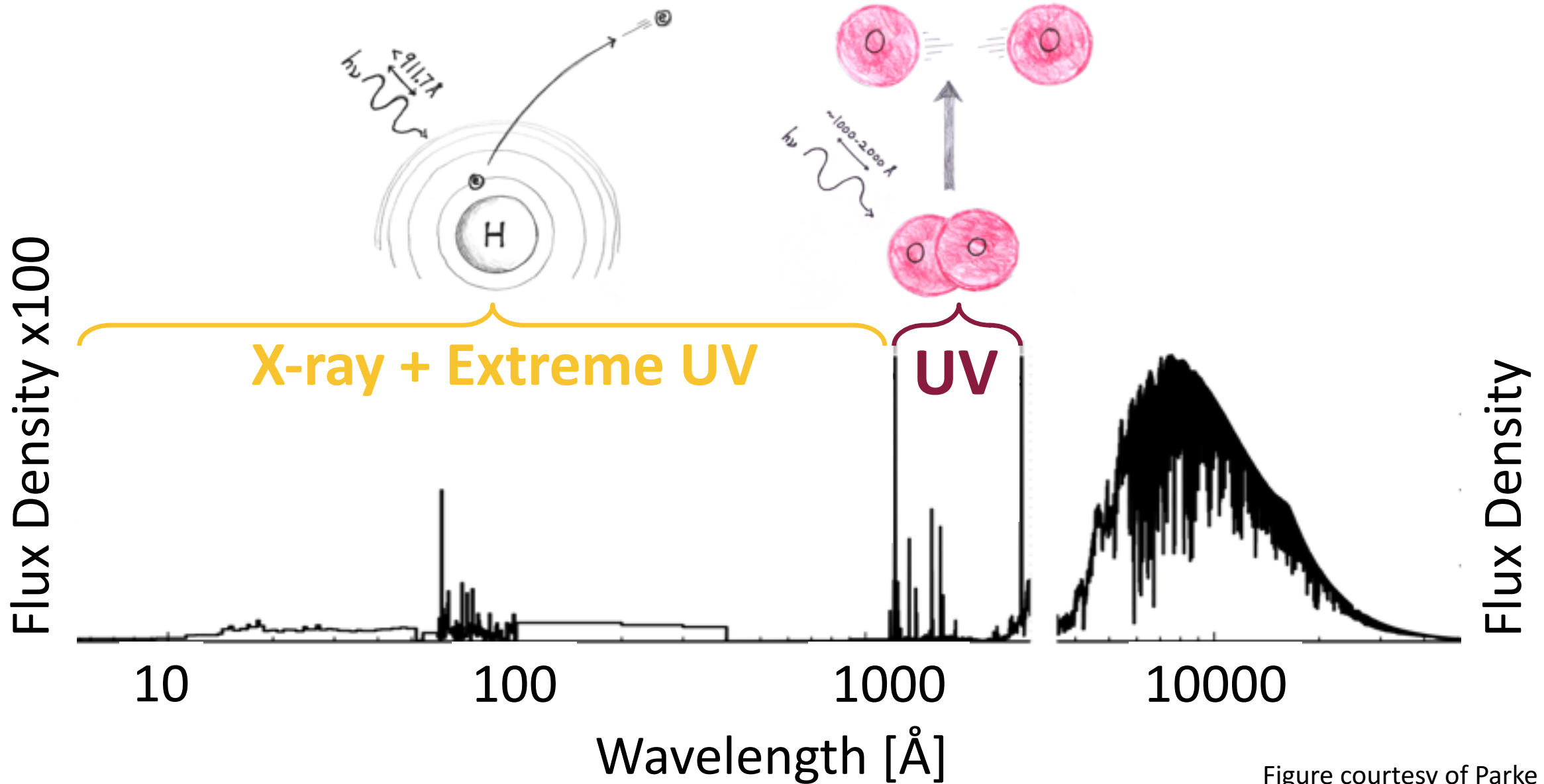
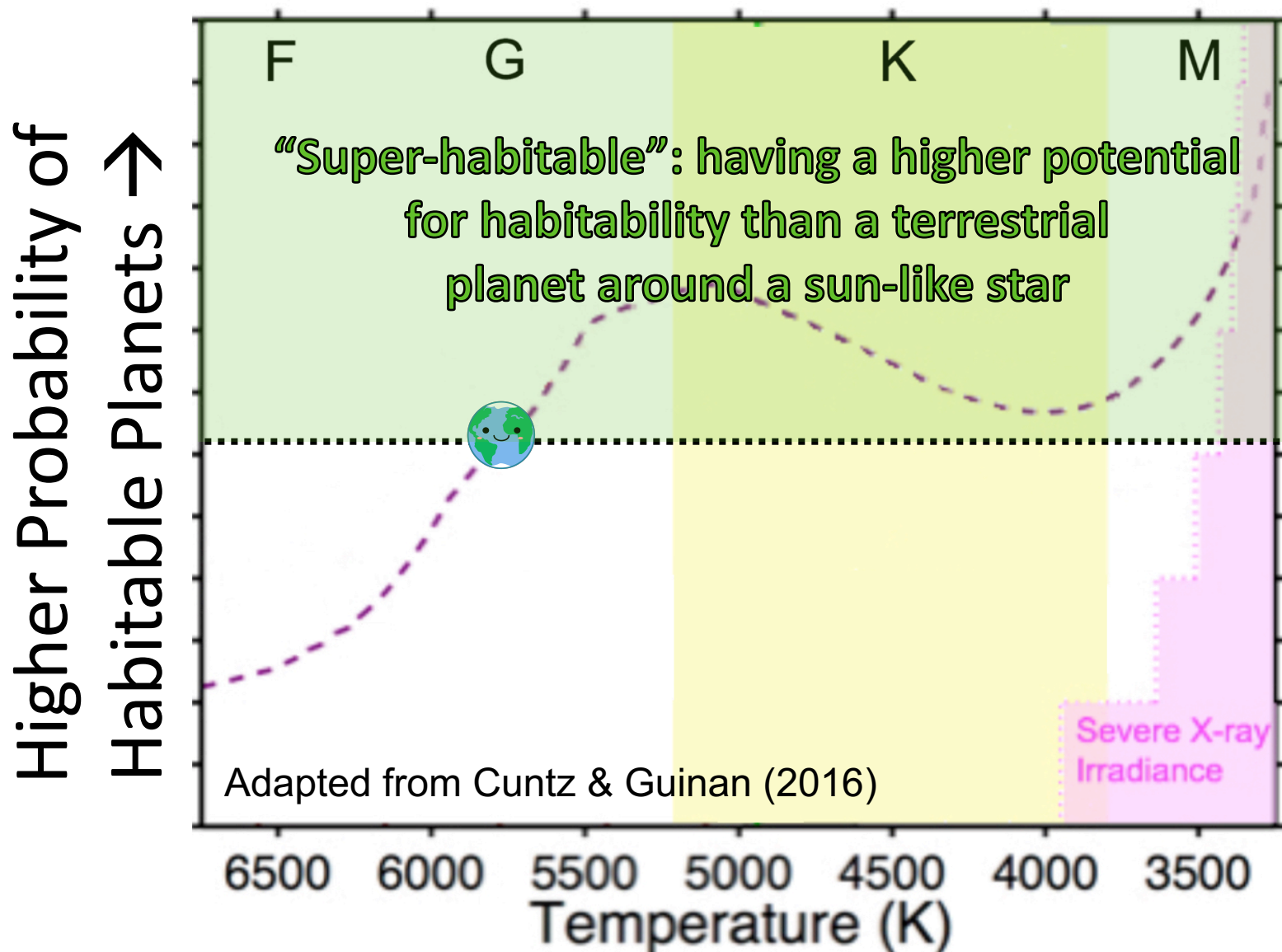
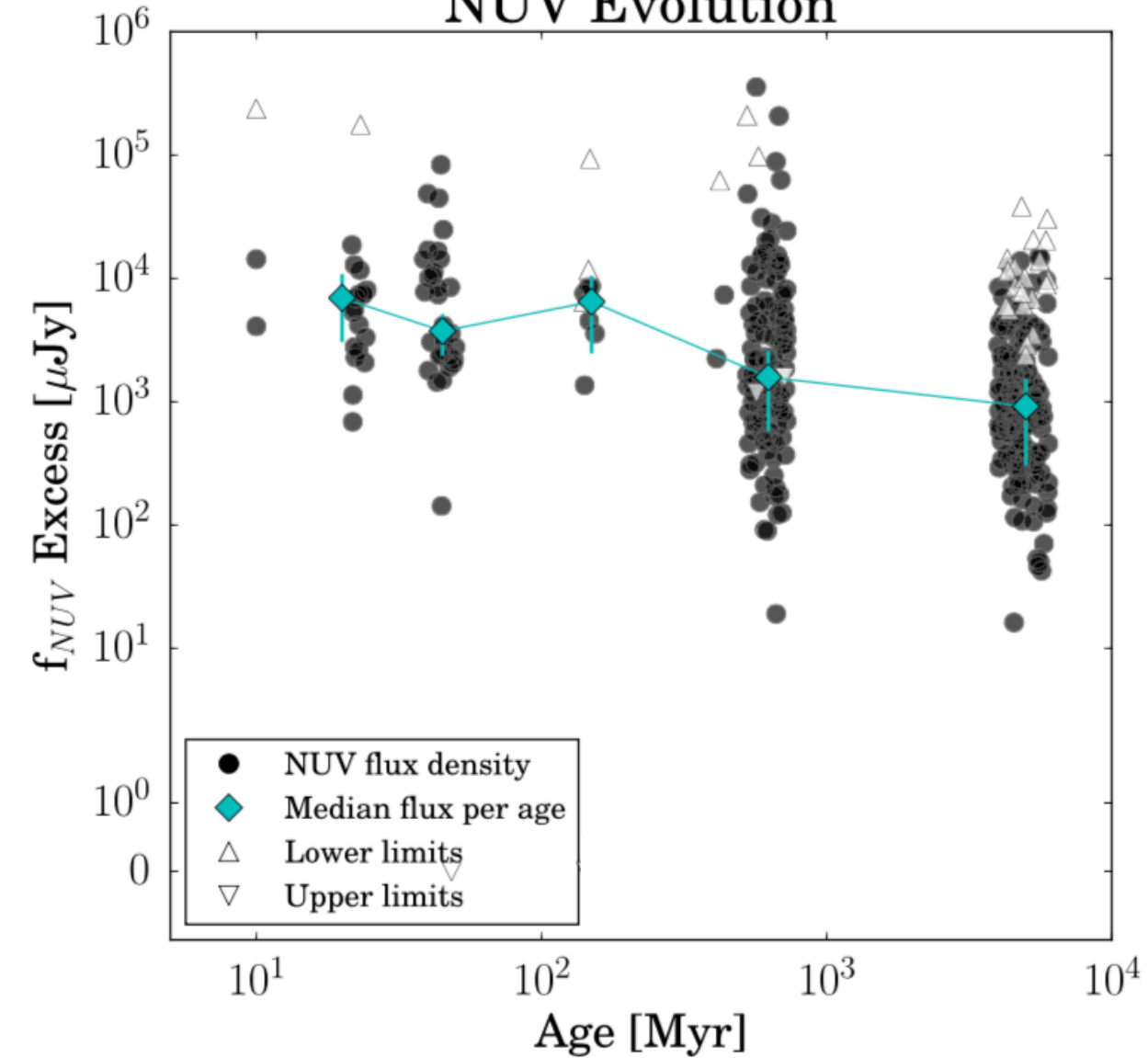


