

VFTS#682: a surprisingly isolated twin of R136's WN5h core stars

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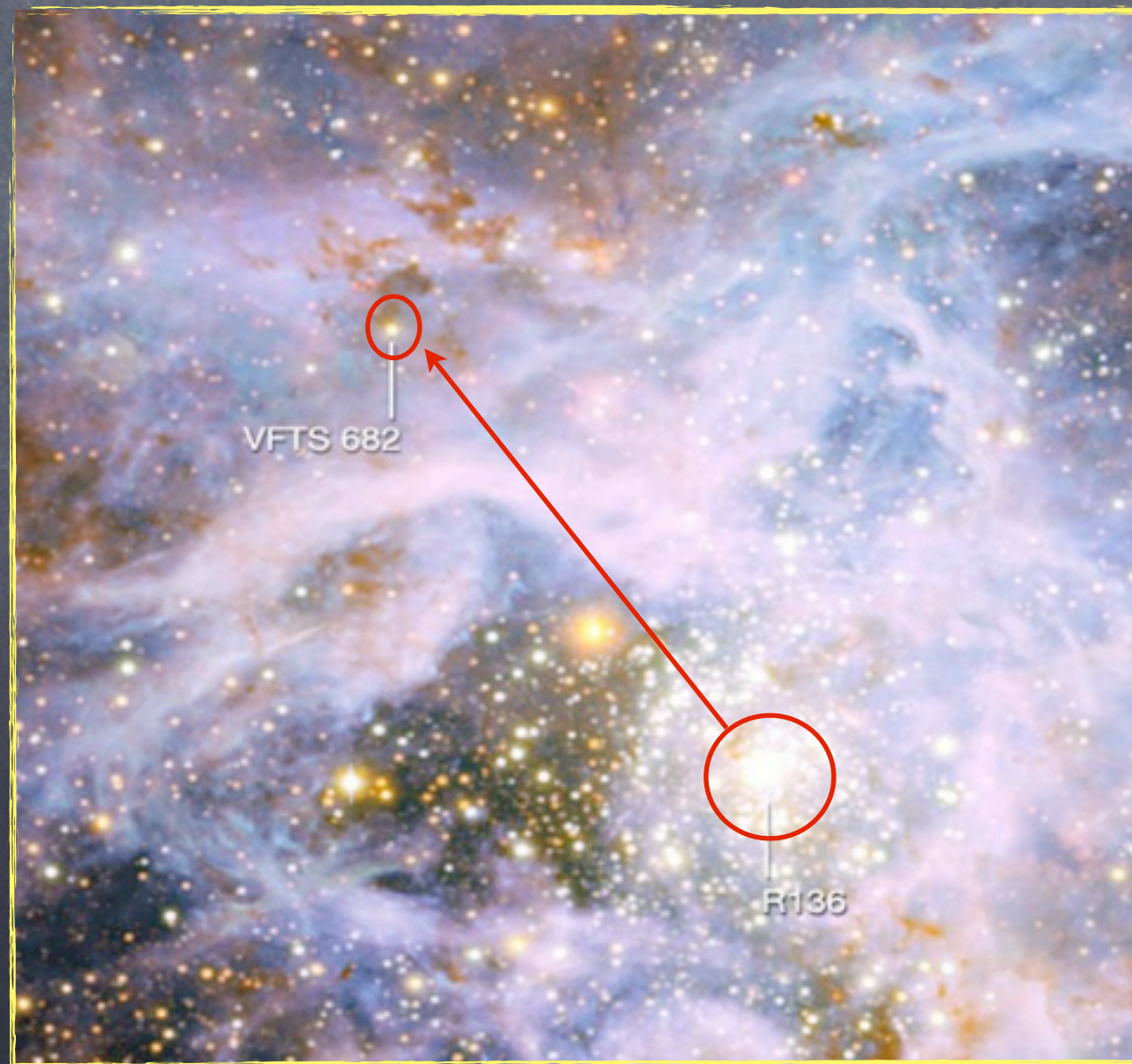
Summary

- What we knew about VFTS#682
- New observations of VFTS#682: Xshooter
- Preliminary Results
- Comparing with the R136's core star R136a3
- X-Ray emission (Is really #682 an isolated star?)
- What we know about VFTS#682

What we knew about VFTS#682

(Bestenlehner et al. 2011)

- **Isolated** object at a project distance of 29 pc northeast of R136 (**Tarantula Nebula-Large Magellanic Cloud**)



