



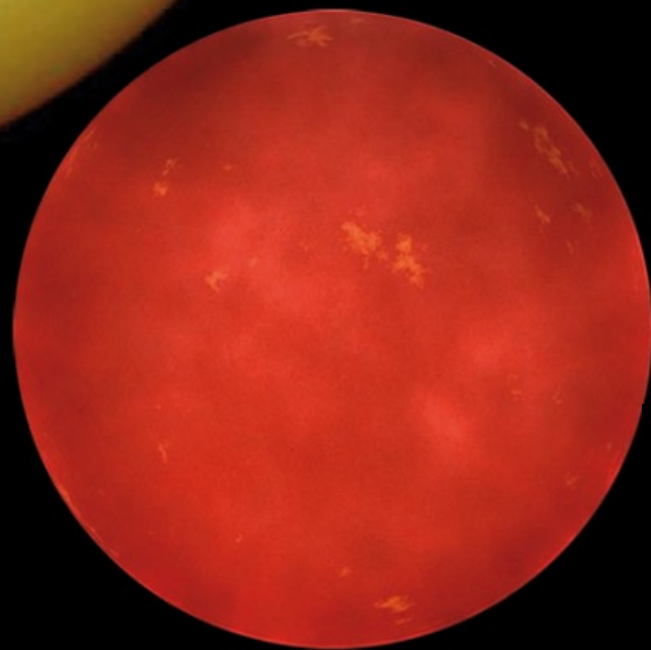
# Young Brown Dwarf Spectra with JWST/NIRSpec