Figure courtesy of Parke Loyd

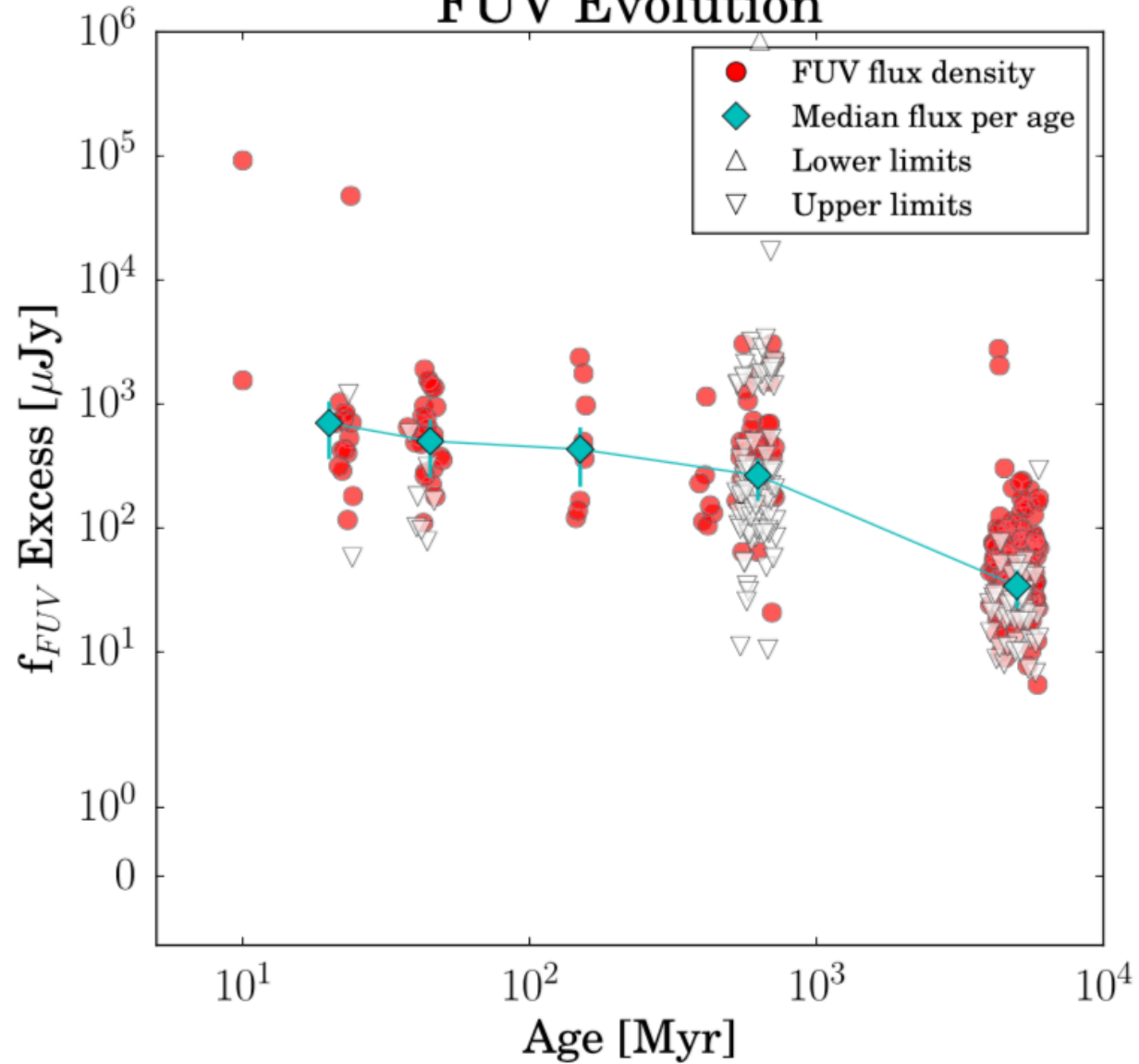
The Case for K Dwarfs

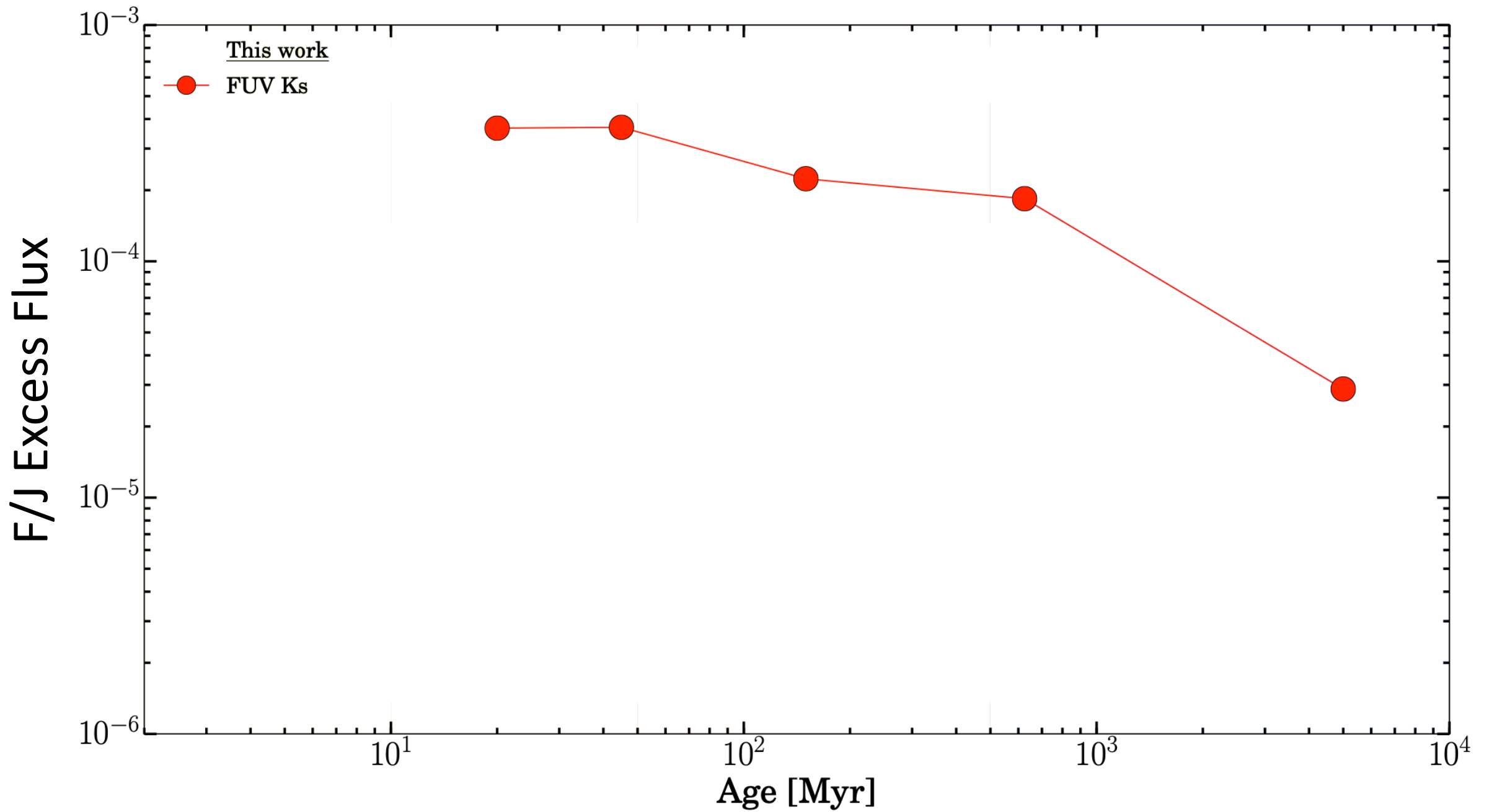