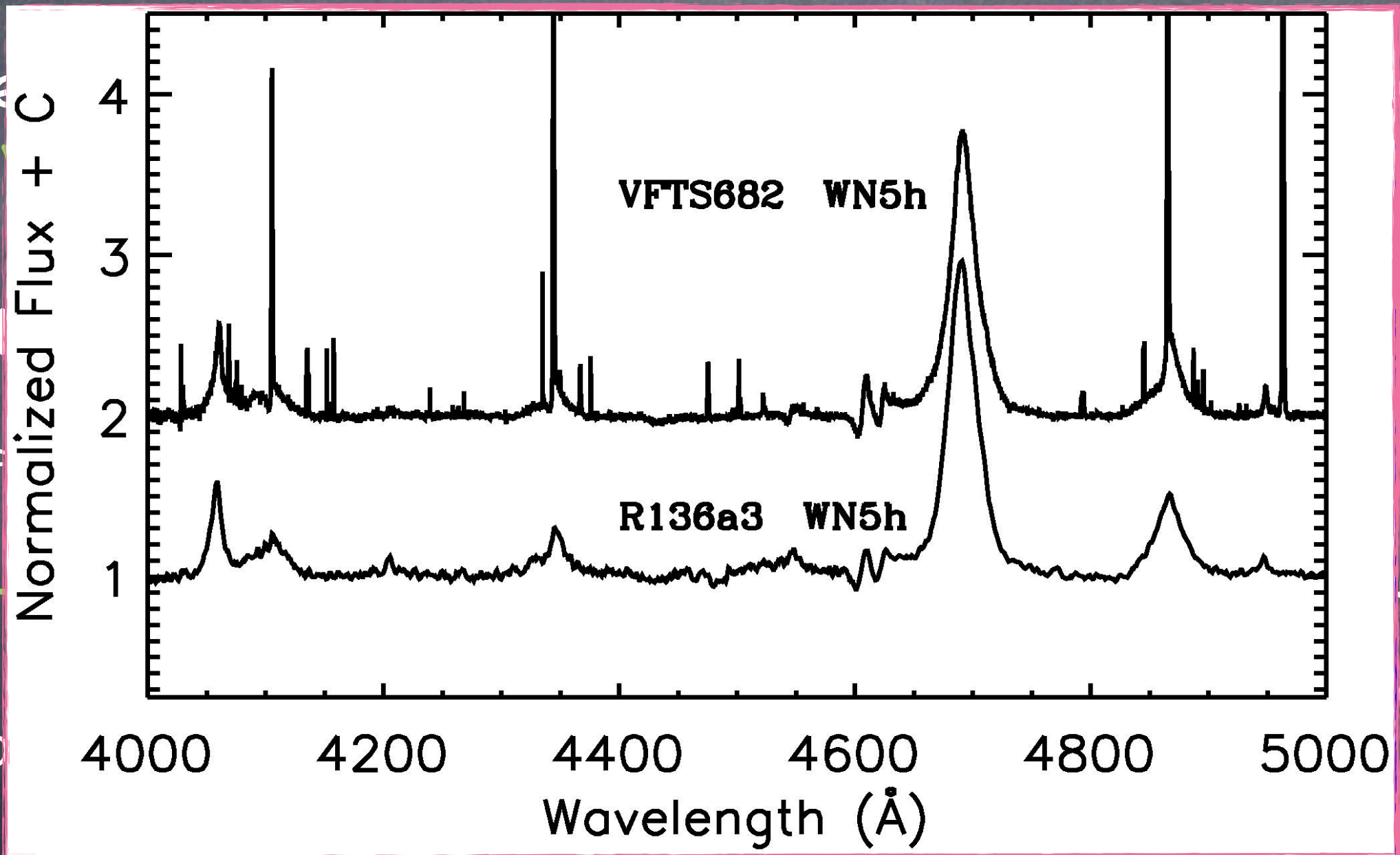
What we knew about VFTS#682

(Bestenlehner et al. 2011)

- The VLT-FLAMES Tarantula Survey (VFTS) identified as **WN5h** star (Evans et al. 2011)
- Optical FLAMES spectrum #682: **$\log (L/L_{\odot})=6.5\pm 0.2$** ,
 $T_{\text{eff}} \sim 52.2\pm 3\text{kK}$, **$M_{*}\sim 150M_{\odot}$**
- **Quite similar to R136a3** star (WN5h) in the core of the young massive cluster R136 (Schnurr et al 2009, Crowther et. 2010)