Sci Science Workshop 16  
January 24, 2024

Elena Manjavacas  
ESA/AURA Astronomer at STScI



Sun



Gliese 229A



Jupiter



5,800 K

3,600 K

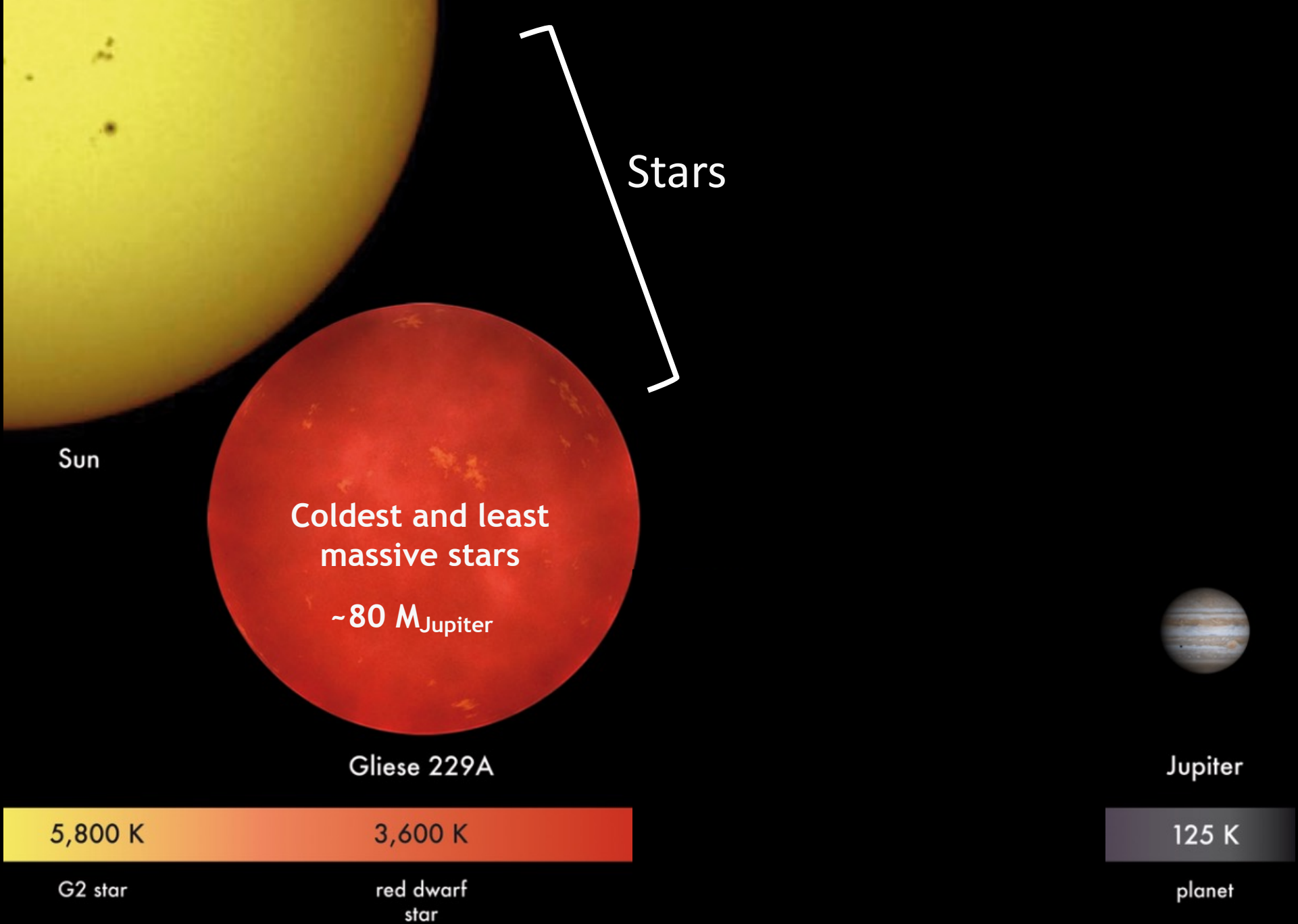
G2 star

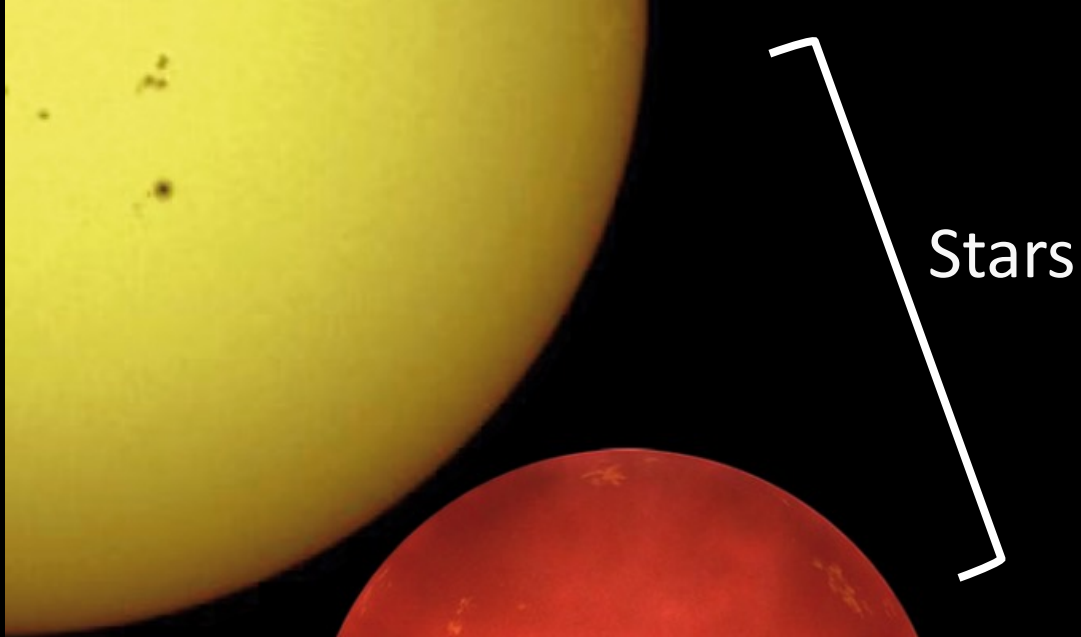
red dwarf  
star



125 K

planet





Sun



Coldest and least massive stars

~80  $M_{\text{Jupiter}}$

Gliese 229A



5,800 K

3,600 K

G2 star

red dwarf star

### Giant Planets



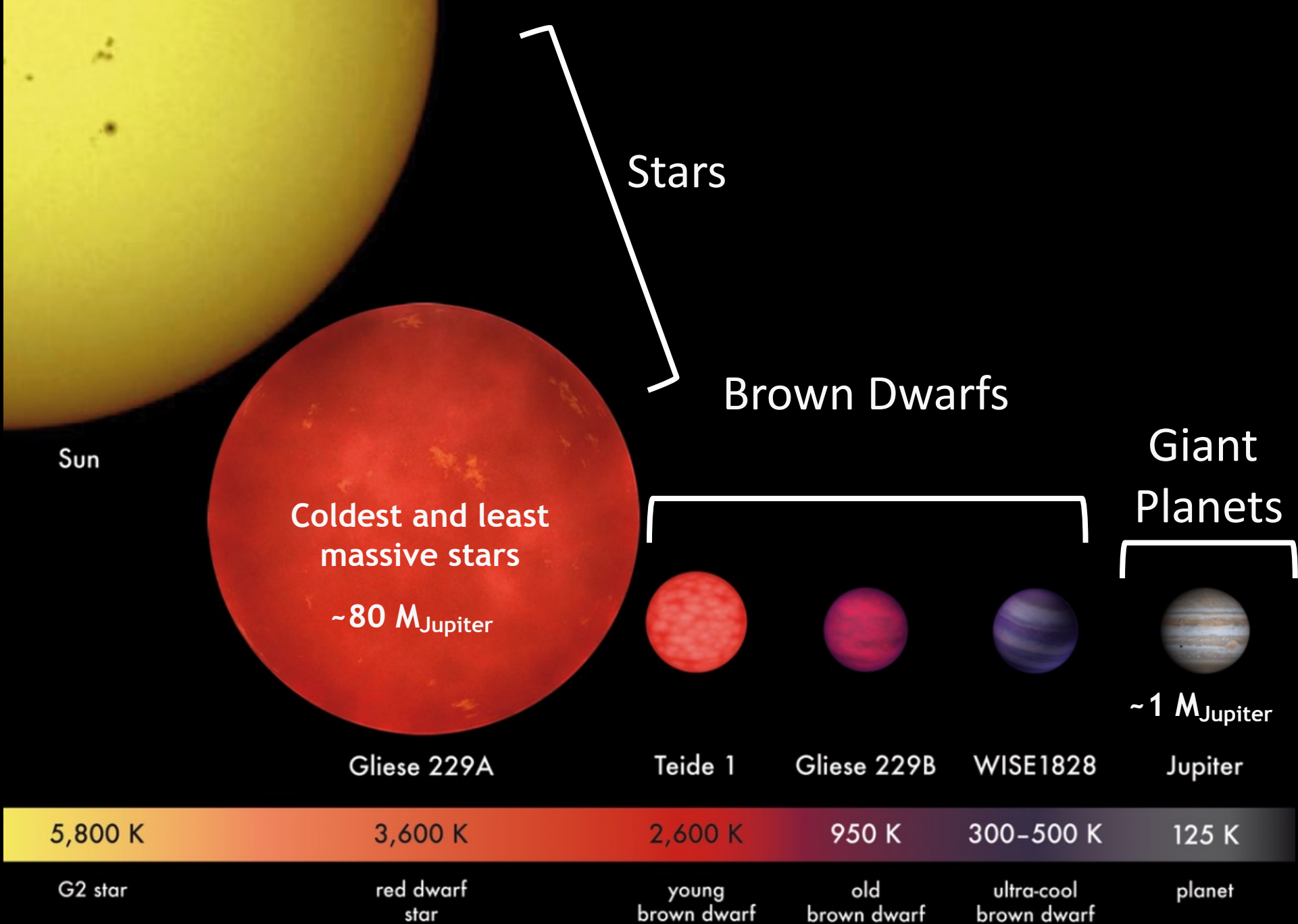
~1  $M_{\text{Jupiter}}$

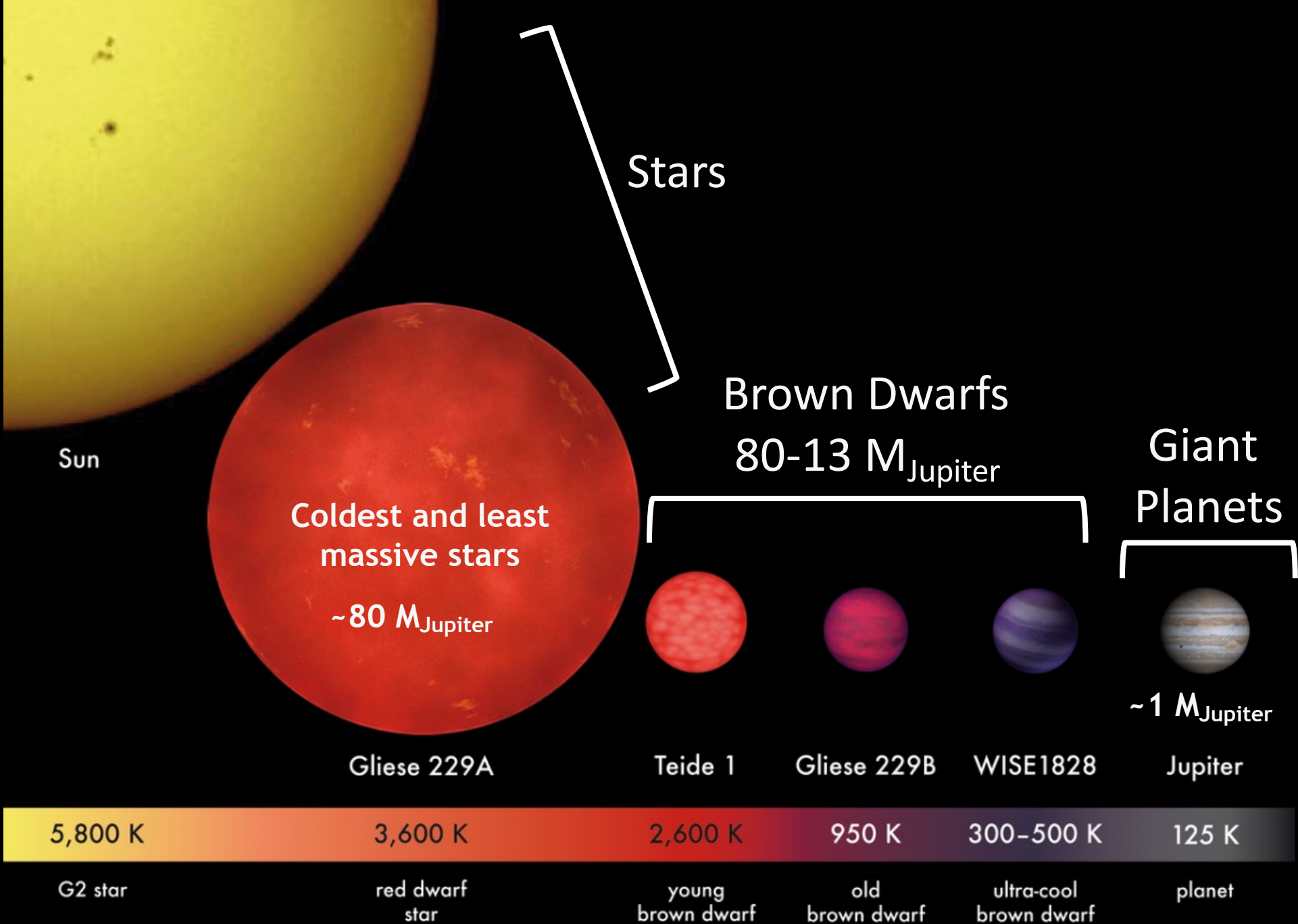
Jupiter

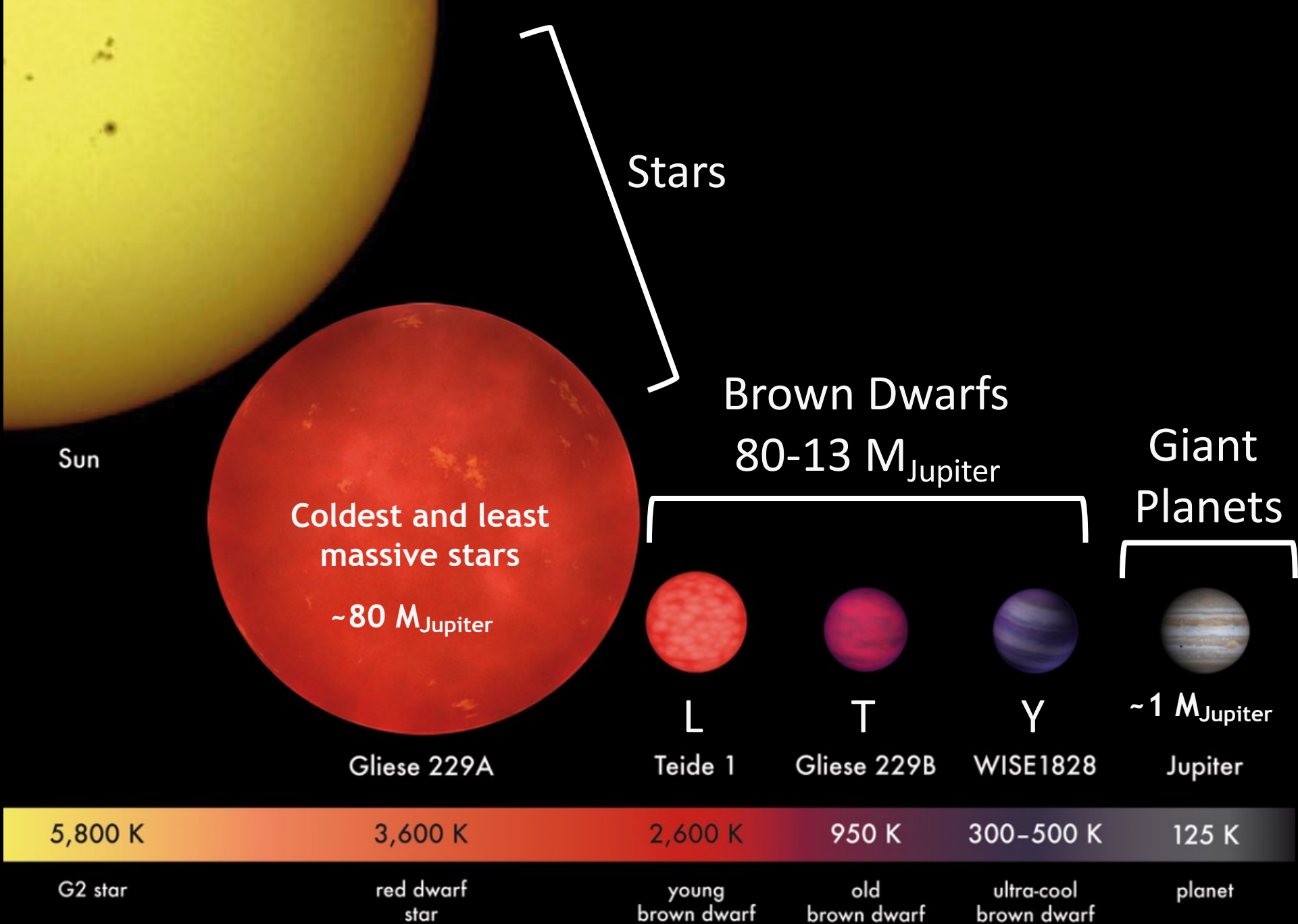


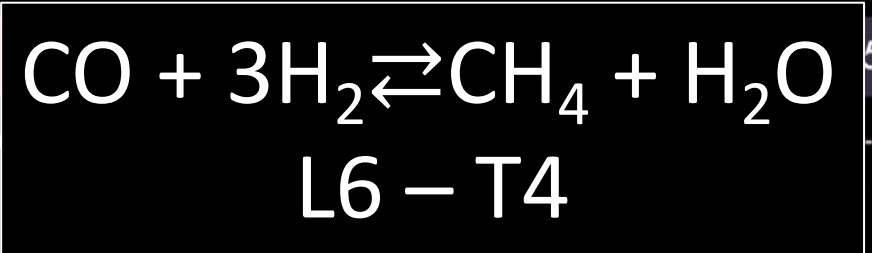
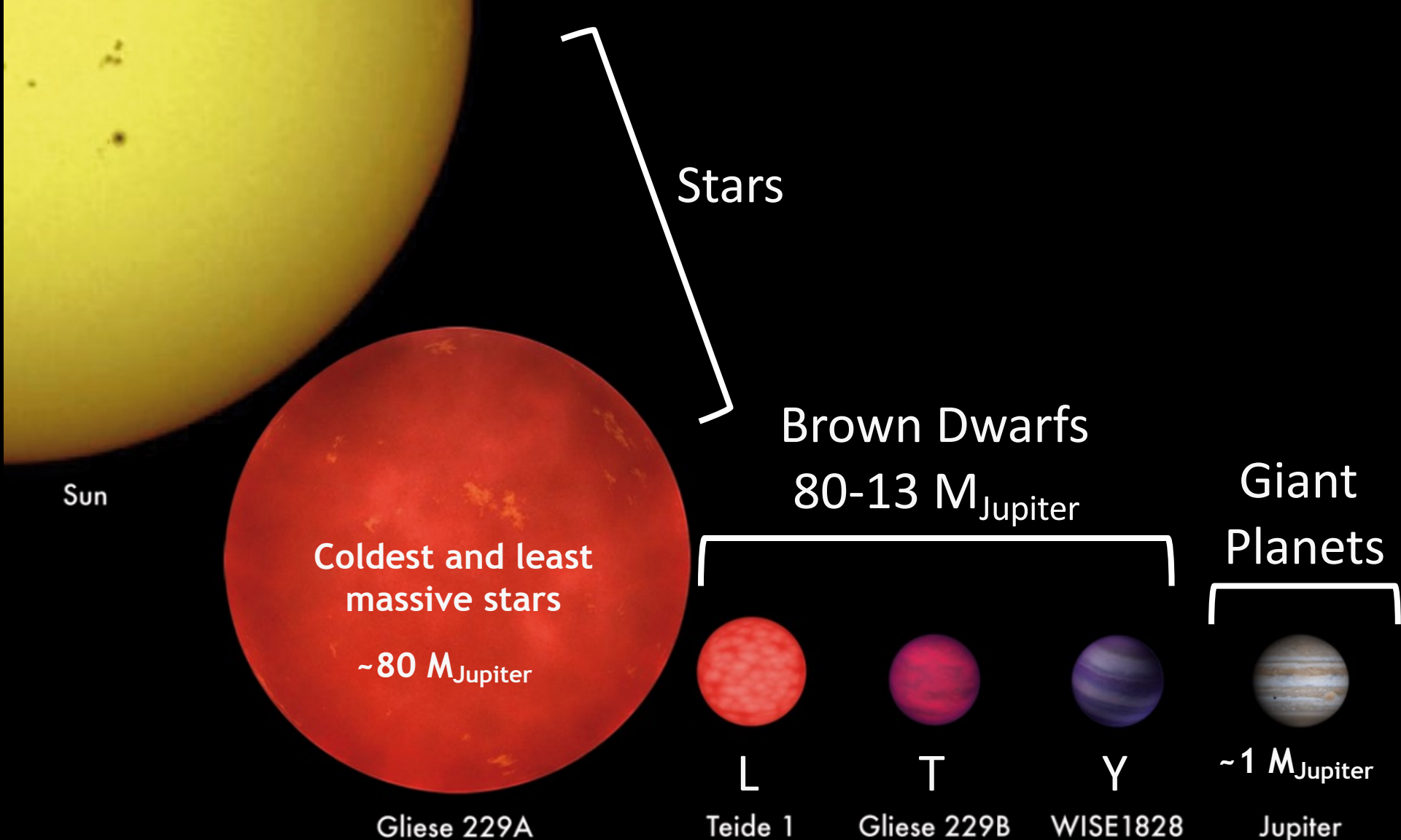
125 K

planet











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3 Members of the TW Hydrae Association  $\sim 10 \pm 2$  Myr

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**JWST/NIRSpec IFU spectra  $R \sim 2700$**