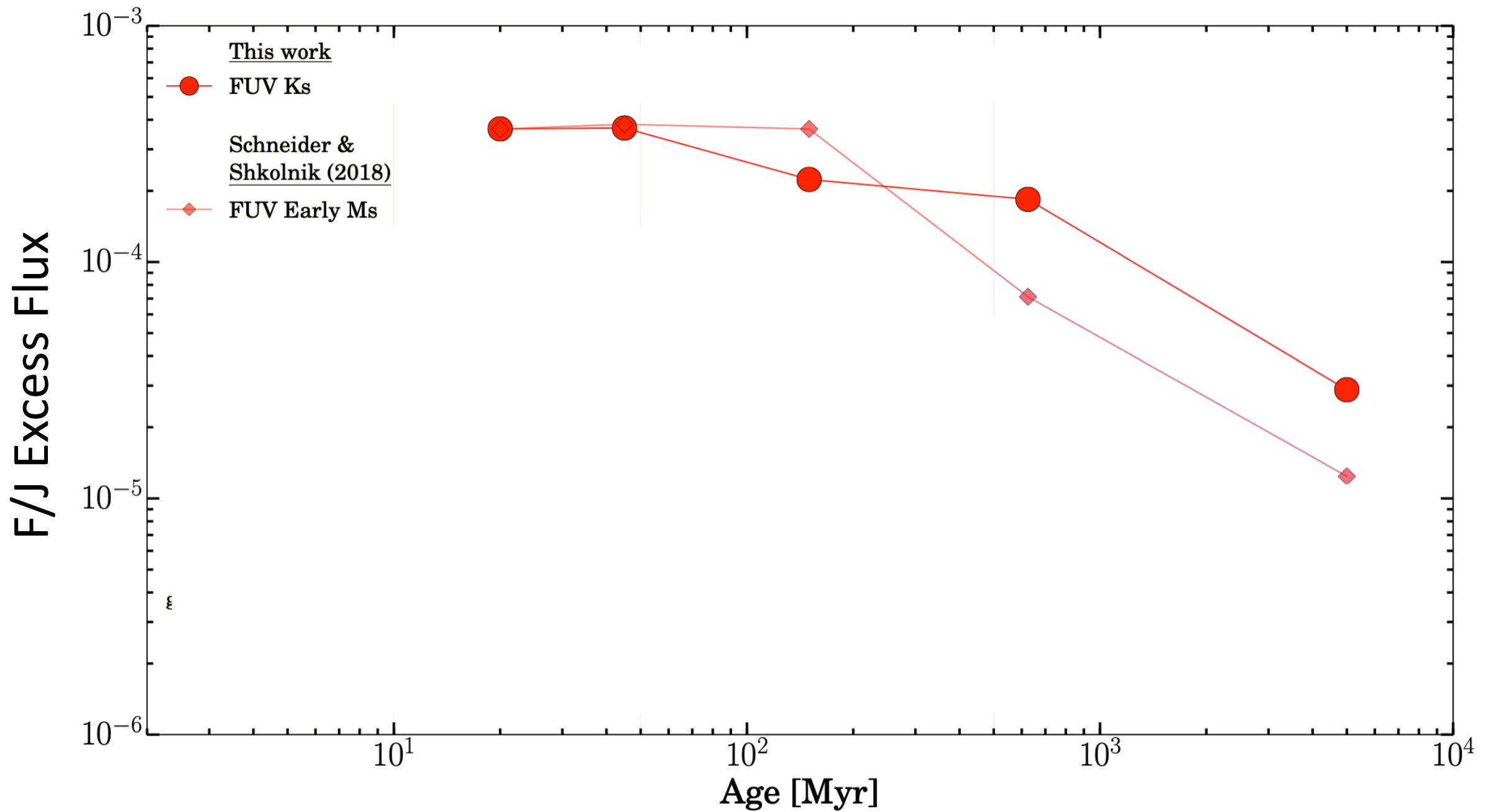
NUV Evolution

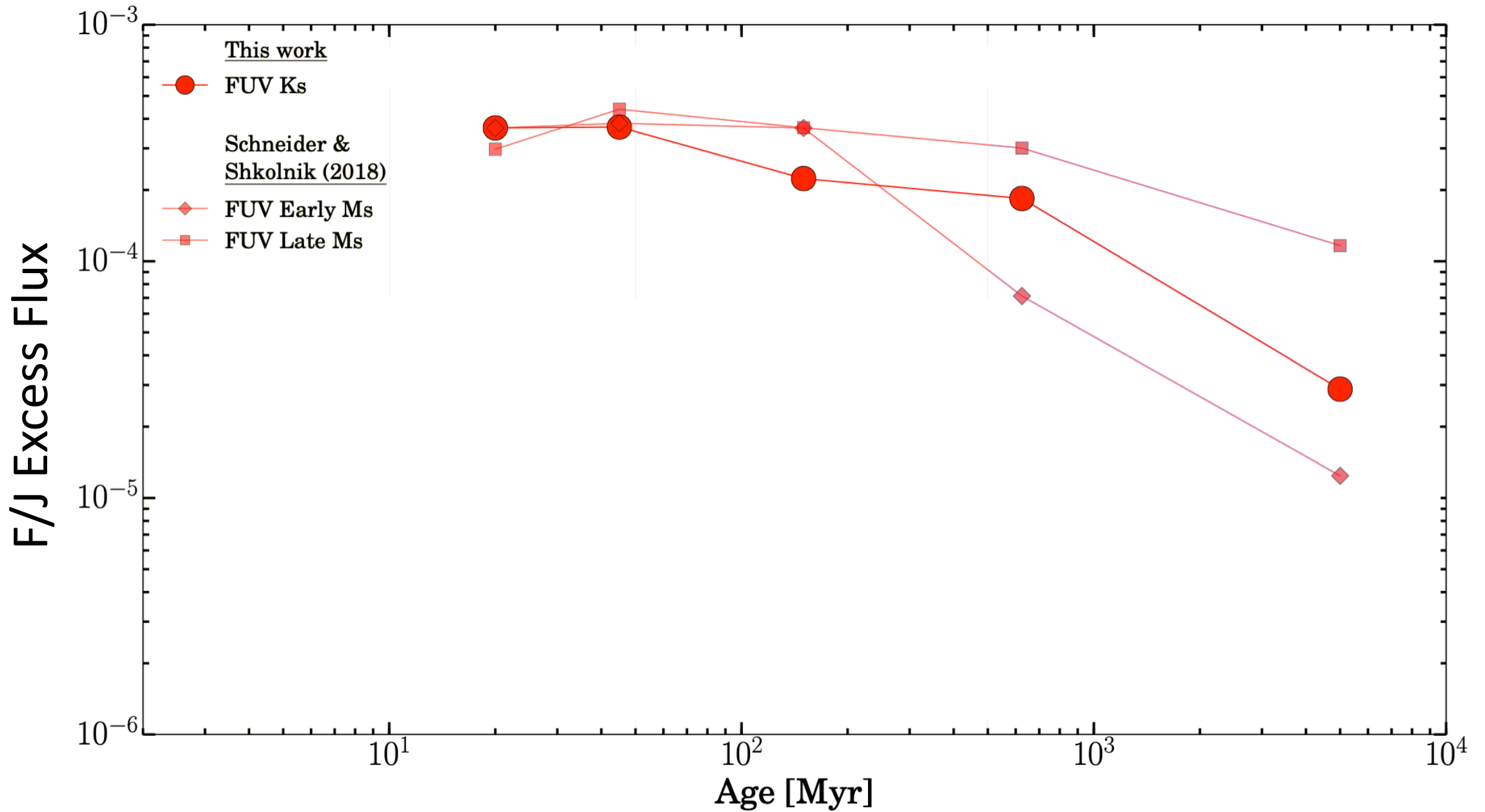


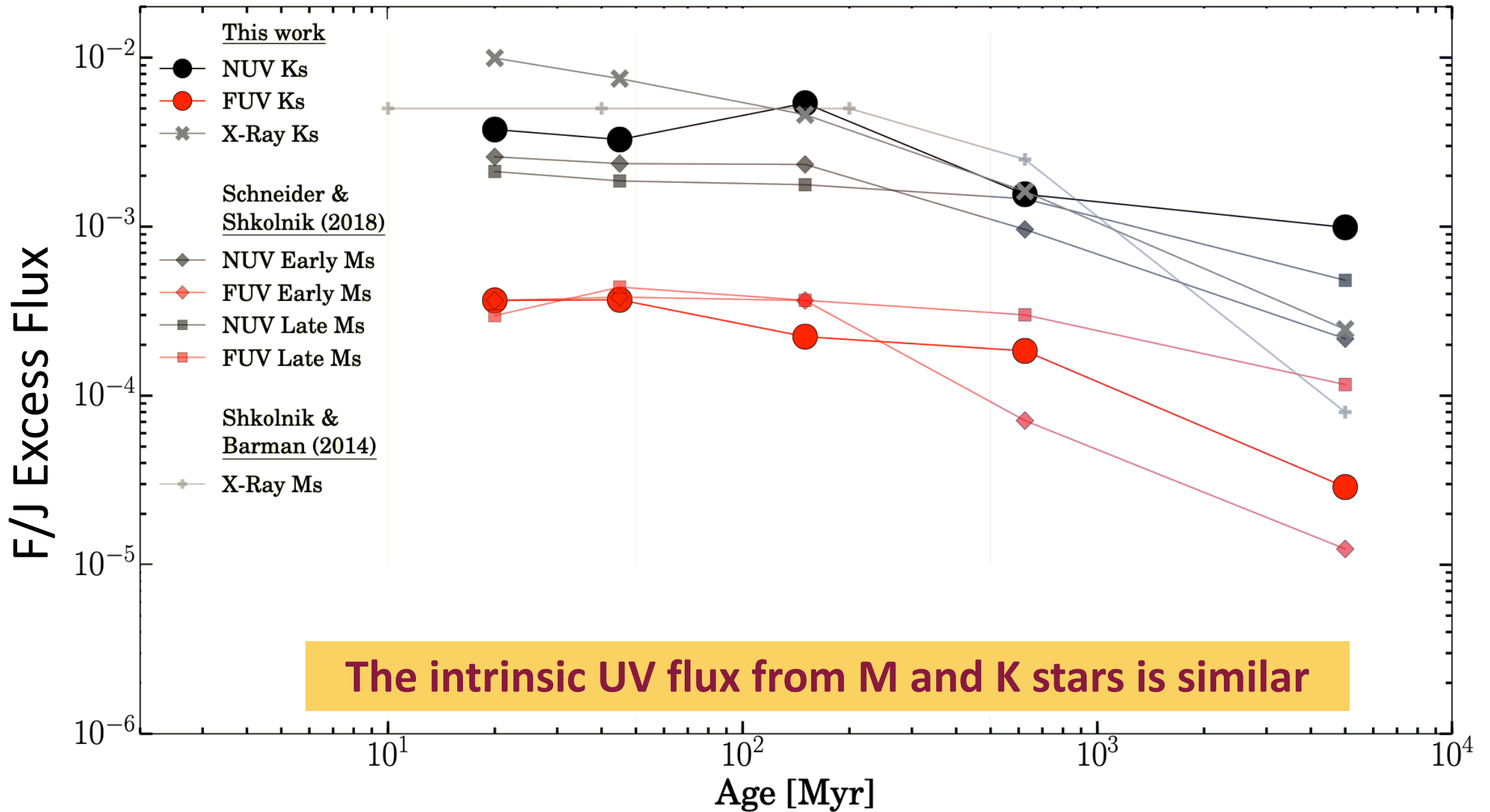