What we knew about VFTS#682

(Bestenlehner et al. 2011)



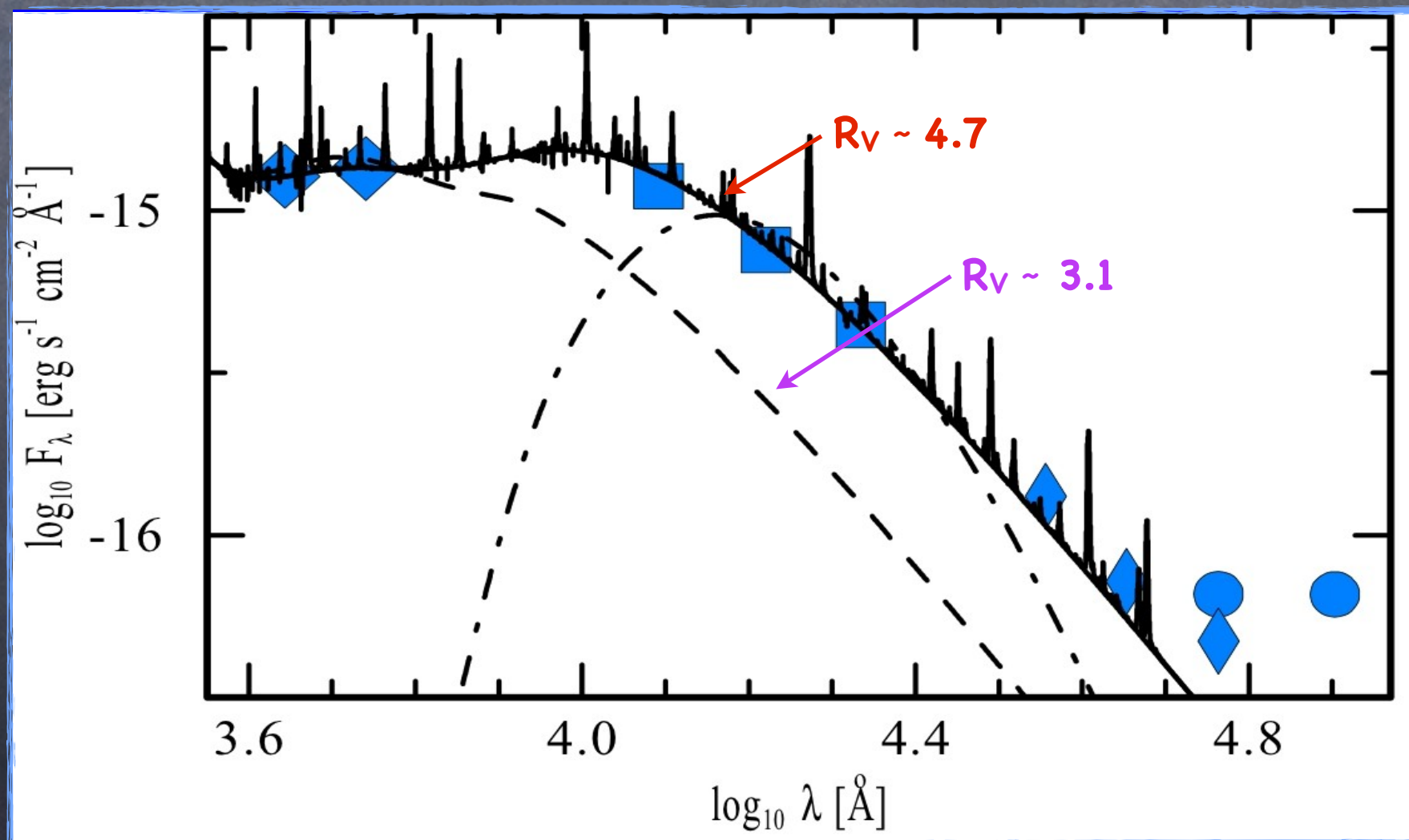
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What we knew about VFTS#682

(Bestenlehner et al. 2011)

- $R_V \sim 4.7 \Rightarrow \log(L/L_\odot) = 6.5 \pm 0.2$
- $R_V \sim 3.1 \Rightarrow \log(L/L_\odot) = 5.7 \pm 0.2 + \text{Cooler companion}$



What we knew about VFTS#682

(Bestenlehner et al. 2011)

- Peculiar R_v \Rightarrow Red Companion?
- $\sim 150 M_{\odot}$ \Rightarrow Single or Binary?
- $\log(L/L_{\odot}) = 6.5 \pm 0.2 \Rightarrow$ ZAMS \Rightarrow CHE?
- Is a real twin of R136a stars?
- Runaway or born in situ?