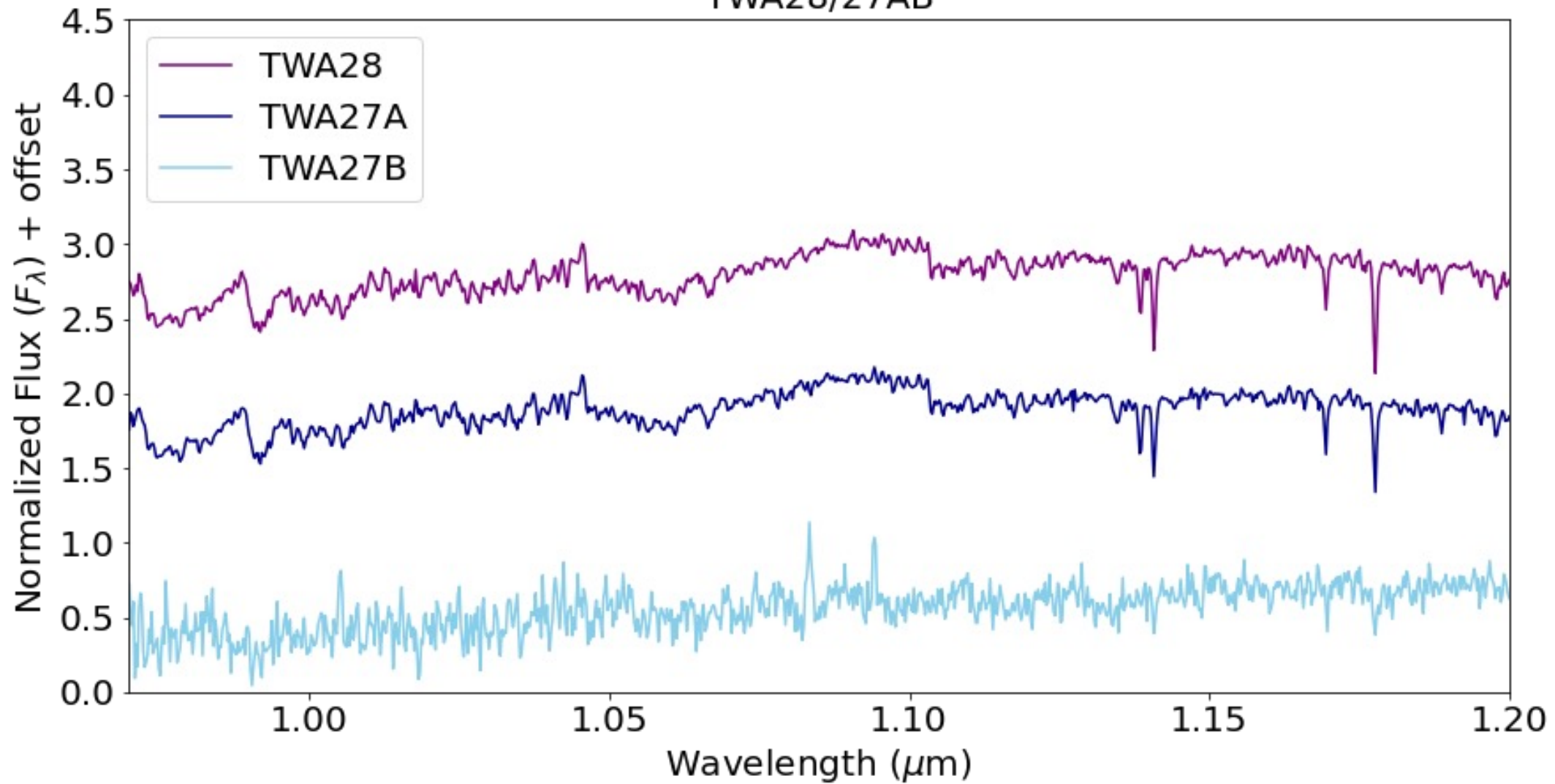
$0.97 - 5.3 \mu\text{m}$



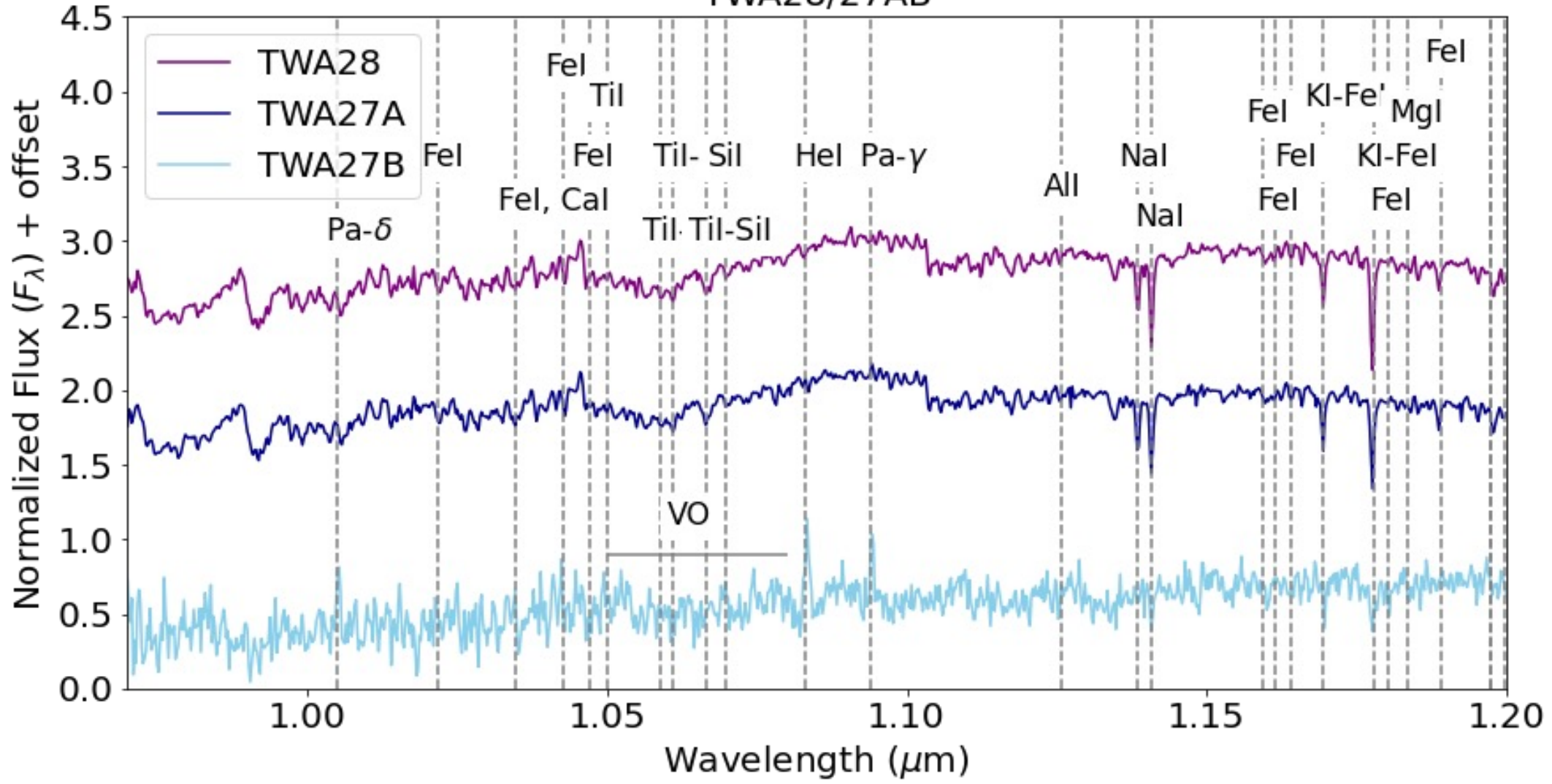
This is how JWST/NIRSpec  
spectra of Young BDs  
look like