FUV Evolution



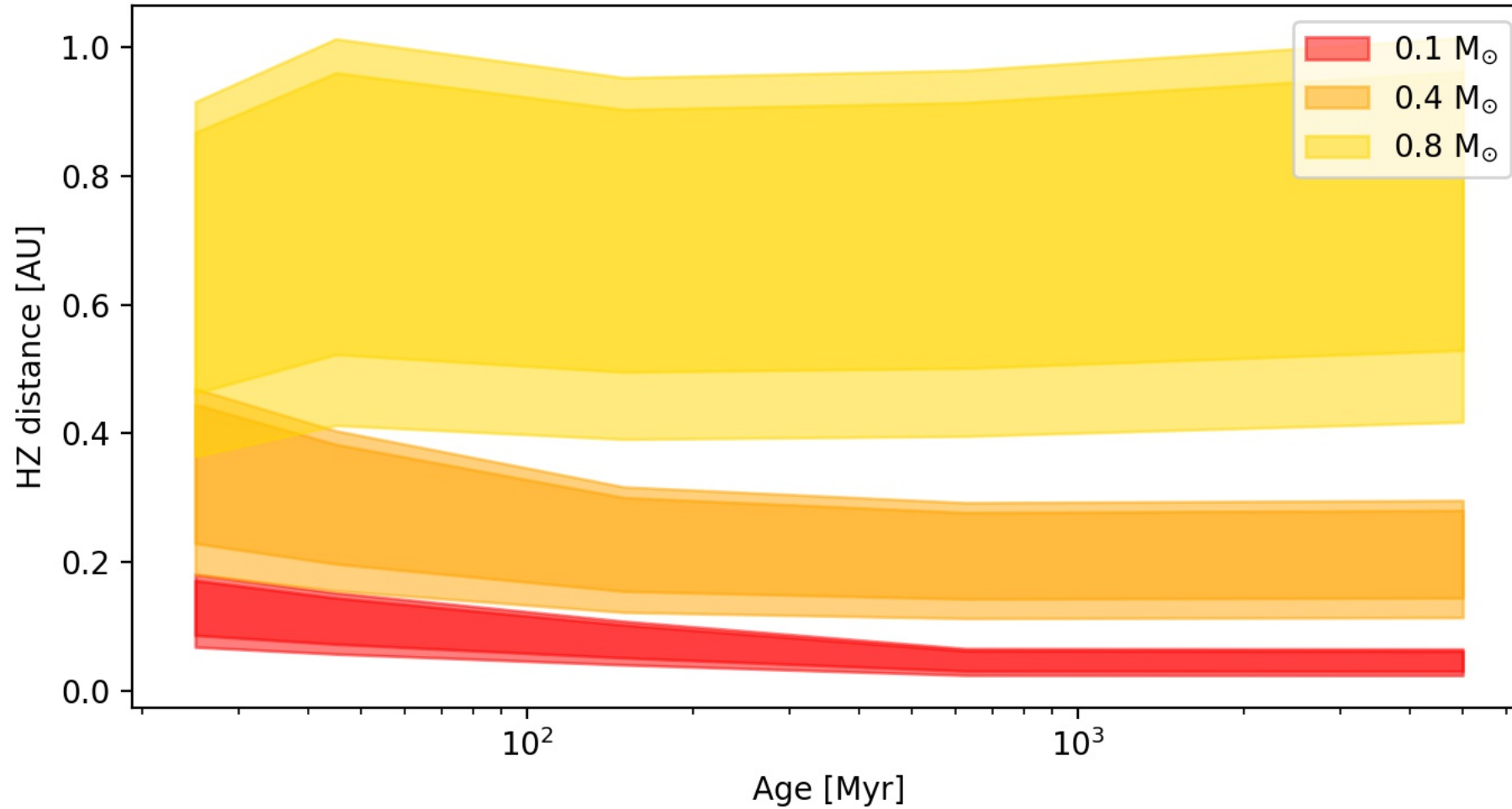






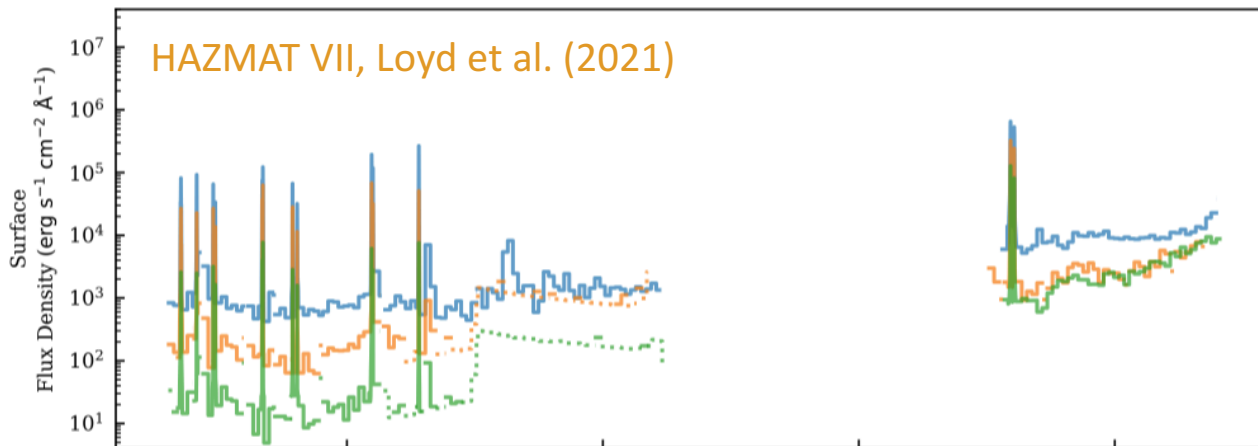
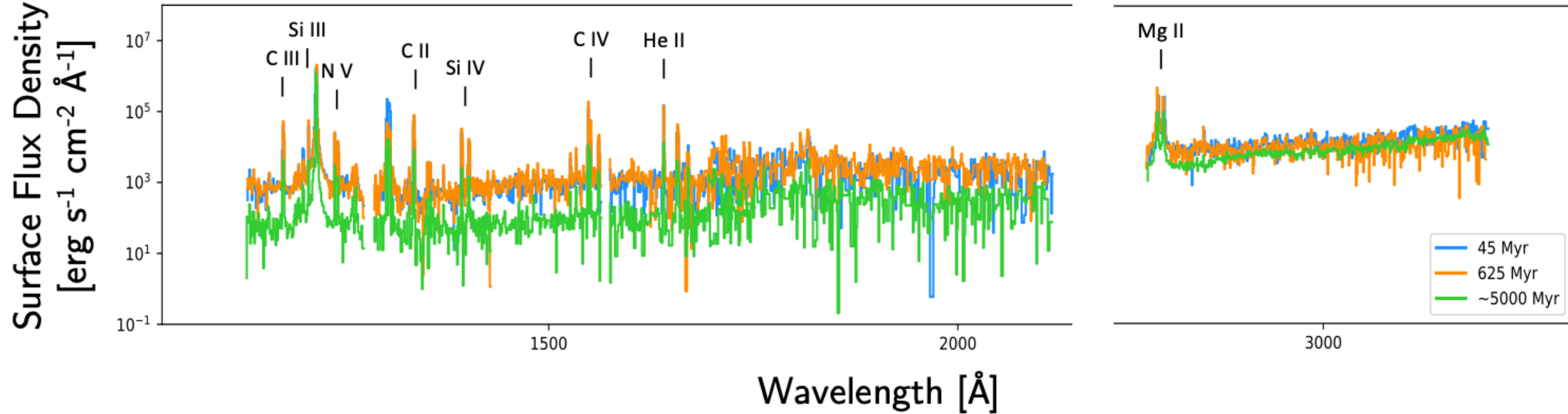