New Observations VFTS#682

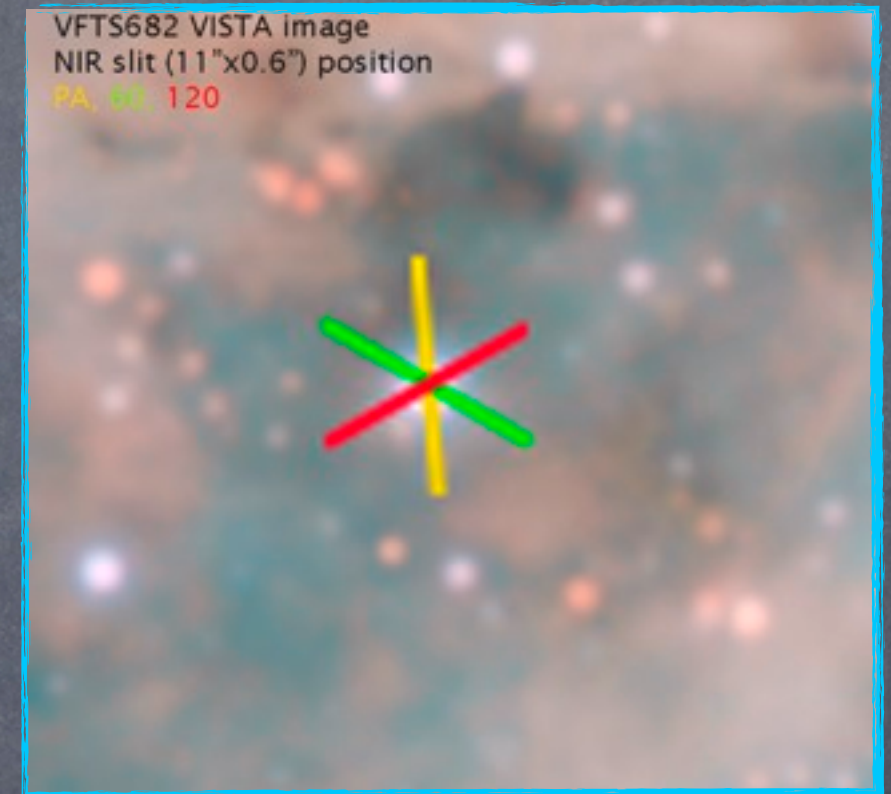
PROPOSAL XSHOOTER

- Goals:

- Accurate flux calibration
- Characterize background
- Address crowding issues

- What we asked:

- Three slit positions, PA, 60° & 120°
- Observing time for a good A0V Telluric Standard
- NOD on SLIT observing mode



New Observations VFTS#682

PROPOSAL XSHOOTER

- What we got:
 - First Night: 60° & 120° (NOD on SLIT) + bad telluric standard (B9V, STARE mode) + WD (LTT49)
 - Second Night: PA + A0V telluric standard (NOD on SLIT) + WD (GD71)
- Reduction data: Esorex, Reflex (ESO Pipelines)
- Flux calibration: Reflex, Xtellcorr_general (Vacca et al. 2003)
- Telluric Correction: Own IDL routine

Preliminary Results

CFMGEN model atmosphere #682

- Blanketing, clumping factor, micro-turbulence, half solar metallicity, N, O, H, HeII, C, P, Fe, Ni, etc.

IMPROVEMENTS:

- CNO abundances:

OIV, CIV

- Velocity field:

HeI (1.083 μm)

- Clumping factor:

NIR Spectra

Preliminary Results

CFMGEN model atmosphere #682

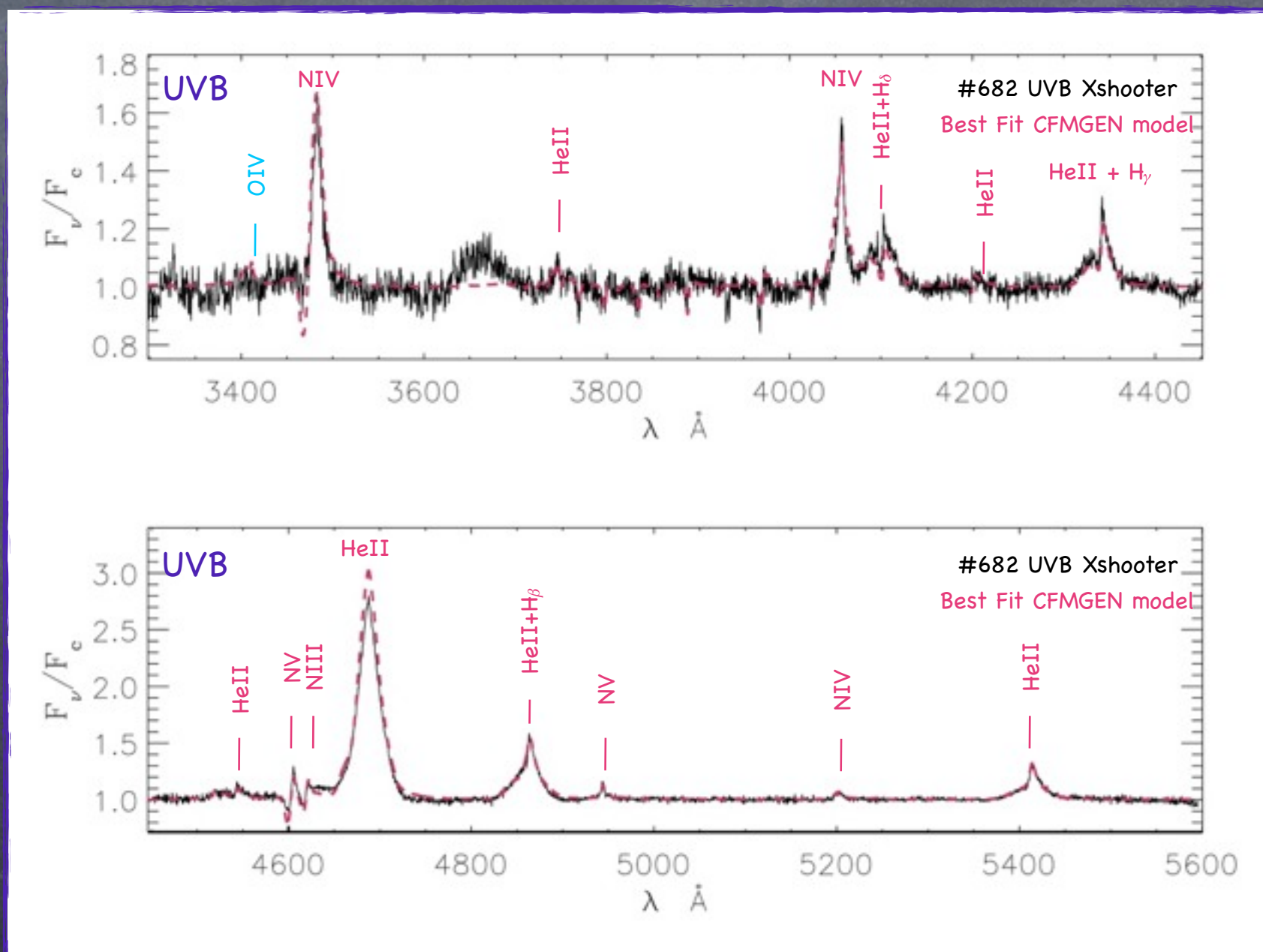
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