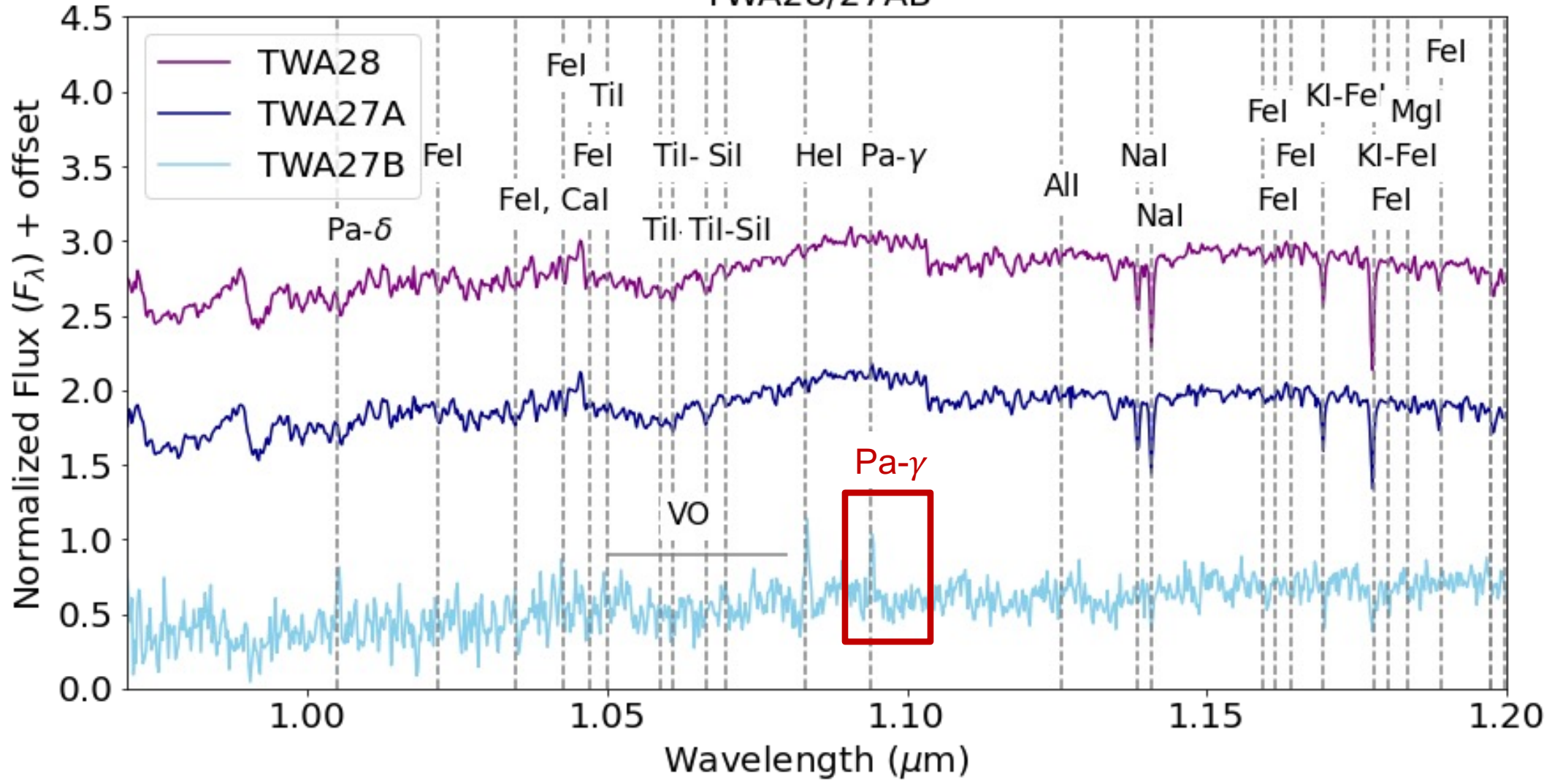
TWA28/27AB



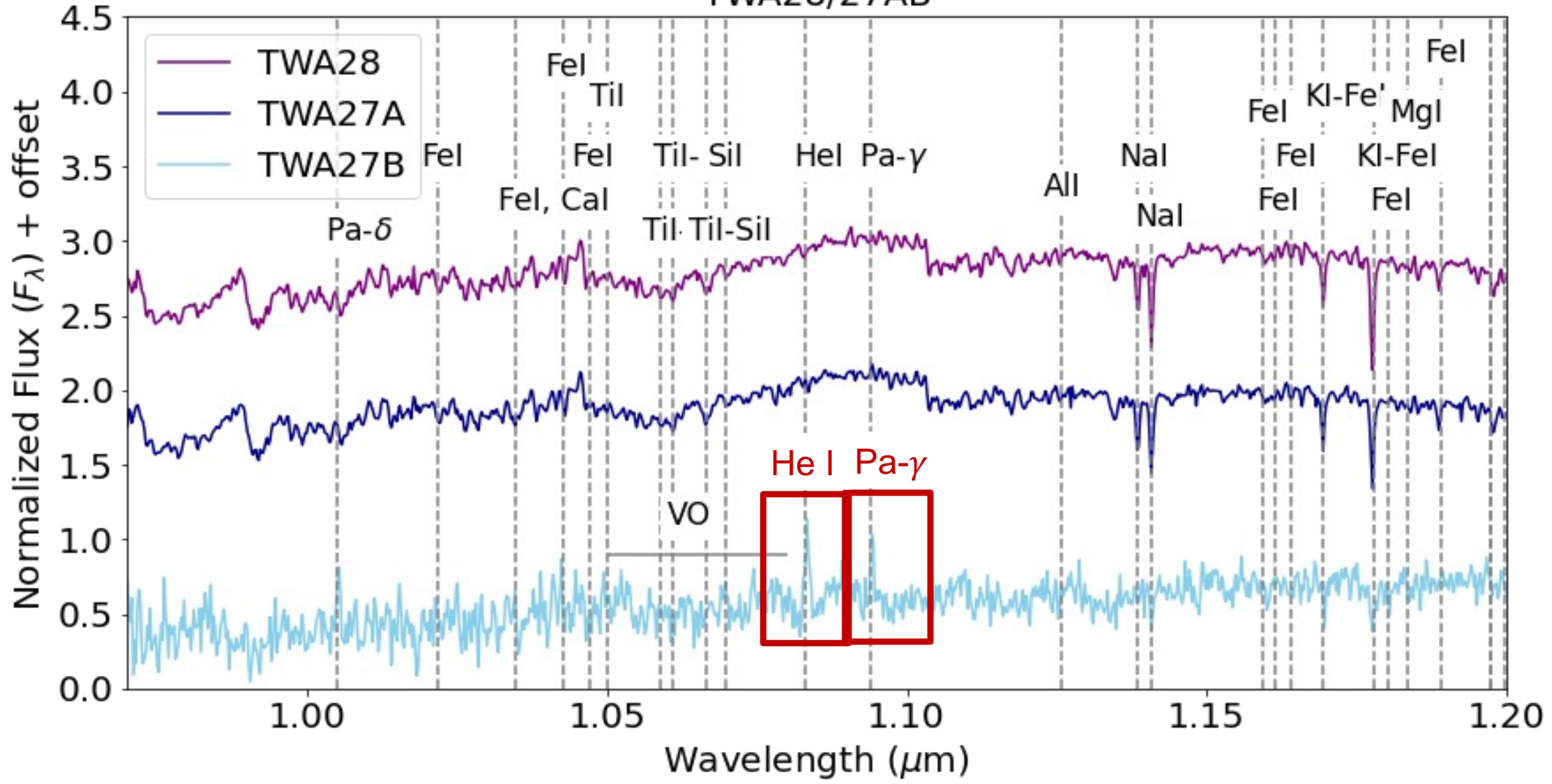
### TWA28/27AB



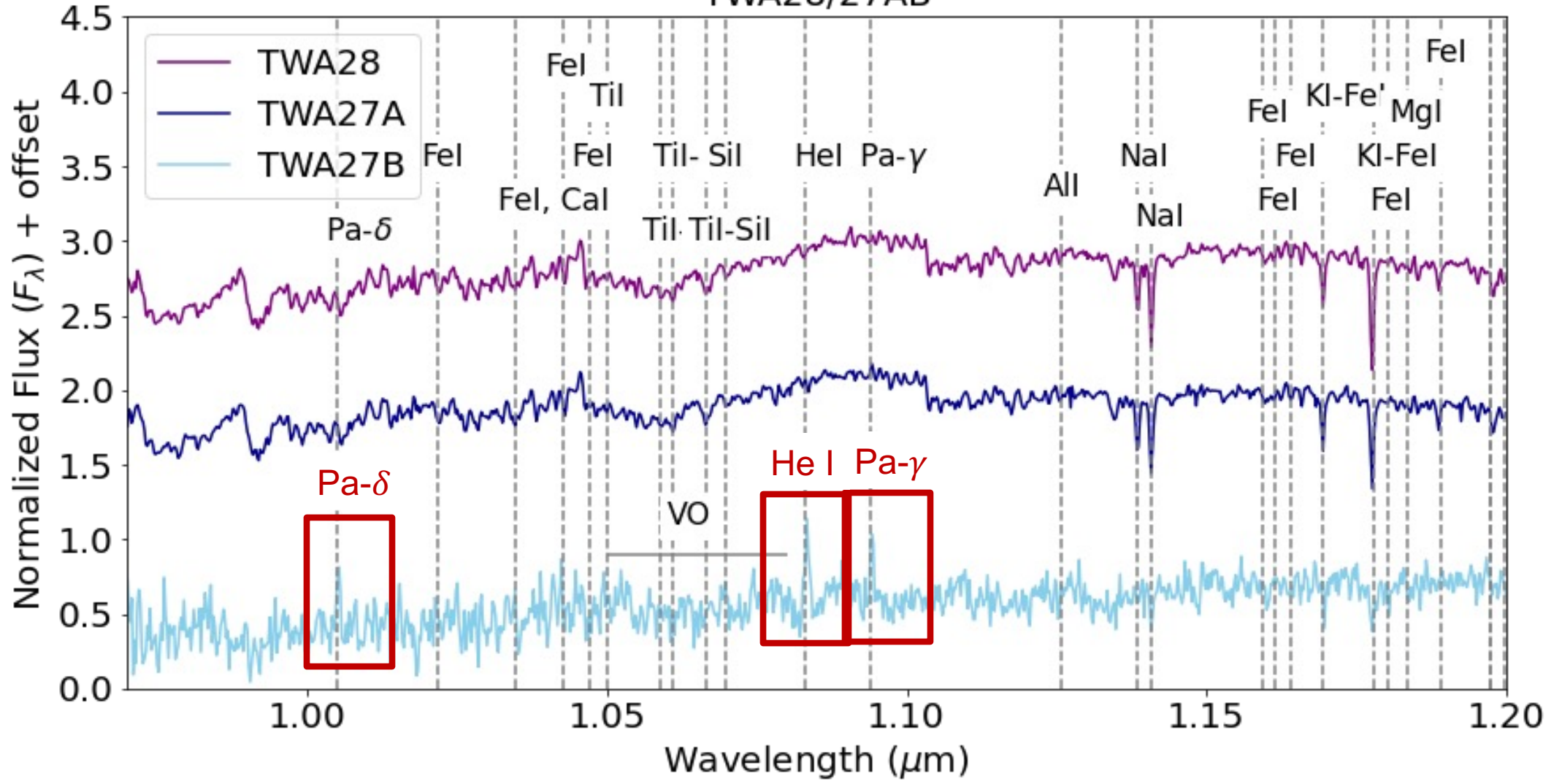
# TWA28/27AB



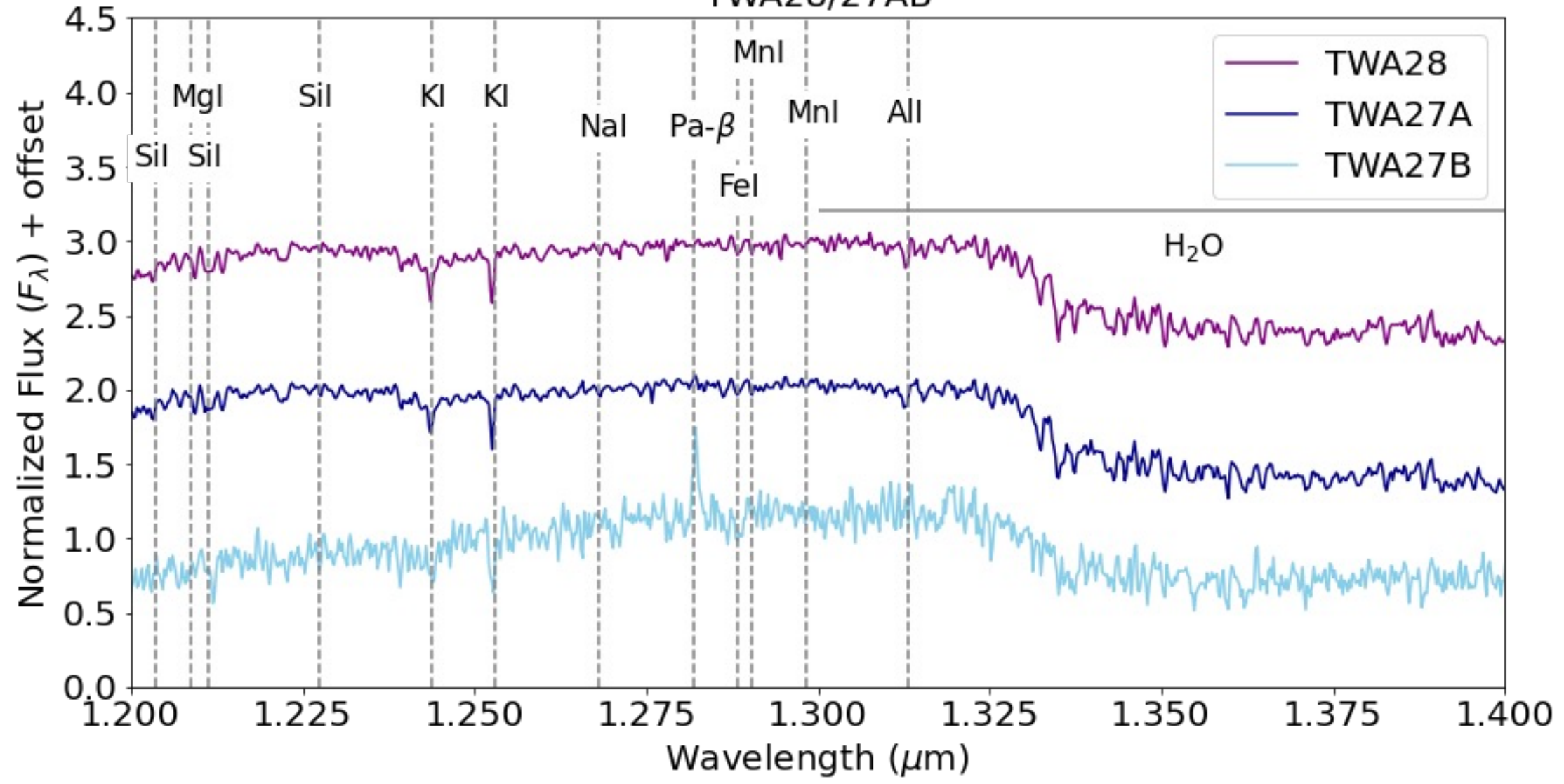
# TWA28/27AB

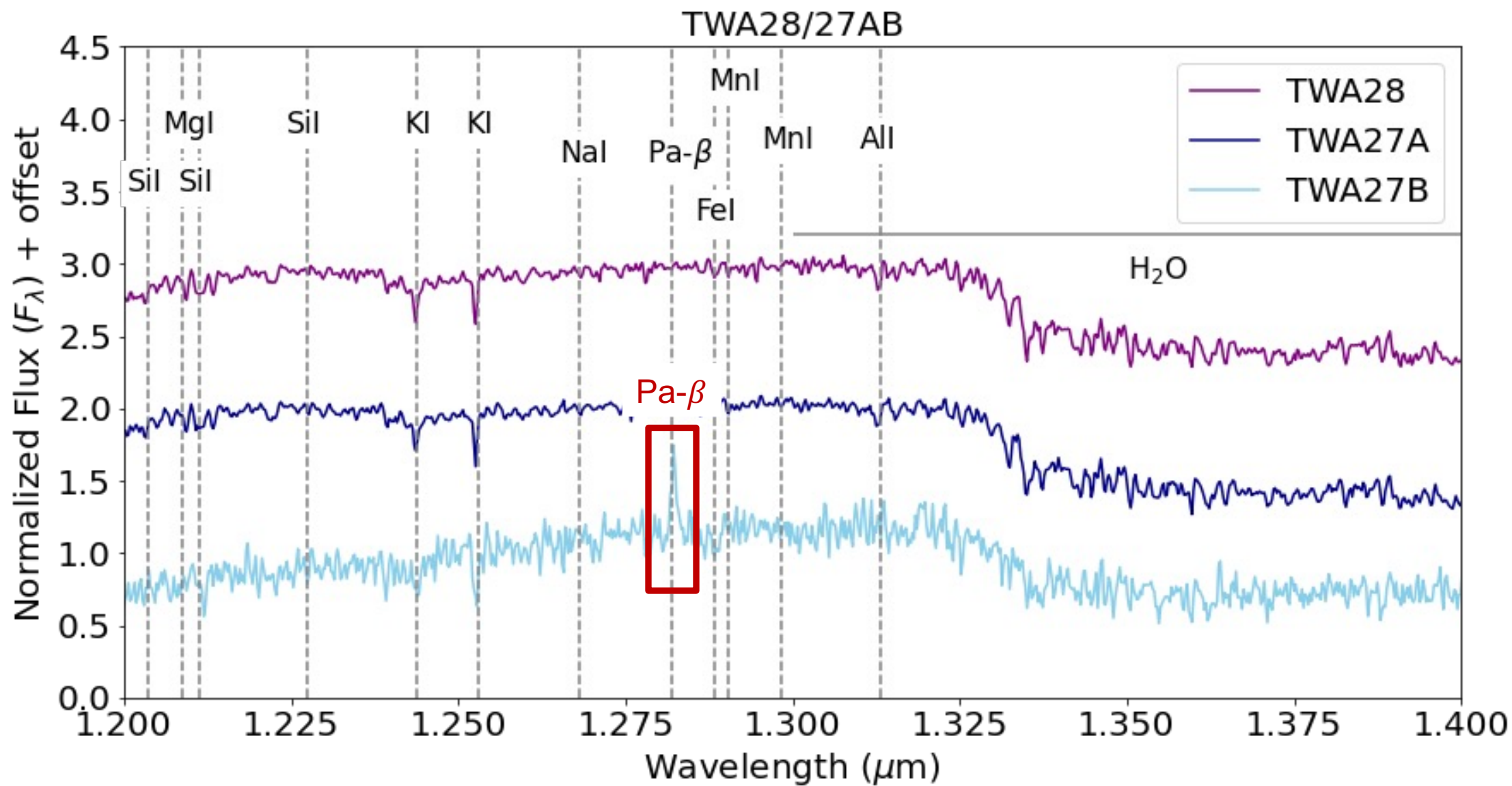


# TWA28/27AB

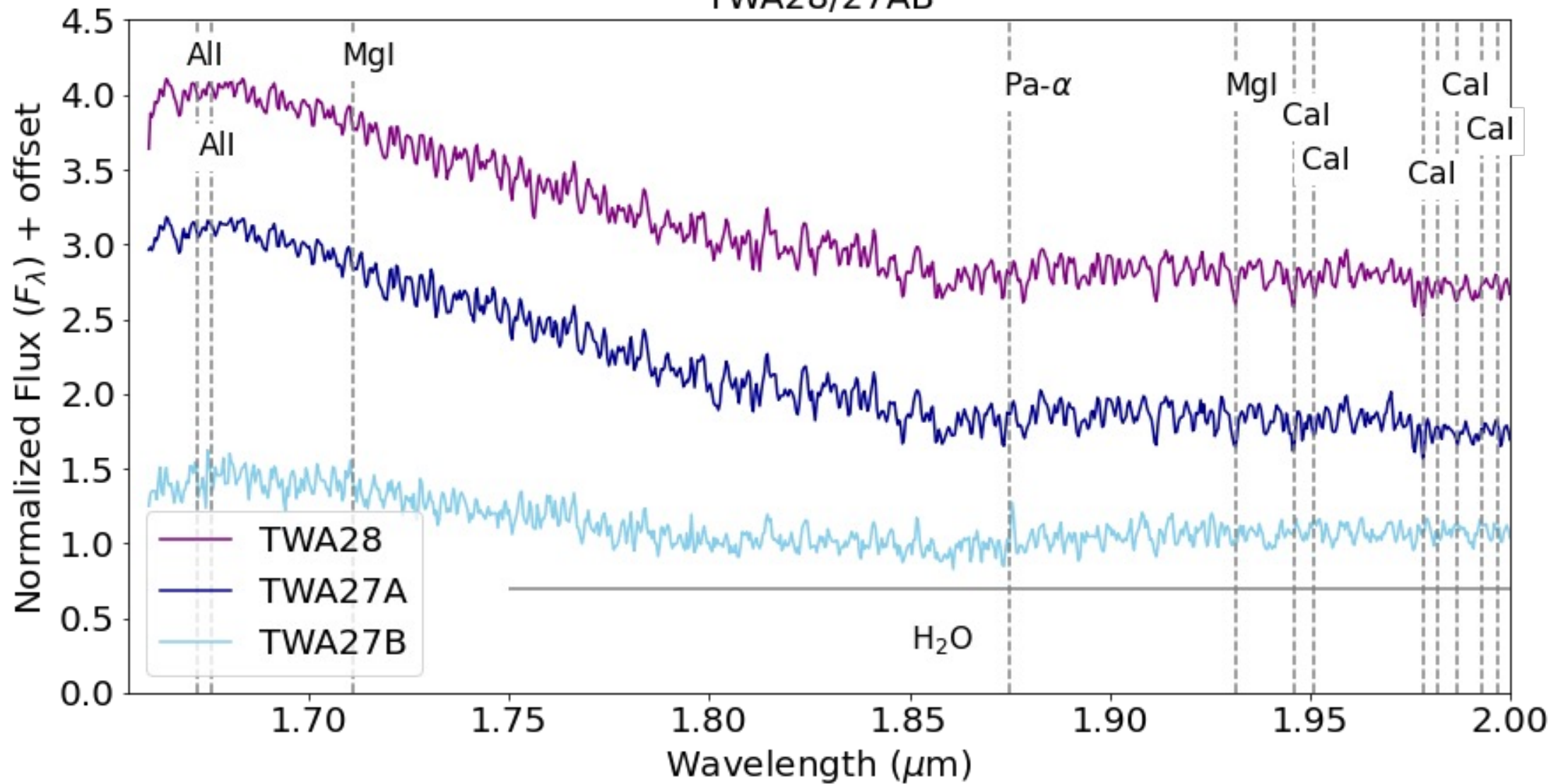


### TWA28/27AB



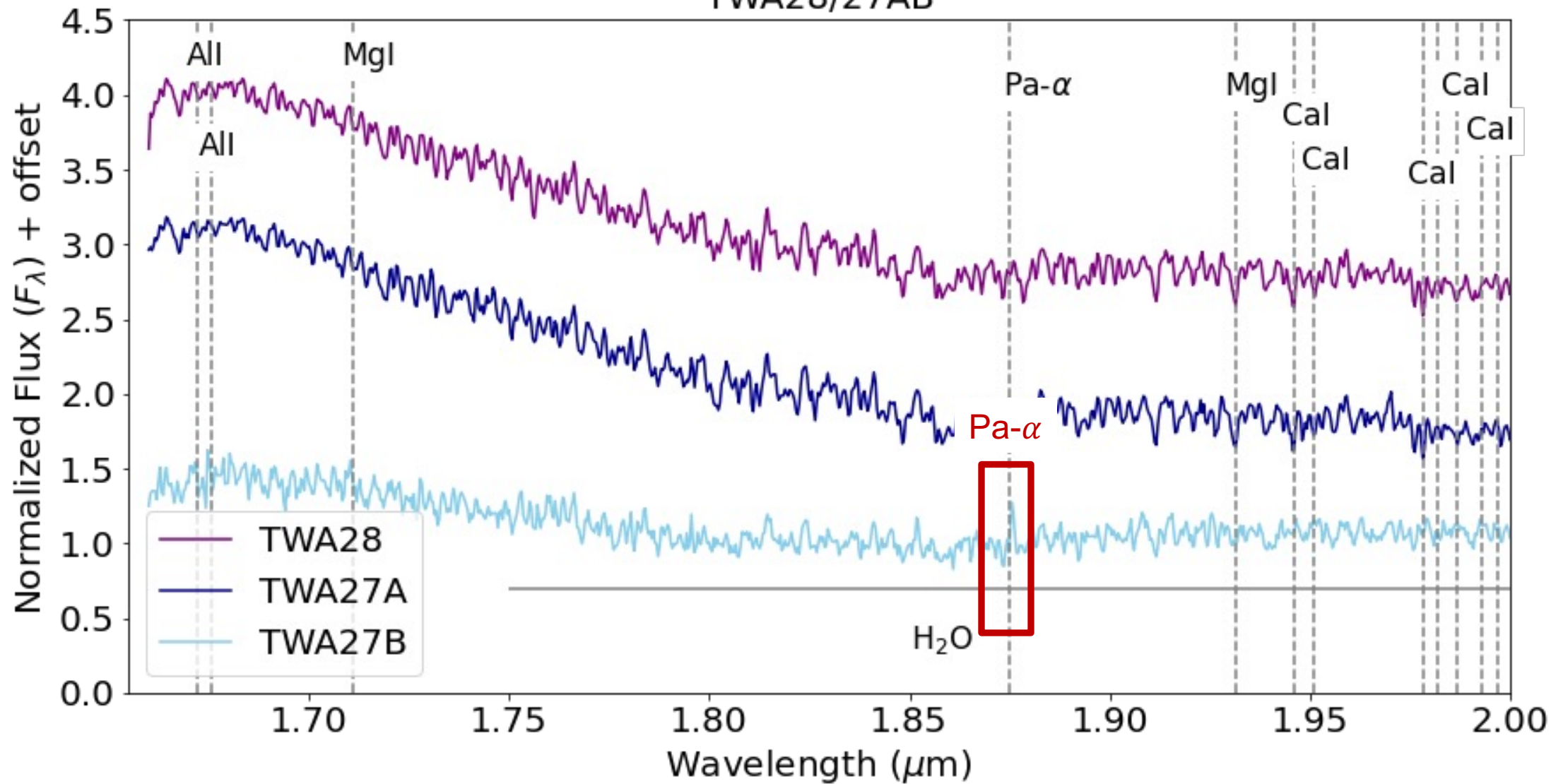


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# Comparison to Modeled Spectra