The Habitable Zone (HZ) is wider and farther out for K stars, so if the intrinsic UV flux is the same, there should be less flux in the HZ

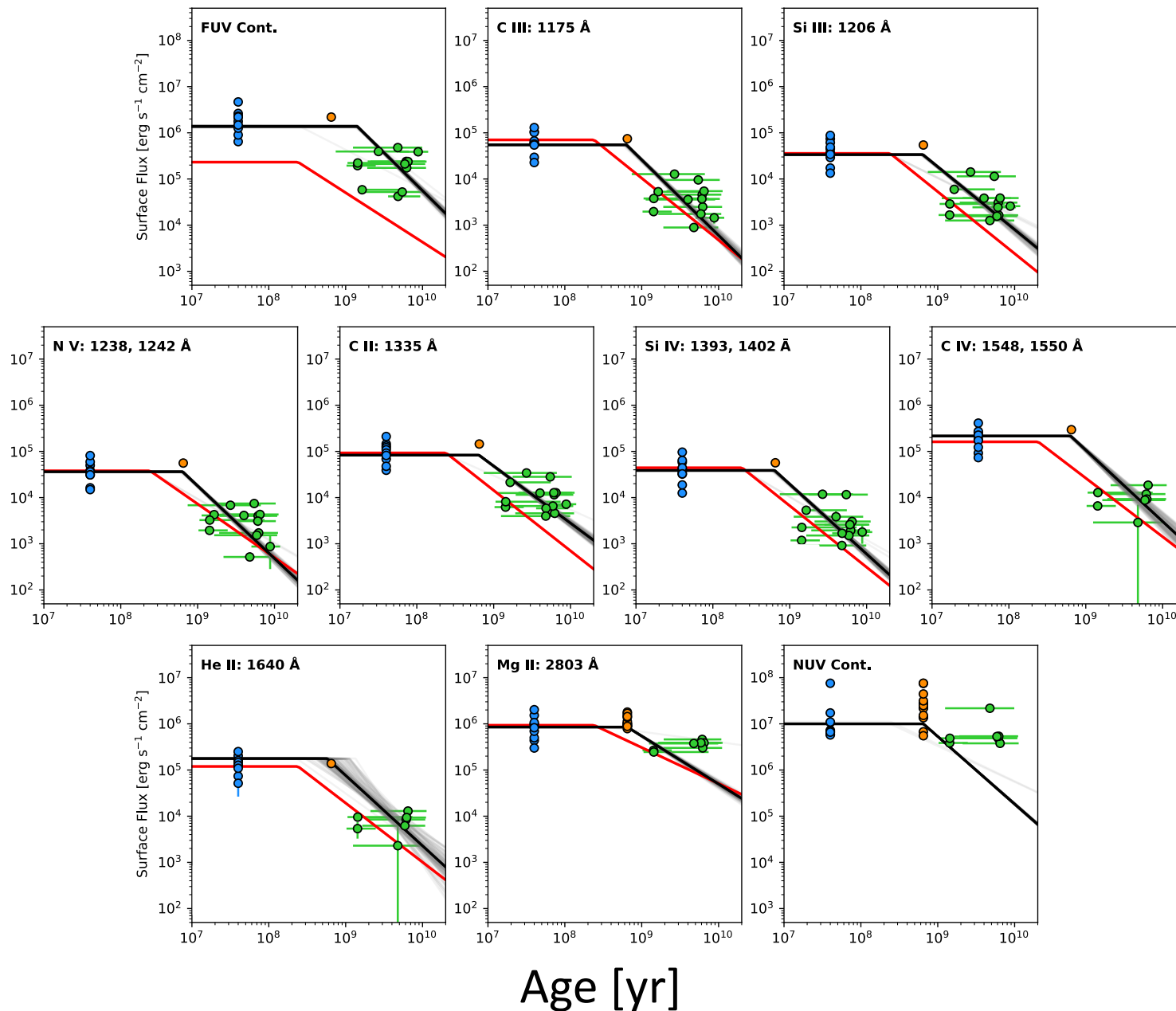


Based on Kopparapu+ 13, 14

Representative K Star Spectra



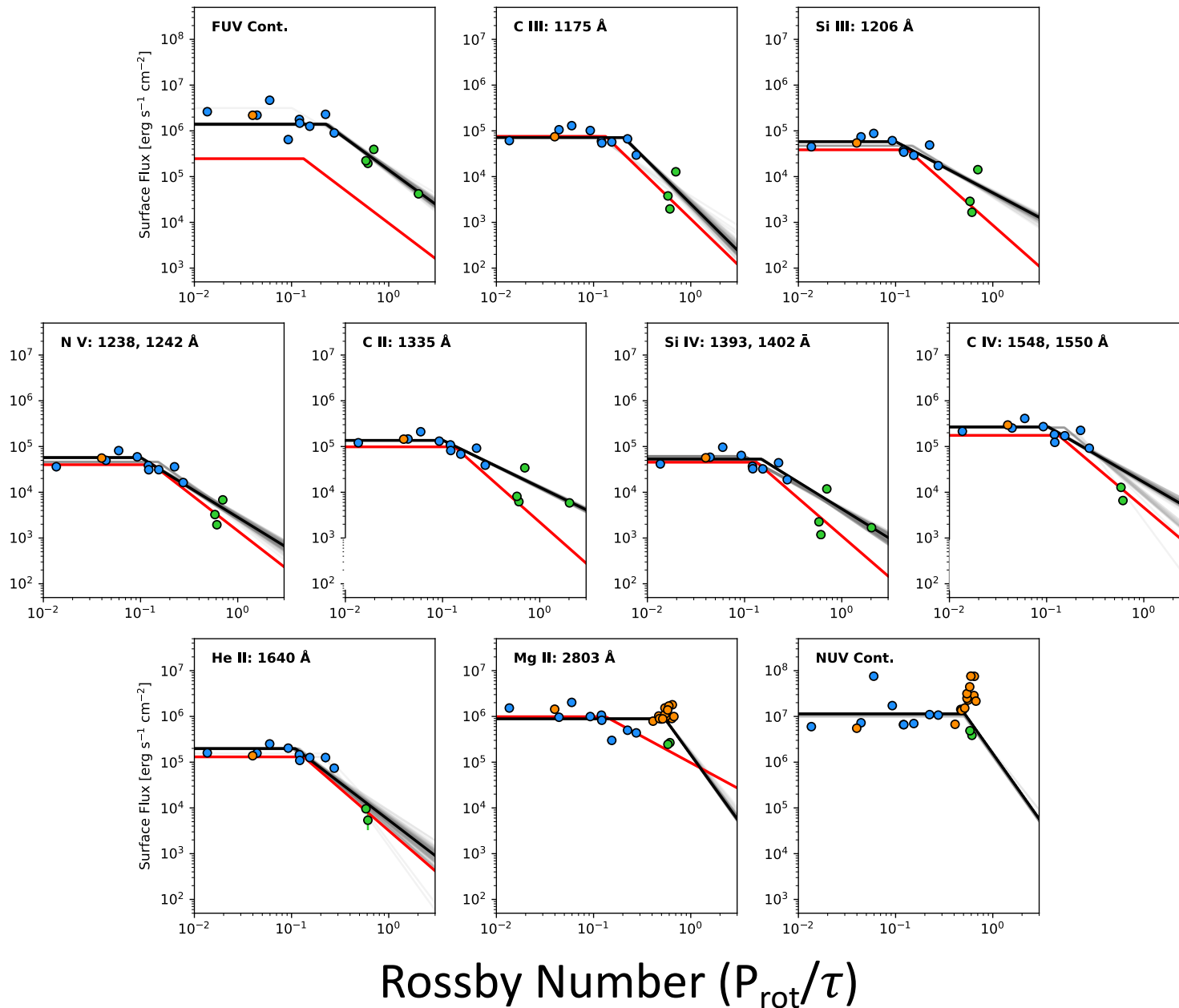
Surface Flux [erg/s/cm²]



K dwarfs show longer periods of saturation than M stars
in Mg II, C II, C III, C IV, Si III, Si IV, He II, N V, and the continua

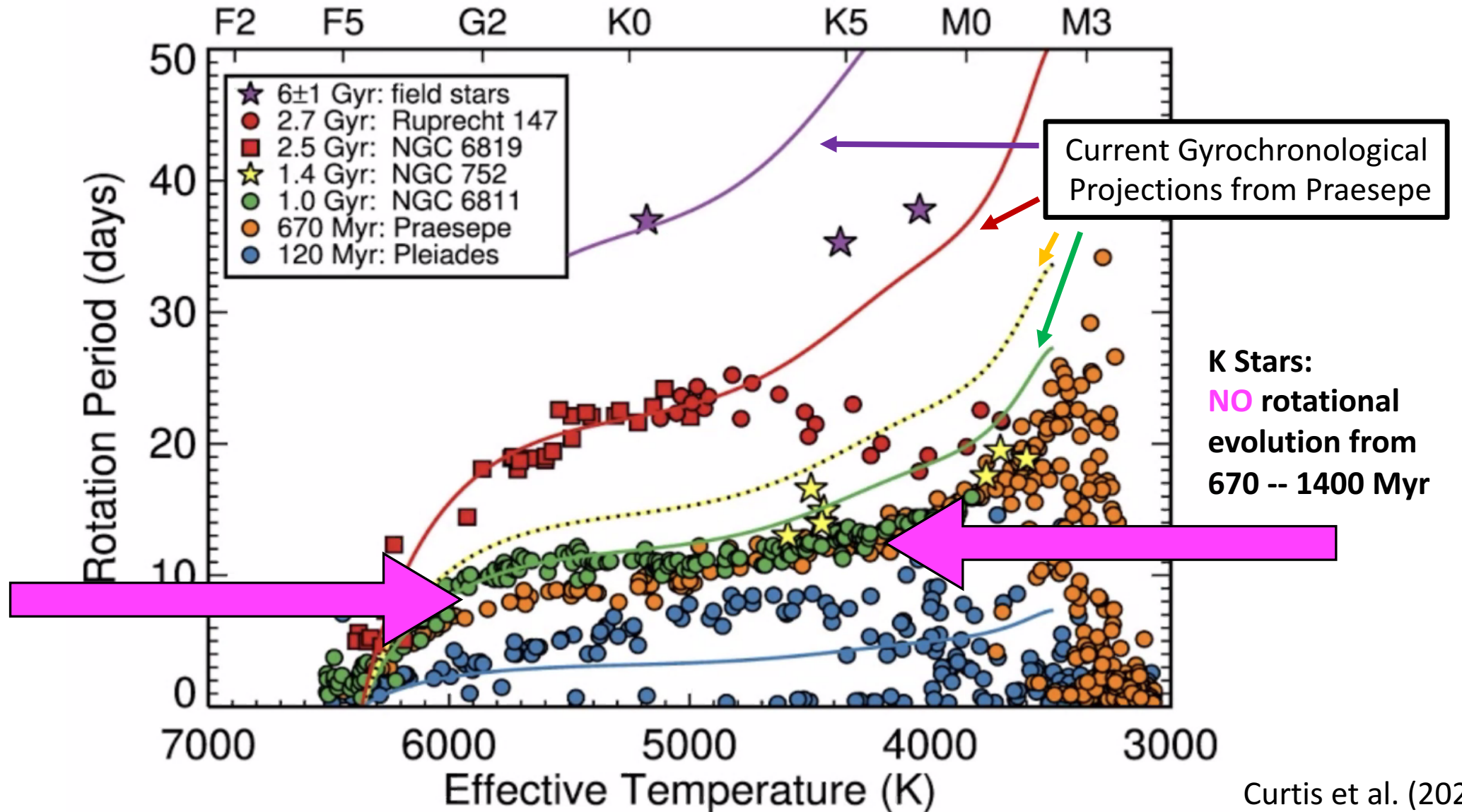
Age [yr]

Surface Flux [erg/s/cm²]



K dwarfs show similar UV evolution with rotation to M stars in Mg II, C II, C III, C IV, Si III, Si IV, He II, N V, and the continua

K dwarf Stalling?



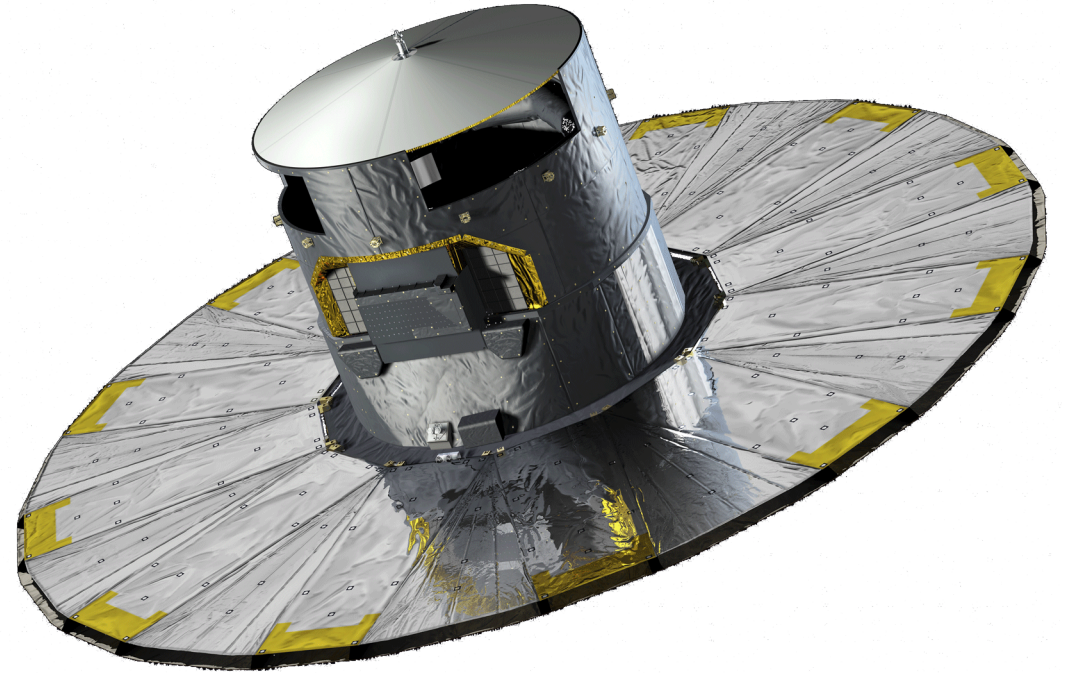
Curtis et al. (2020)

HAZKAT Update with Gaia

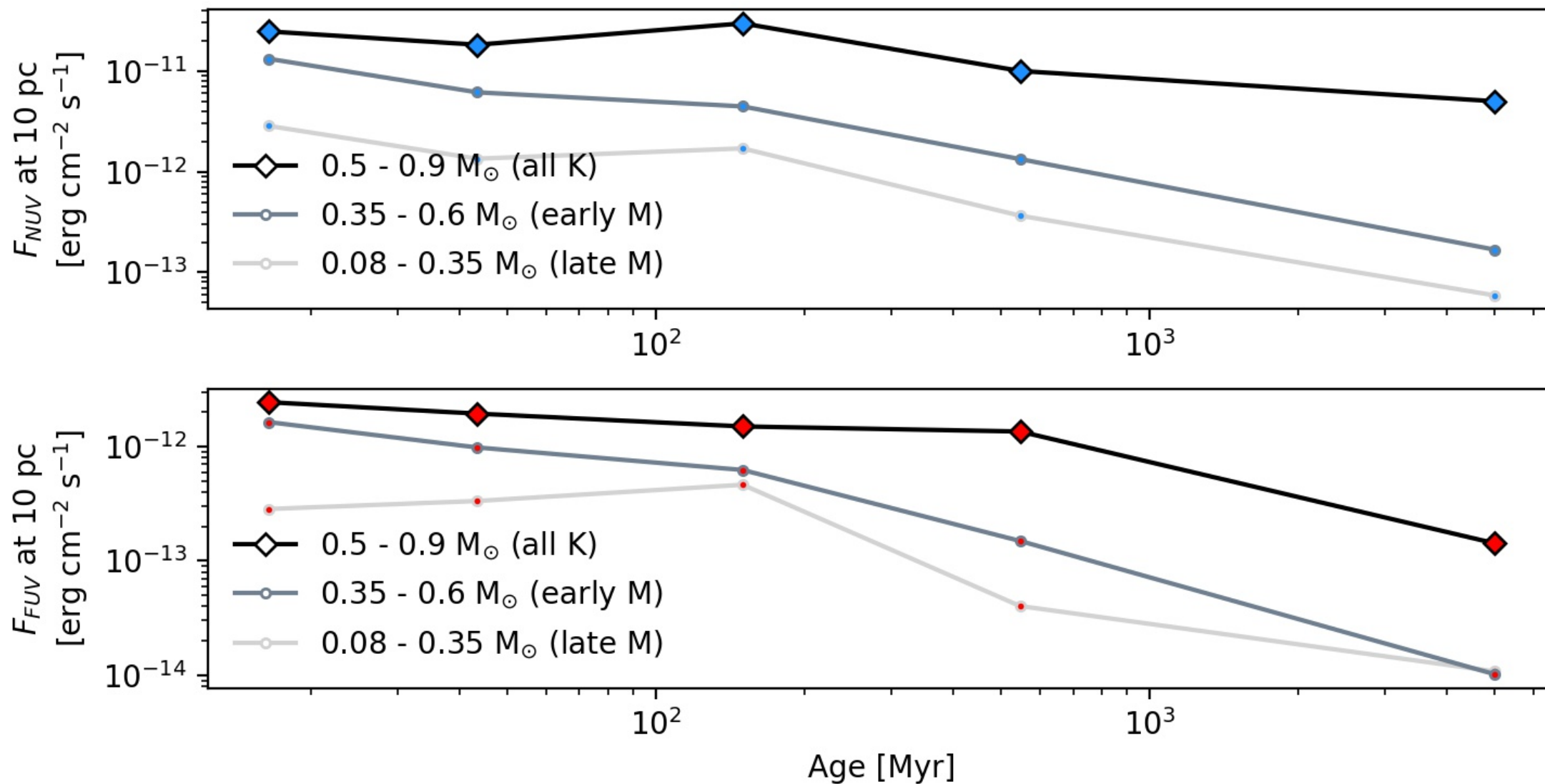
The M star data from HAZKAT was before we knew the distances to the stars