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## **BT-Settl Atmospheric Models**

(Allard et al. 2012)

- Cloudy Models
- Disequilibrium chemistry for CO, CH<sub>4</sub>, CO<sub>2</sub>, N<sub>2</sub>, and NH<sub>3</sub>



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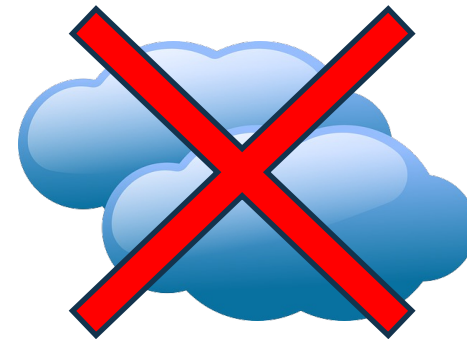
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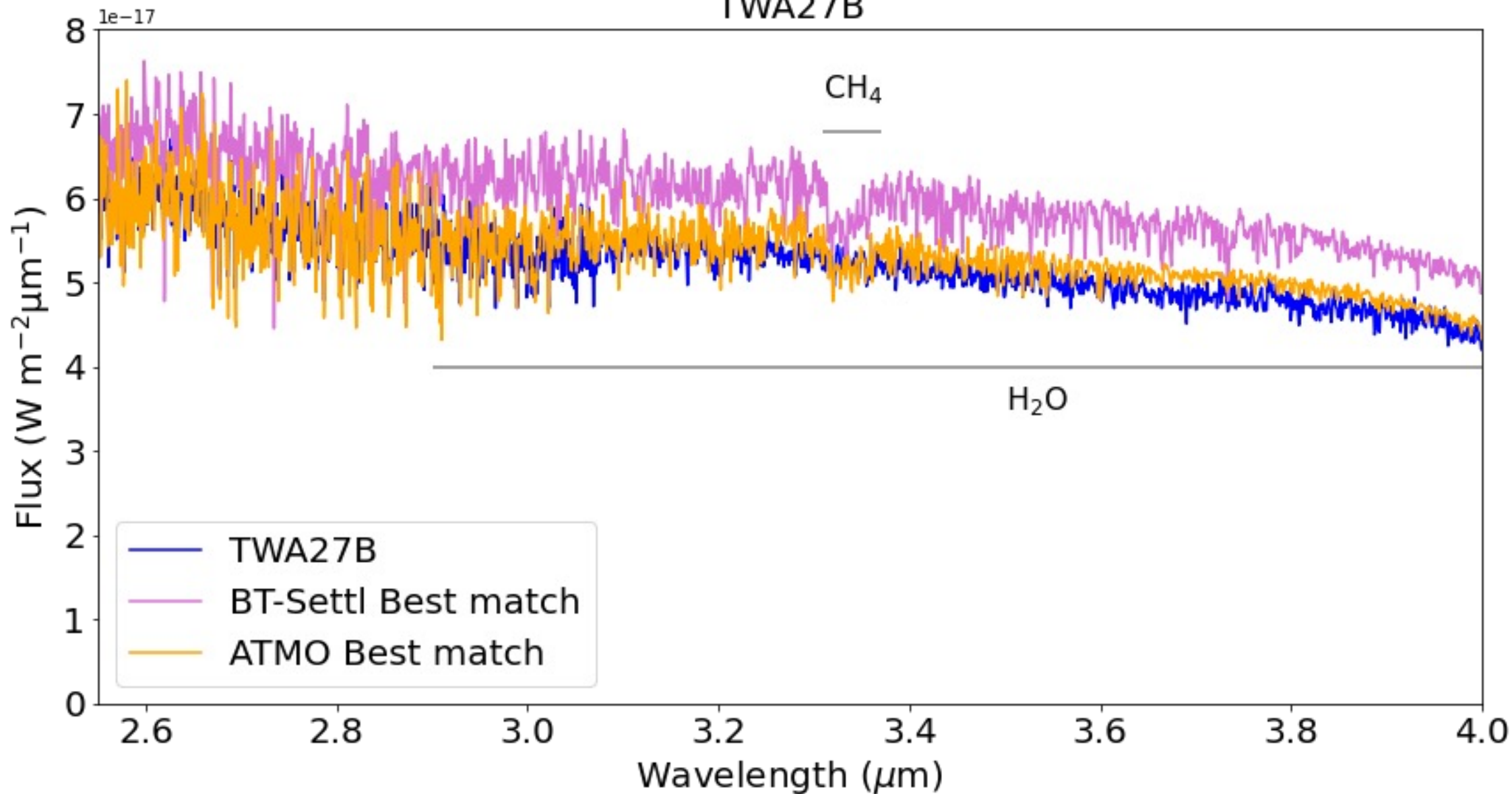
## **ATMO Atmospheric Models**