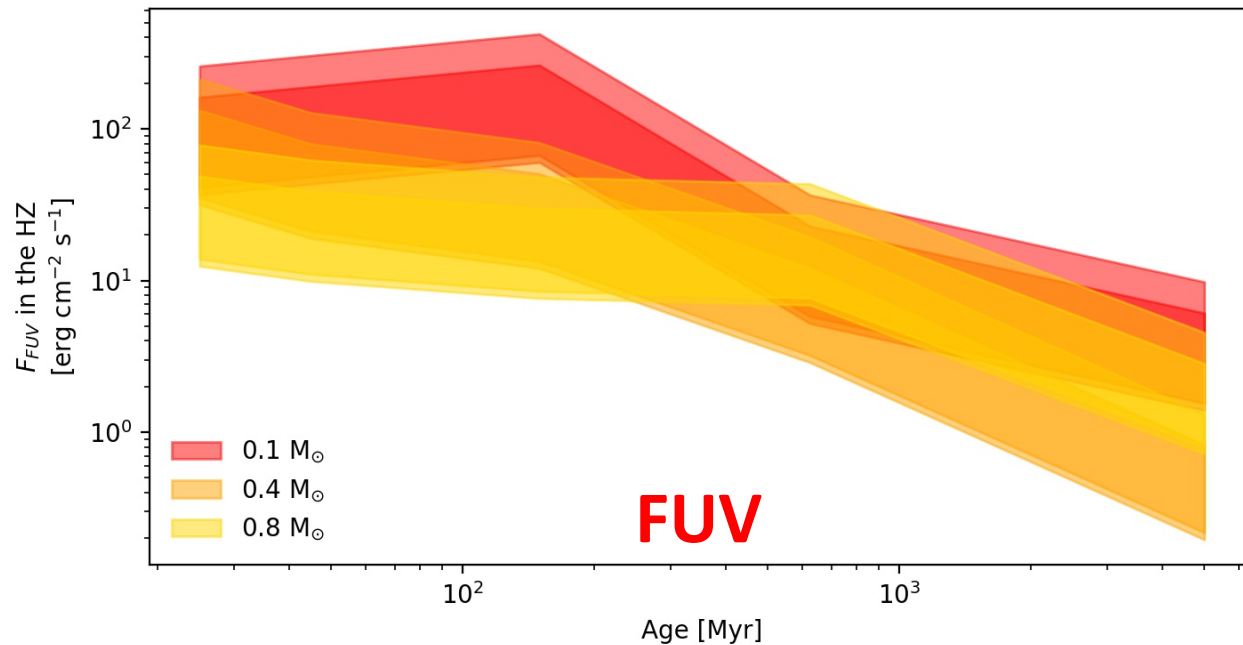
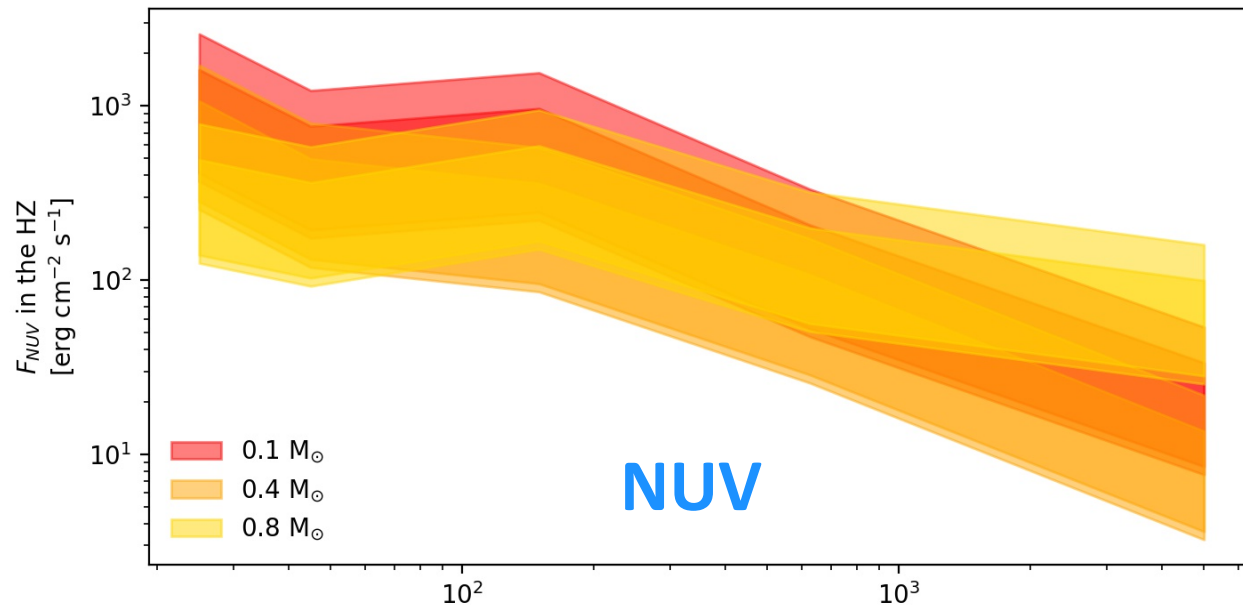
- We used a **distance proxy** for our comparisons

With new data from **Gaia**, we now know almost all of the distances!



With updated distances, M star UV flux is decreased





With updated distances, the habitable zone fluxes are now similar!

What does this mean for planets around K stars?

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Conclusions:

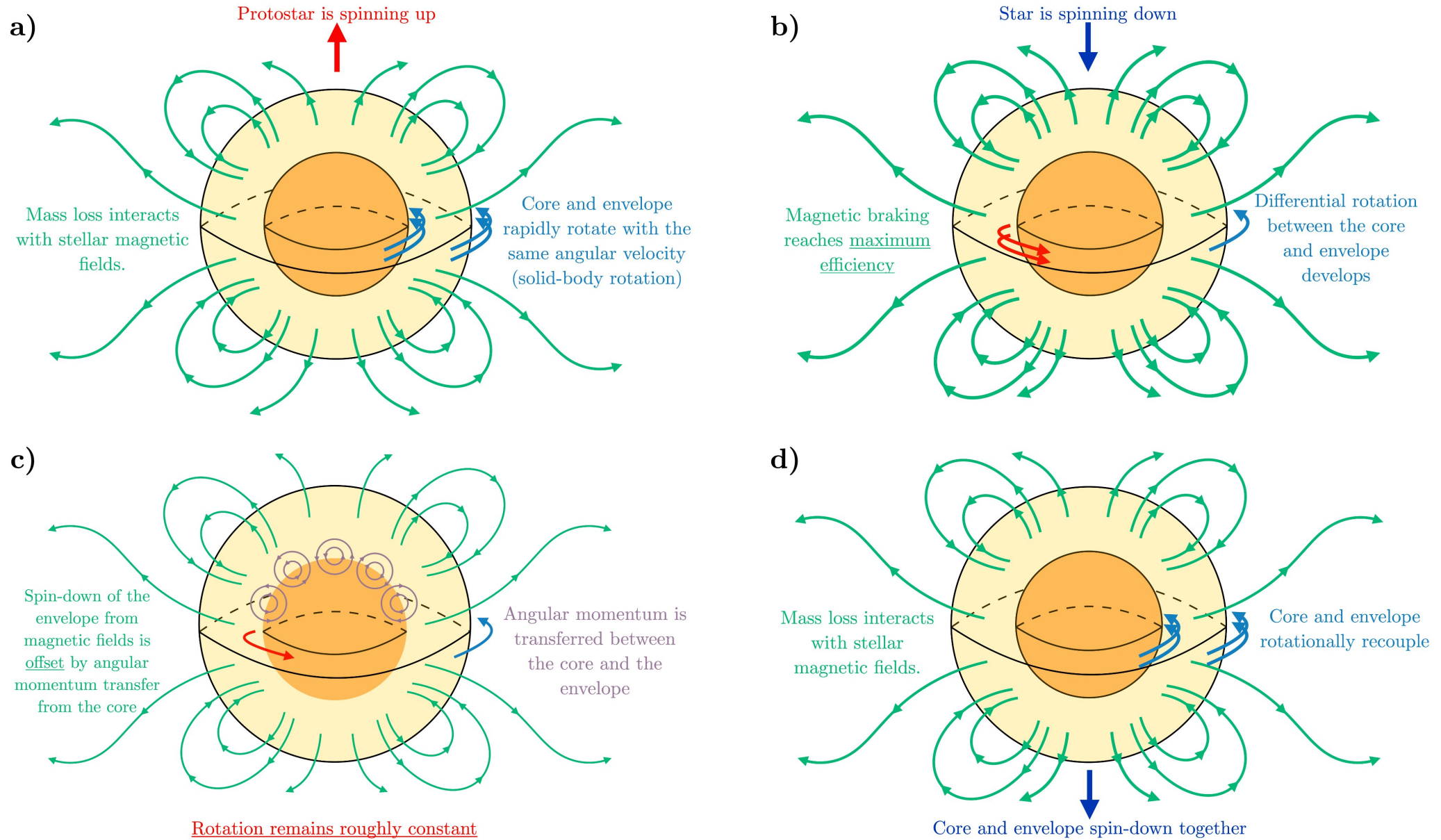
1. We see a **prolonged** period of saturation in K stars in comparison to M stars.
2. The intrinsic UV flux of K stars is **larger** than for M stars, especially by field age.
3. The UV flux in the habitable zones of both K and M stars is **similar**.
4. K dwarf **flare evolution** will determine whether K dwarfs do show an advantage.

Maybe K stars aren't as great of hosts as we thought?