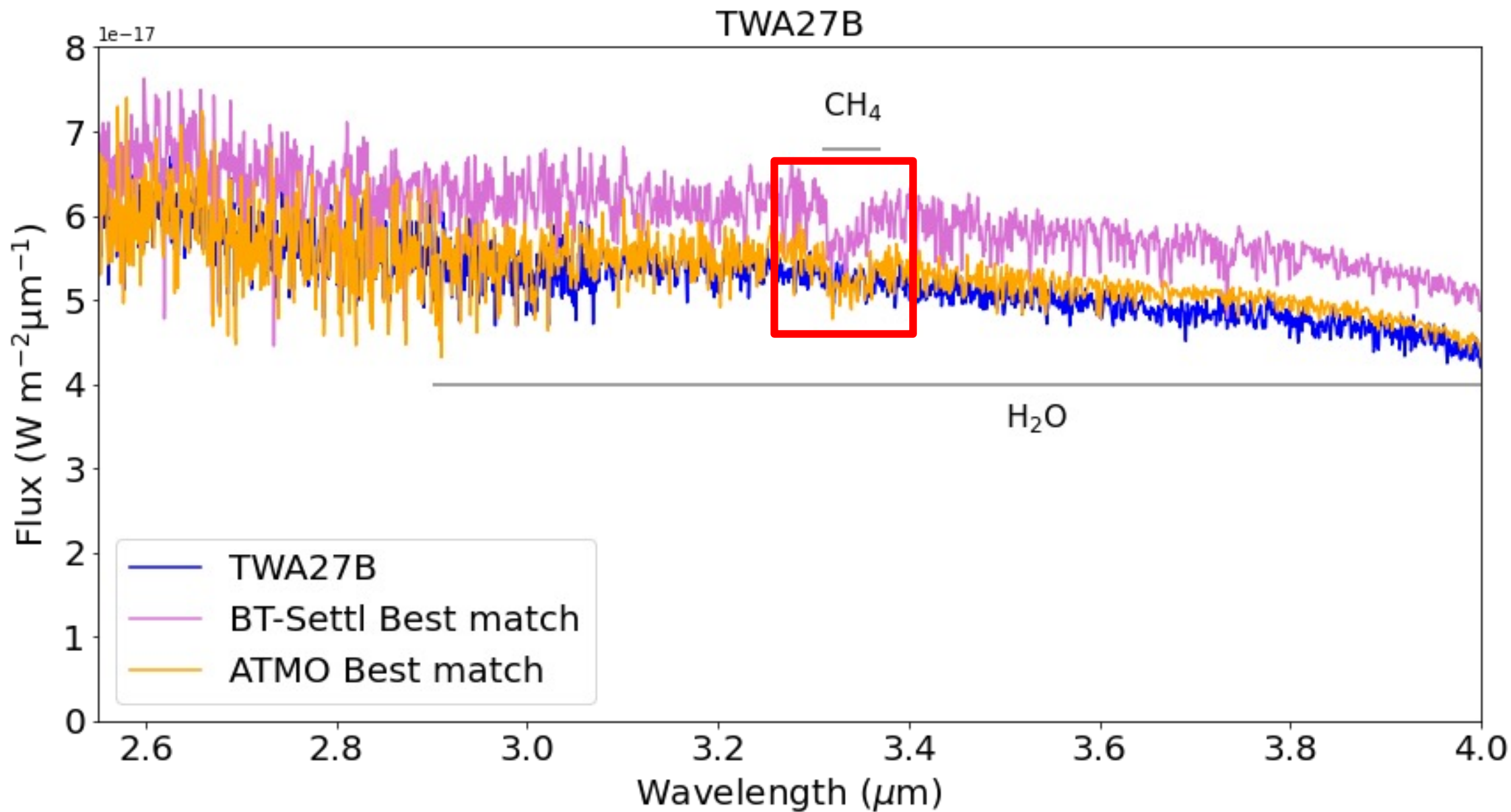
(Tremblin et al. 2017, 2017)

- Cloudless Models
- Fingering convection -> Turbulent mixing
- Disequilibrium chemistry

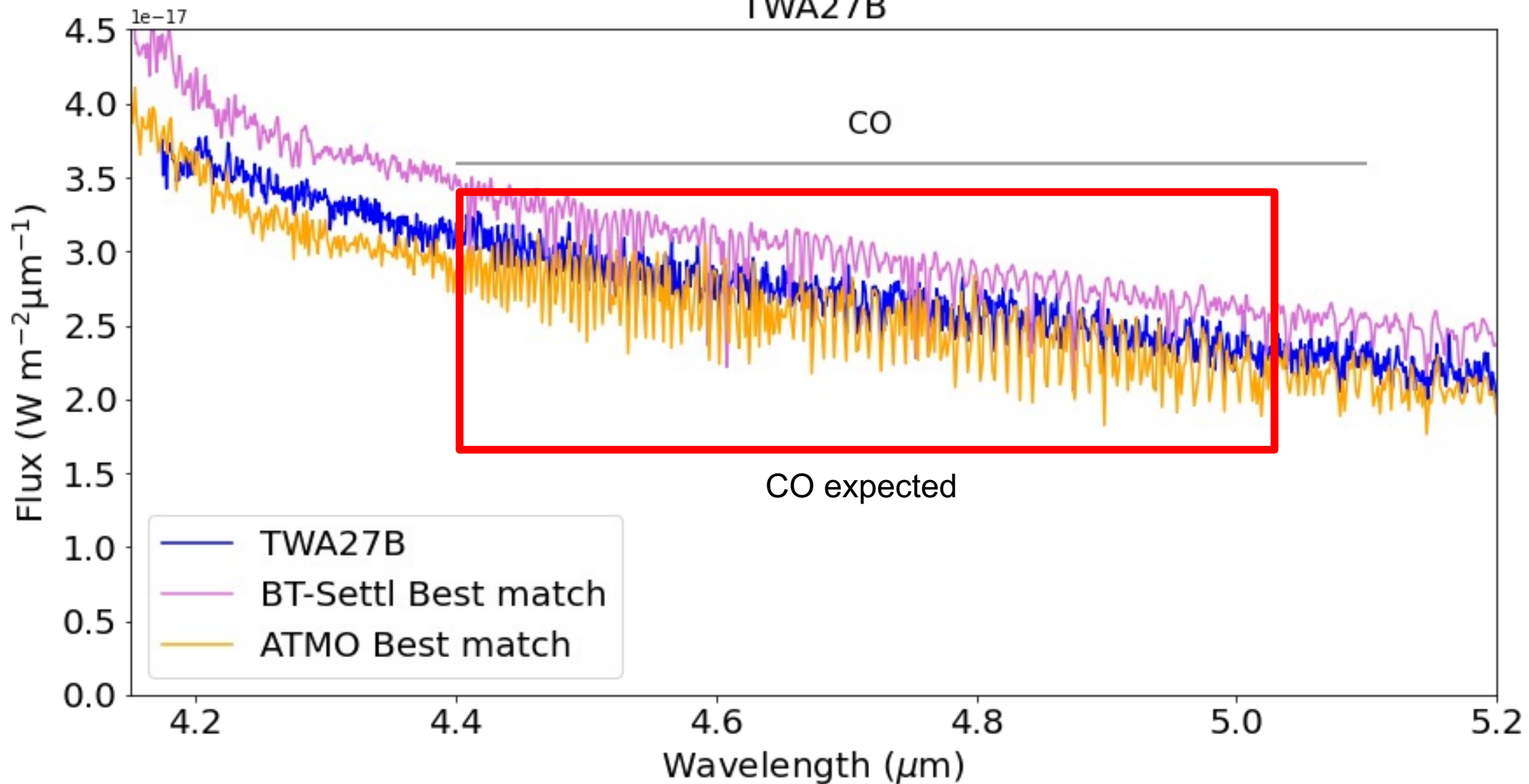


# TWA27B





TWA27B

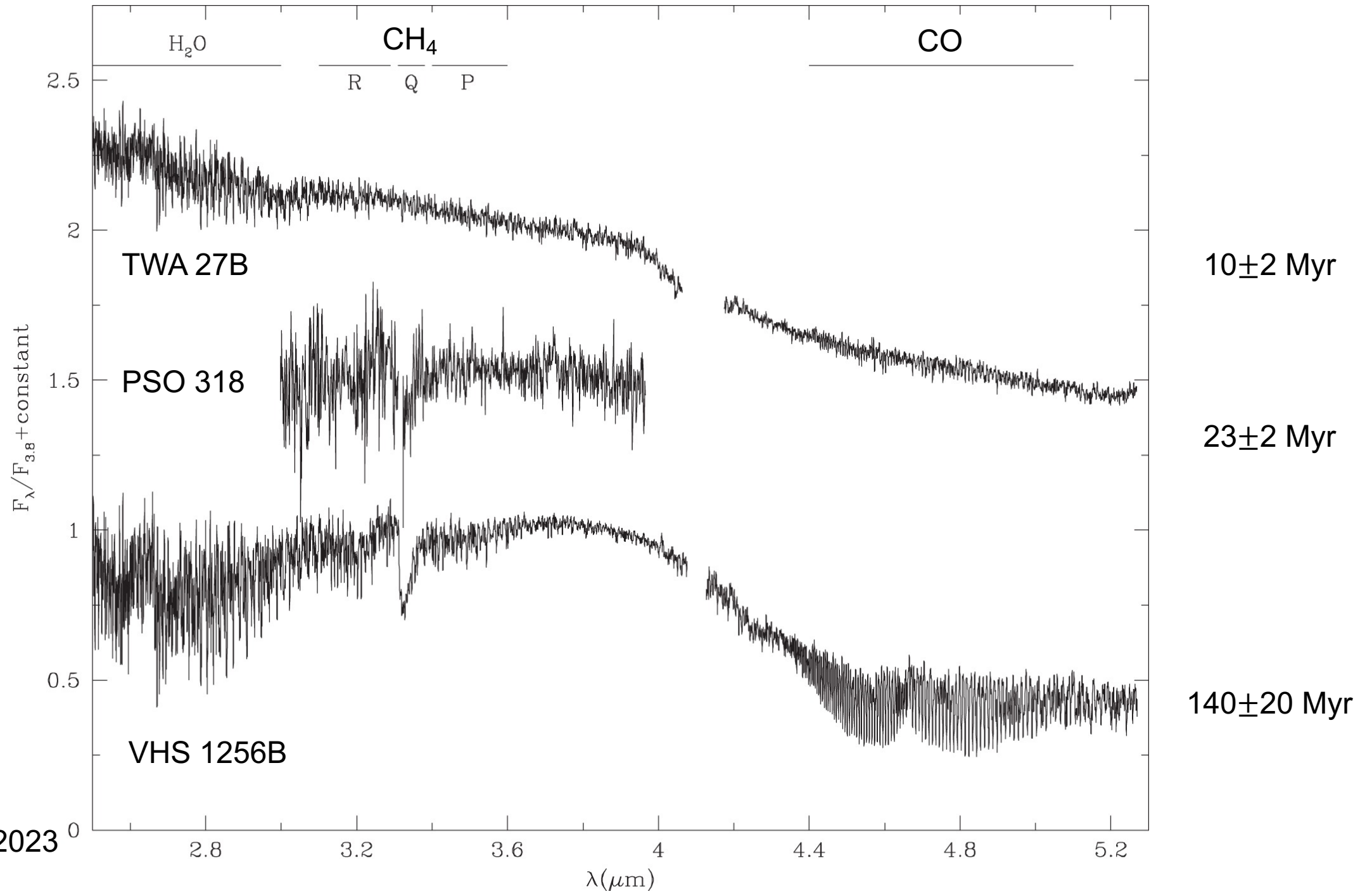


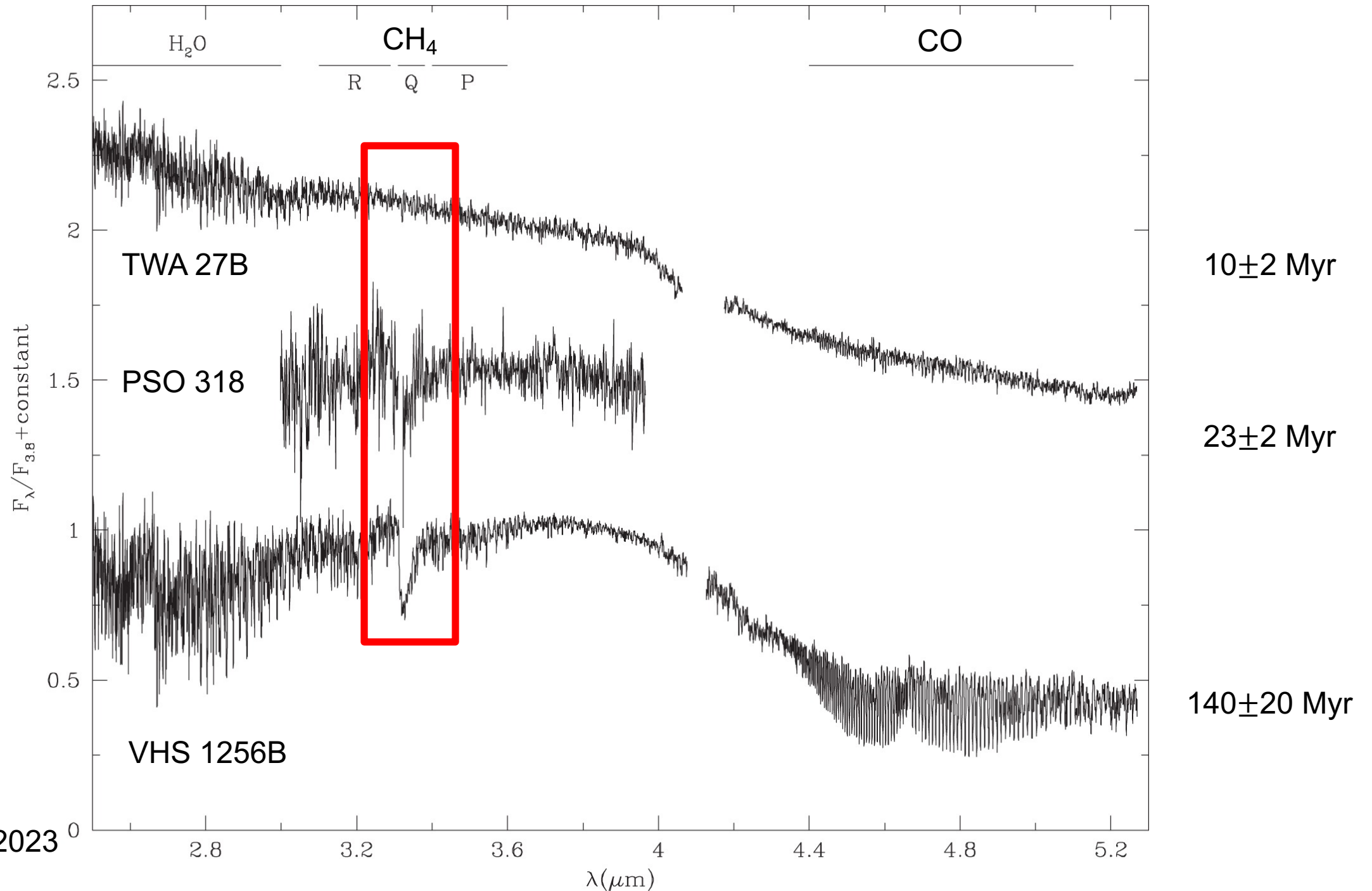
CO

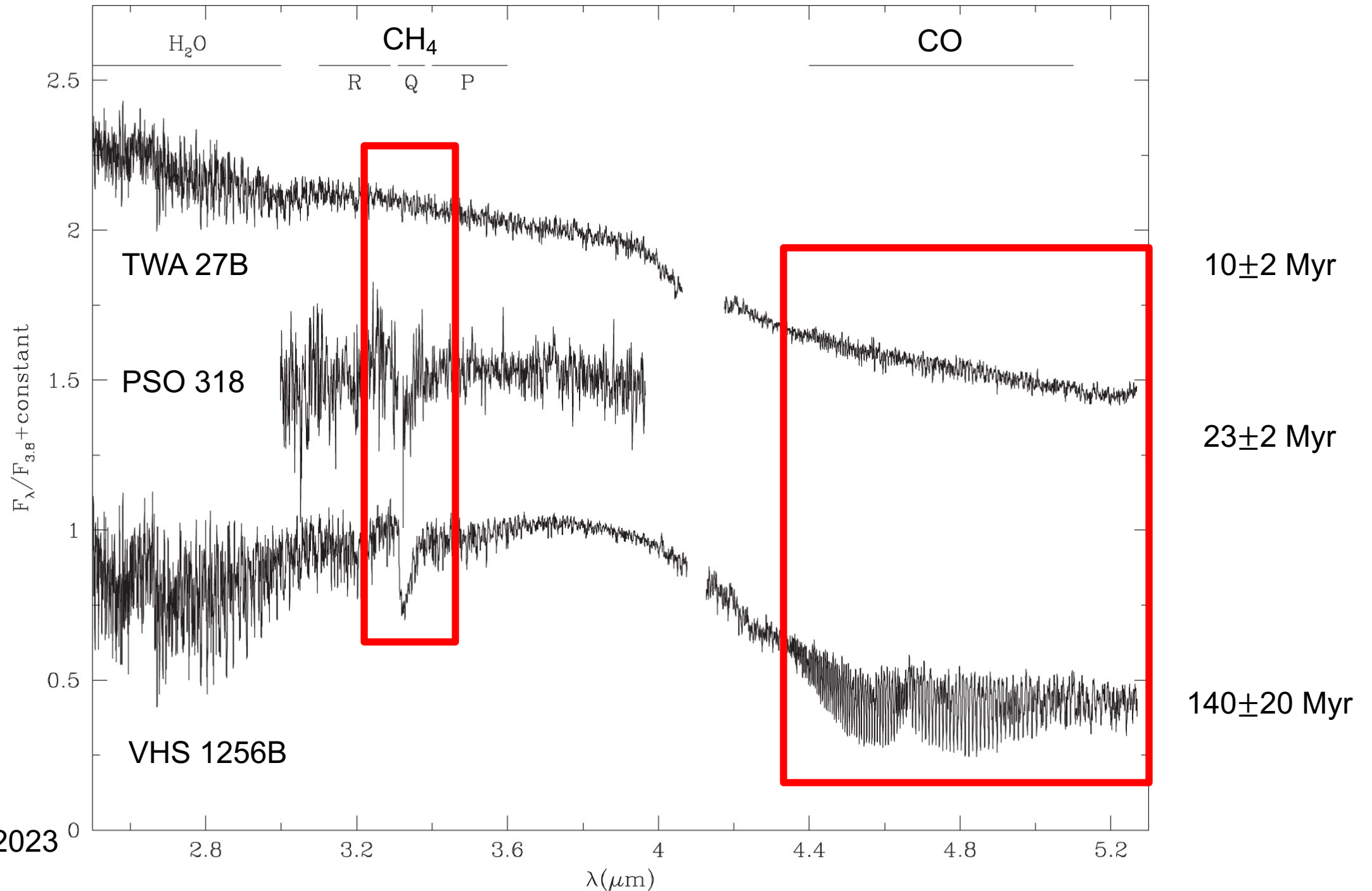
CO expected

- TWA27B
- BT-Settl Best match
- ATMO Best match









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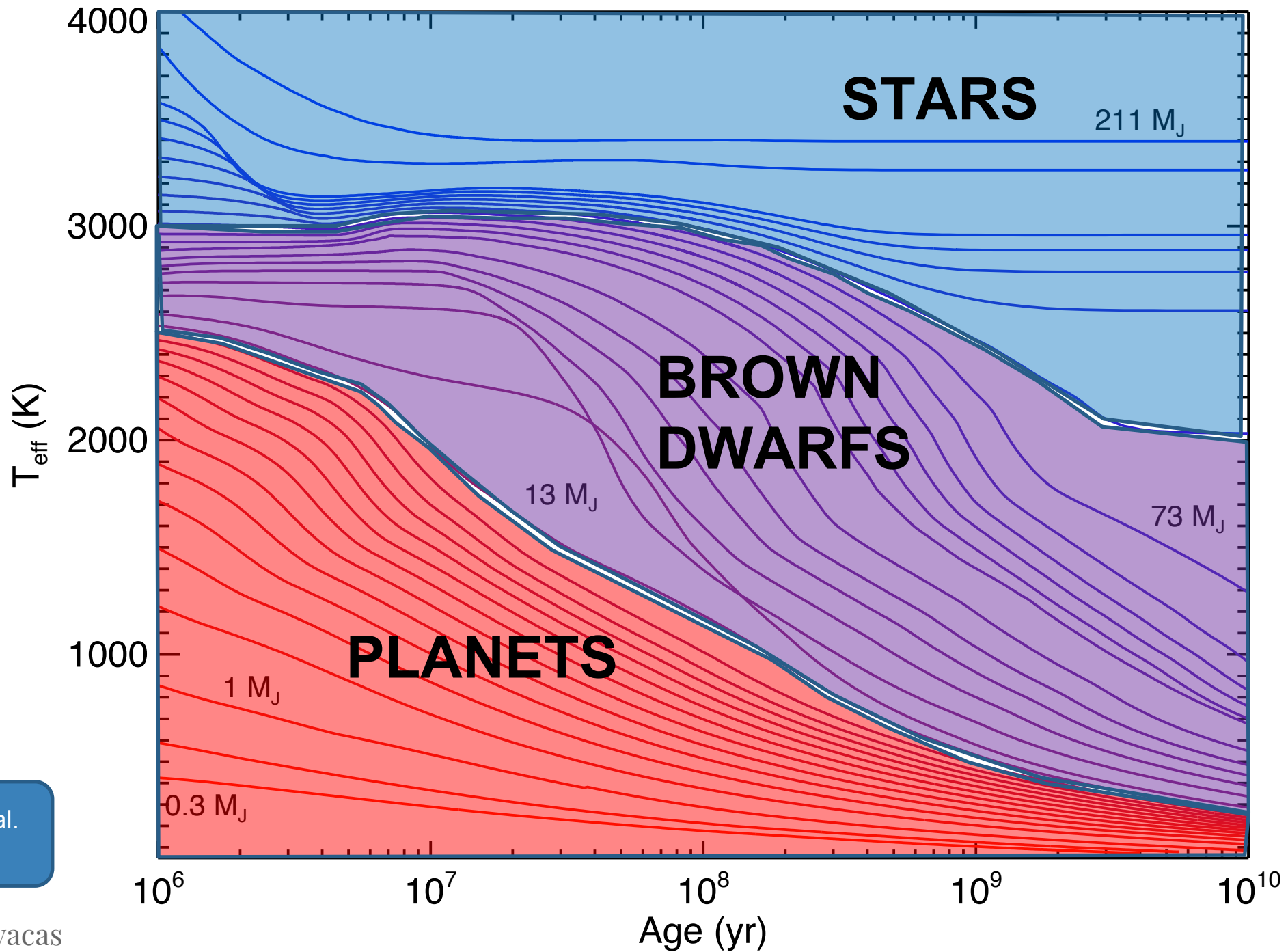


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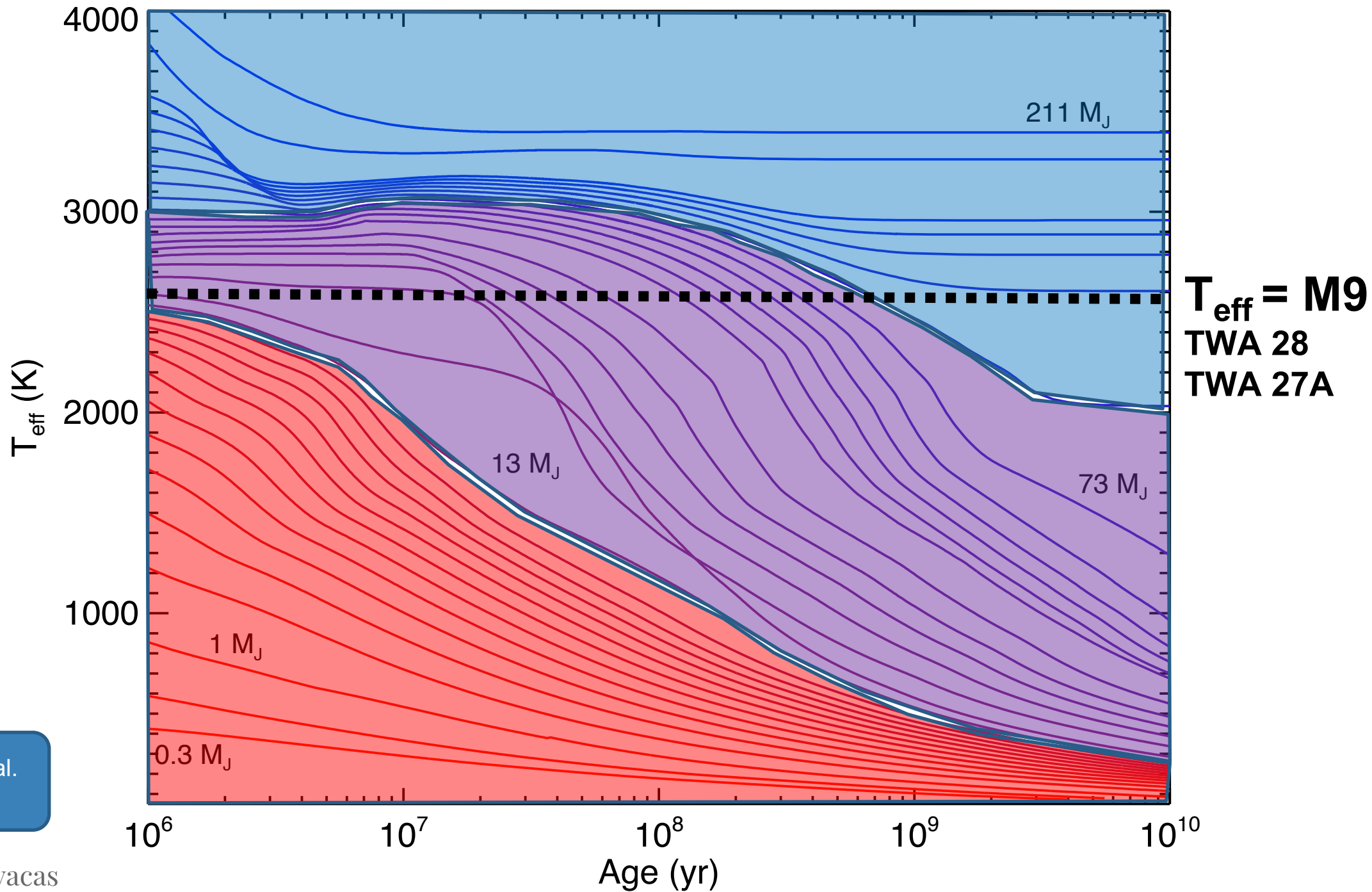