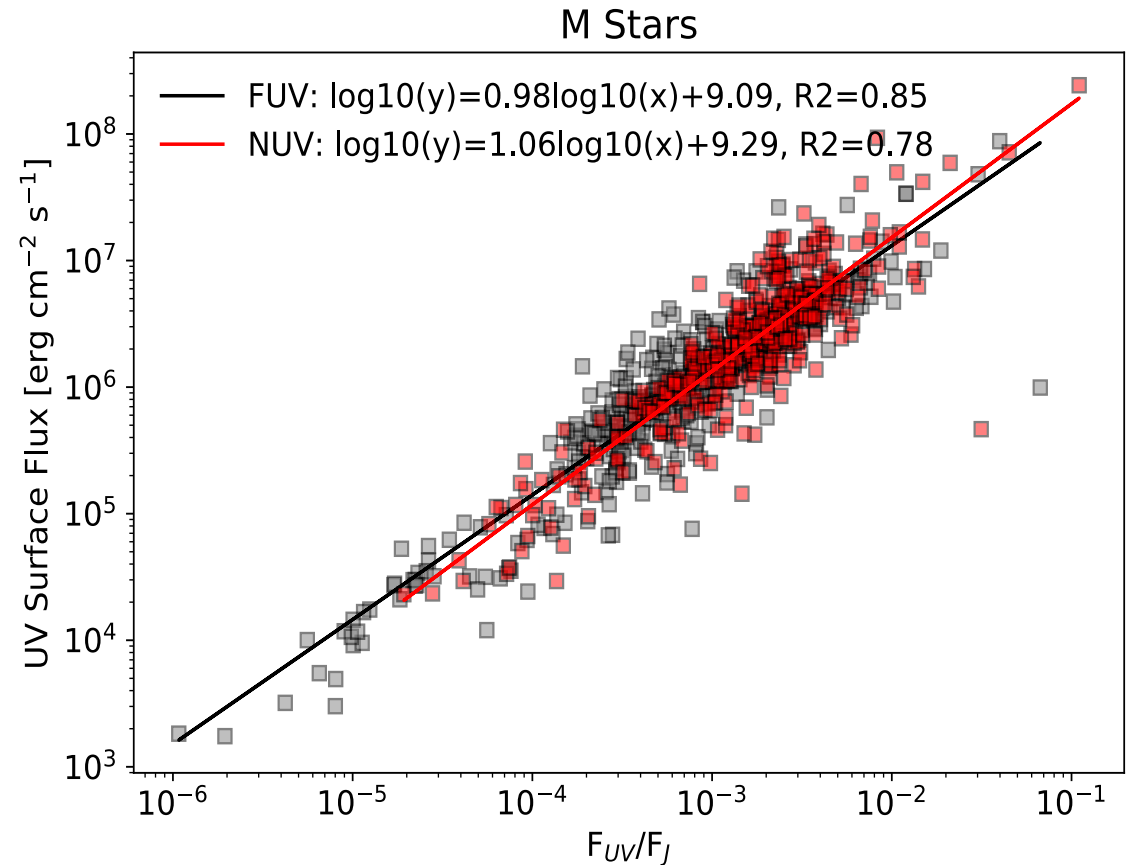
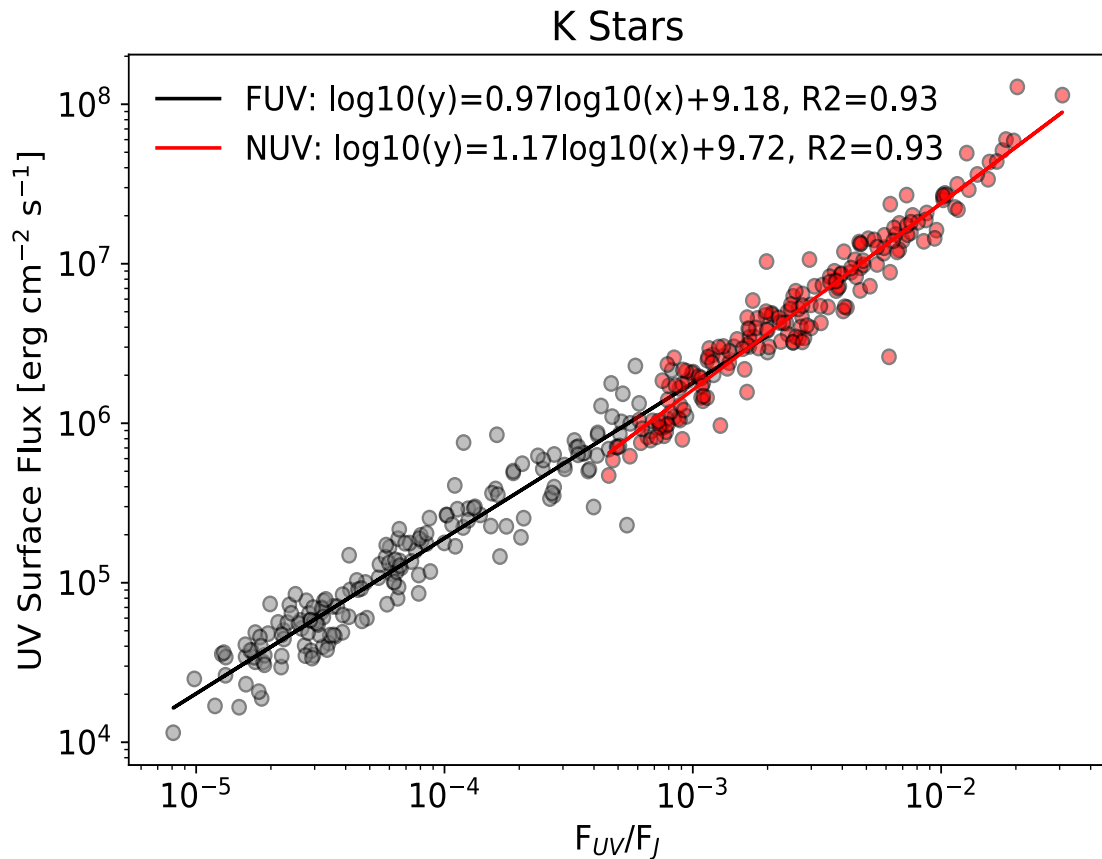
Backup Slides

Core-envelope recoupling (Spada & Lanzafame 2020)

Figure by Erica Sawczynek

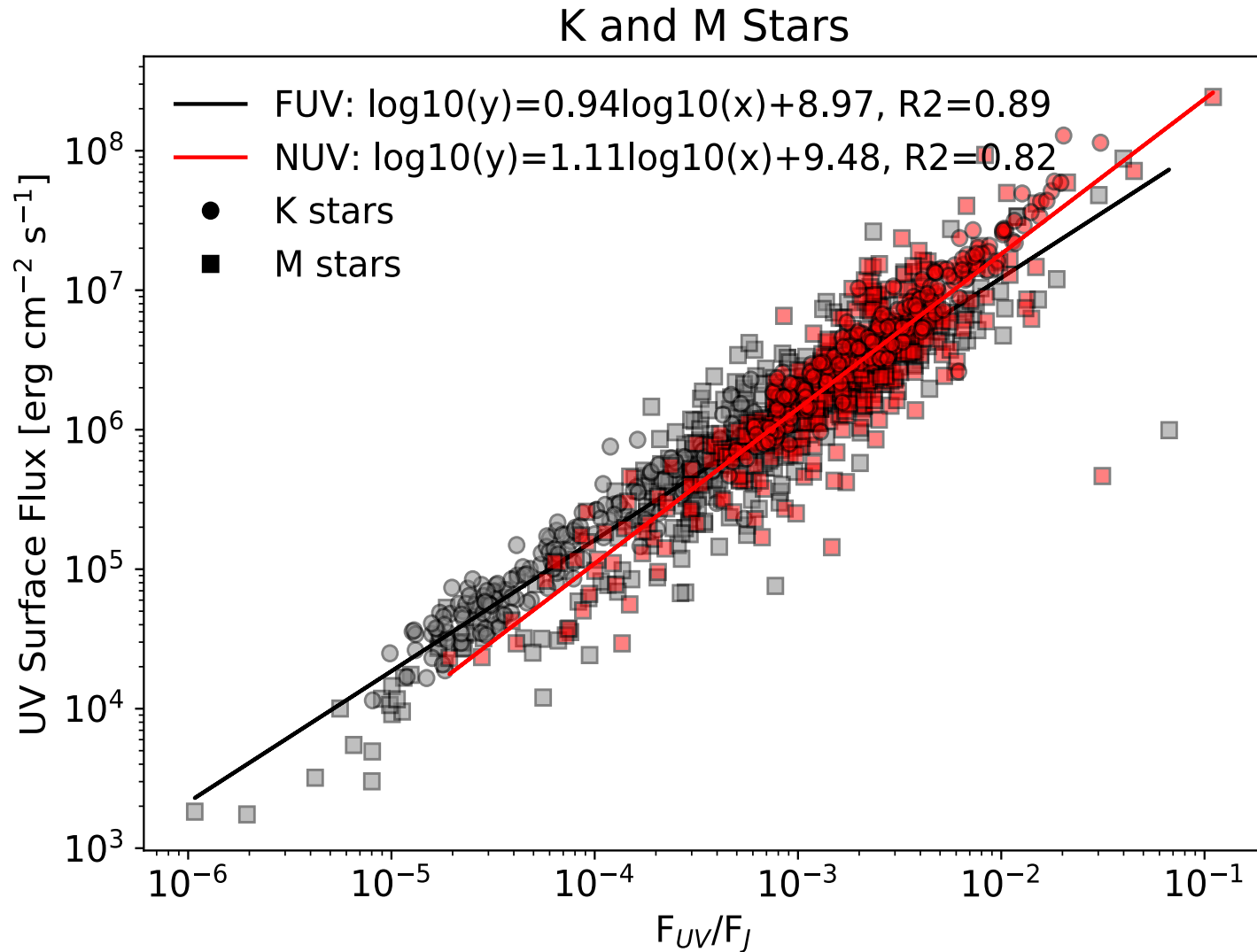


UV/J relations overestimate FUV, underestimate NUV



Richey-Yowell+ in prep

UV/J relations overestimate FUV, underestimate NUV



Richey-Yowell+ in prep