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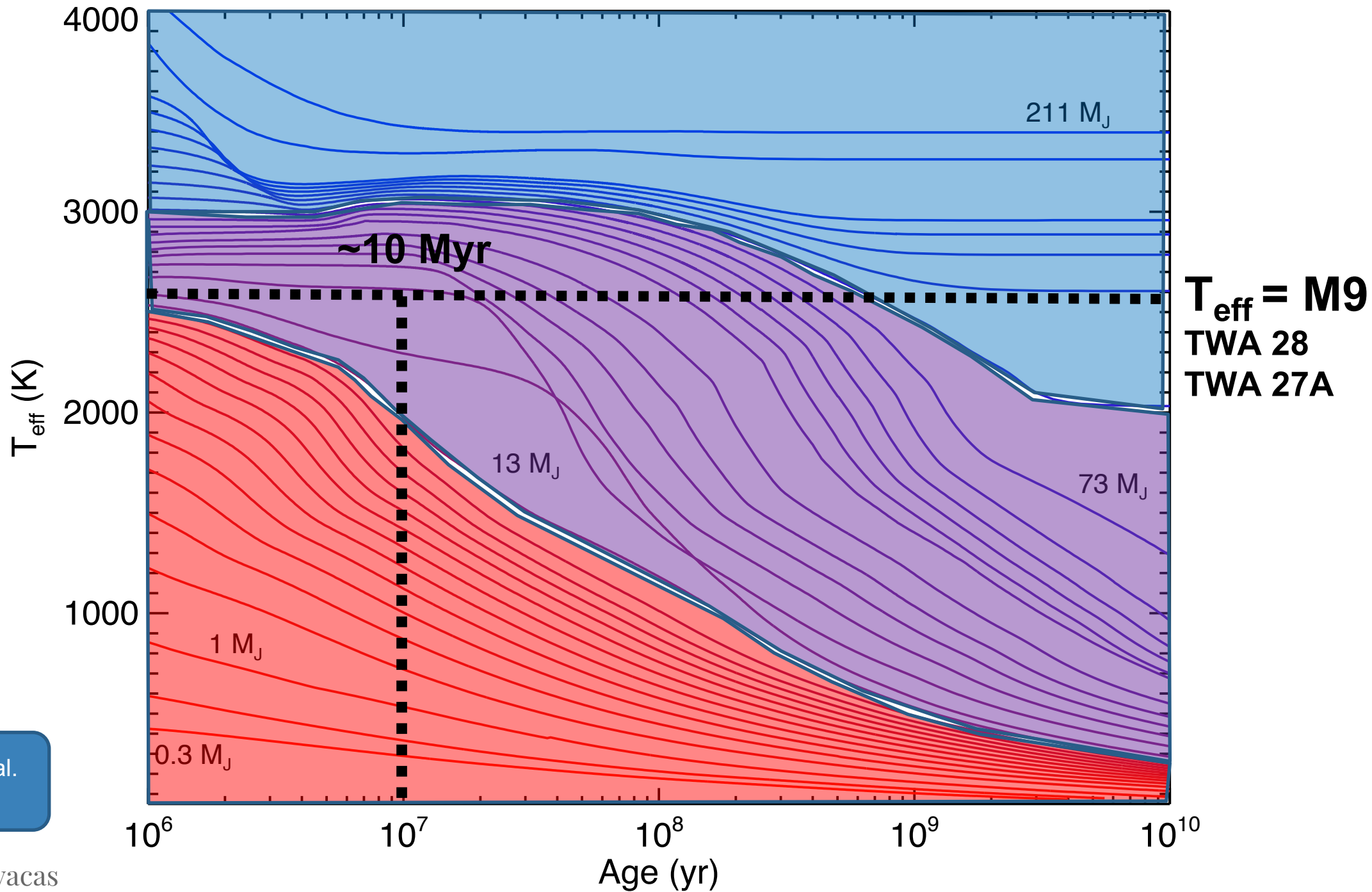
**The L/T transition might be delayed for very young Brown Dwarfs**



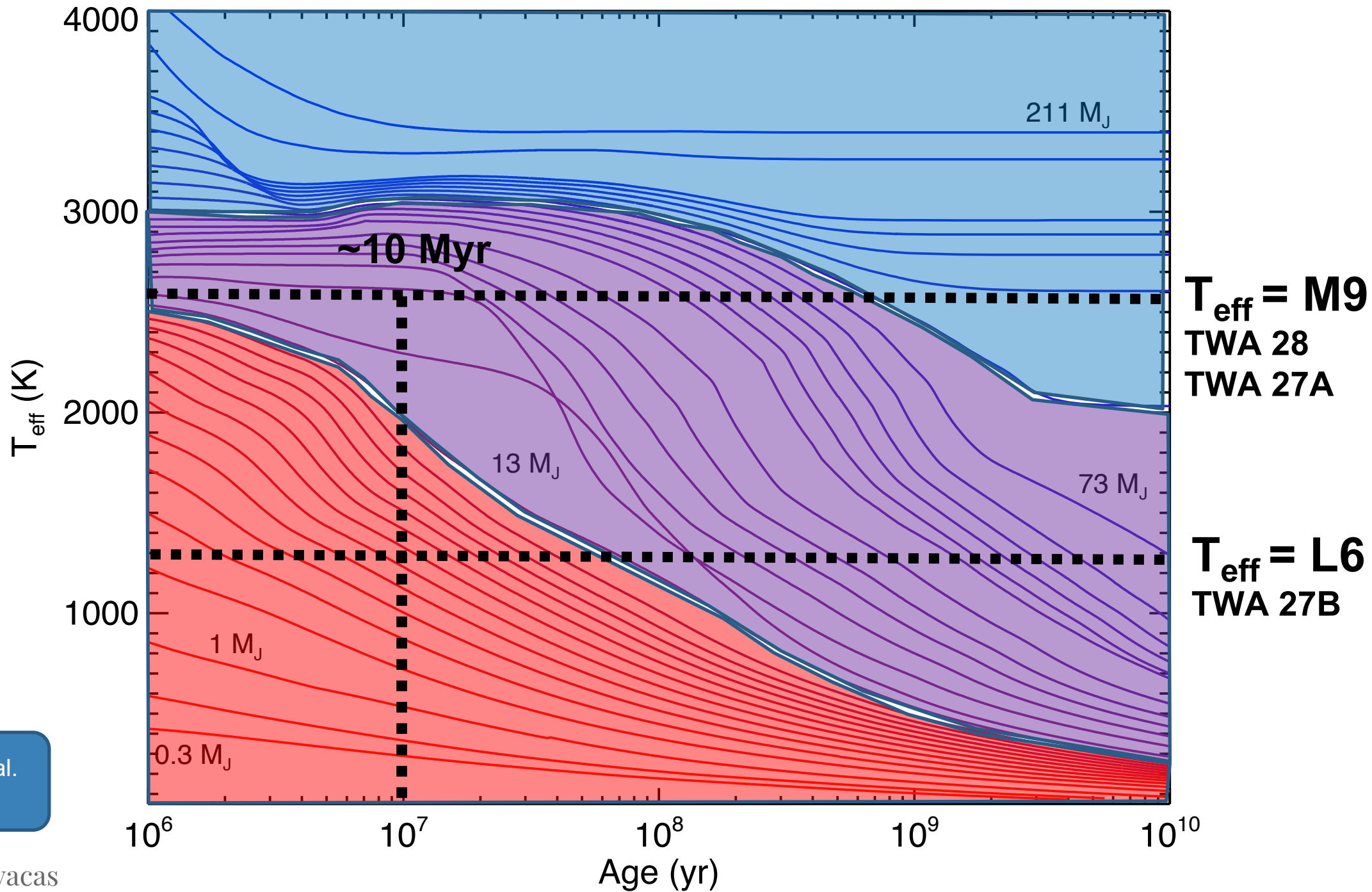
Burrows et al.  
(1997)



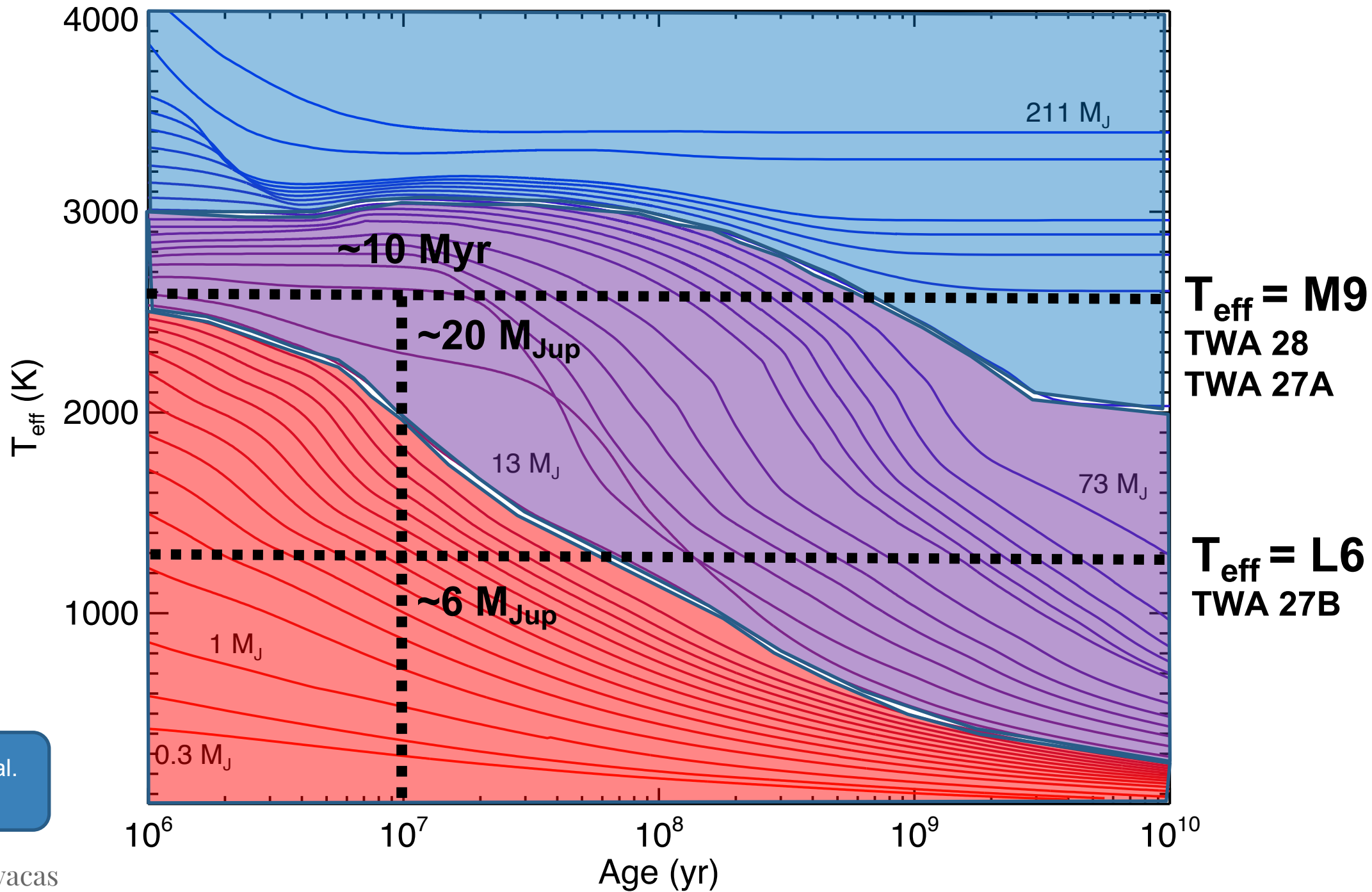
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