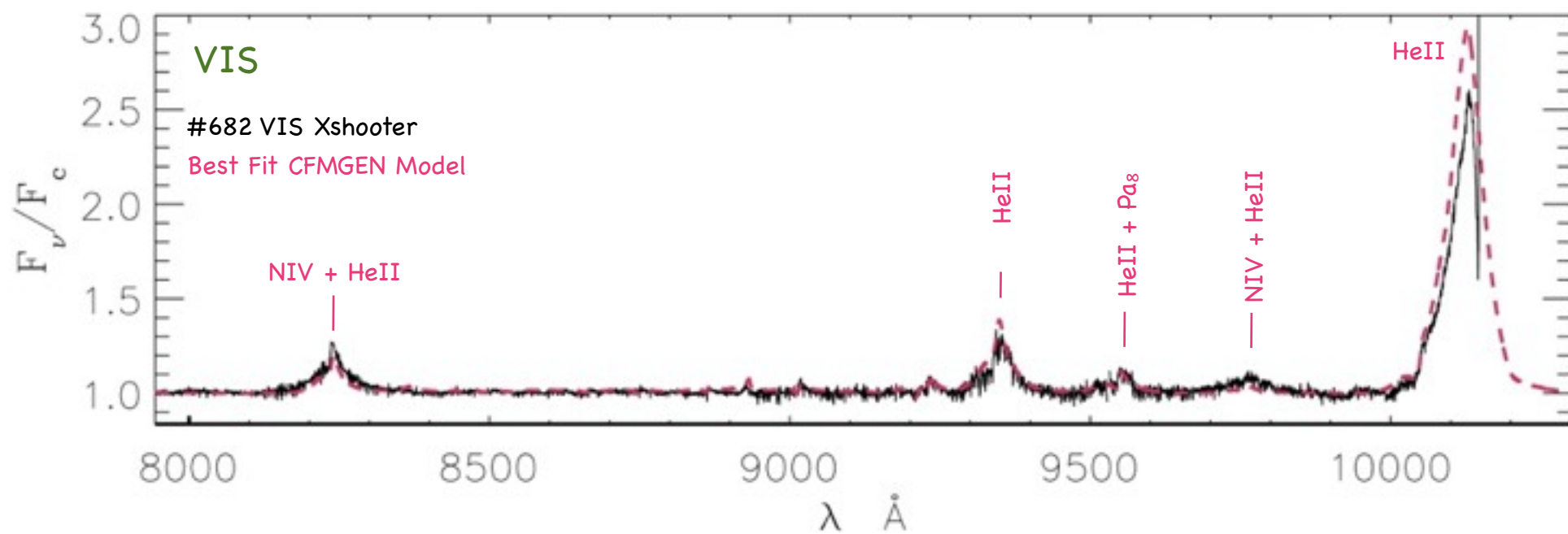
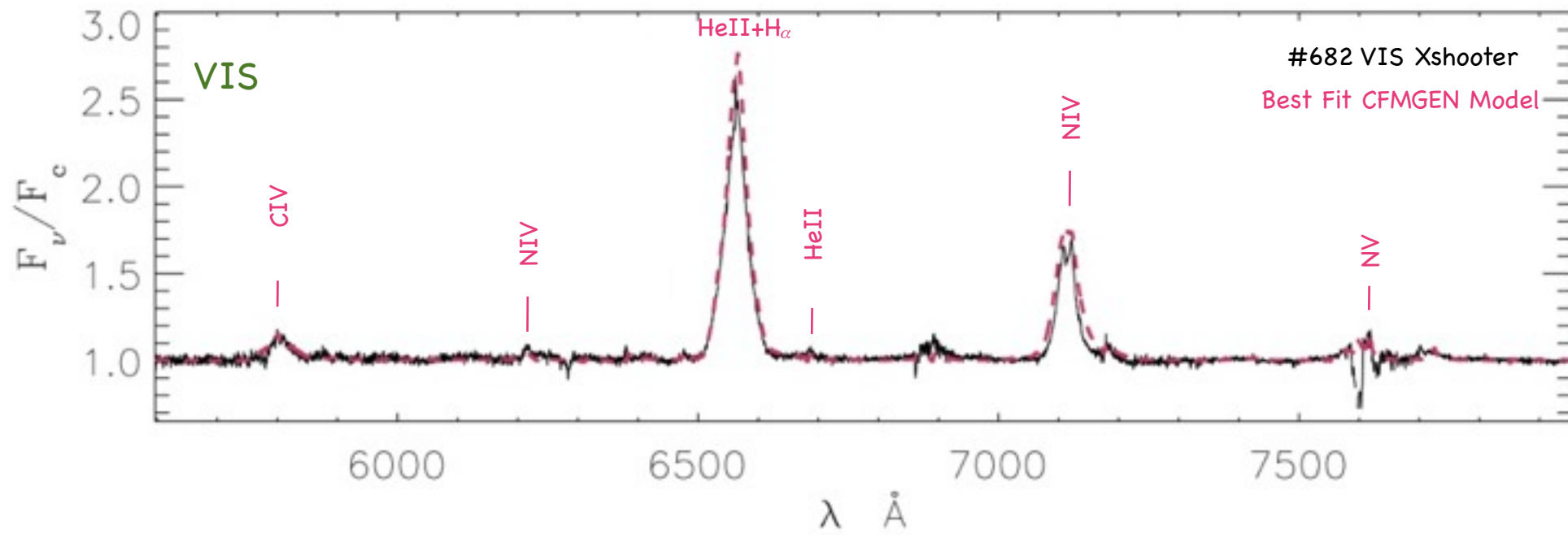
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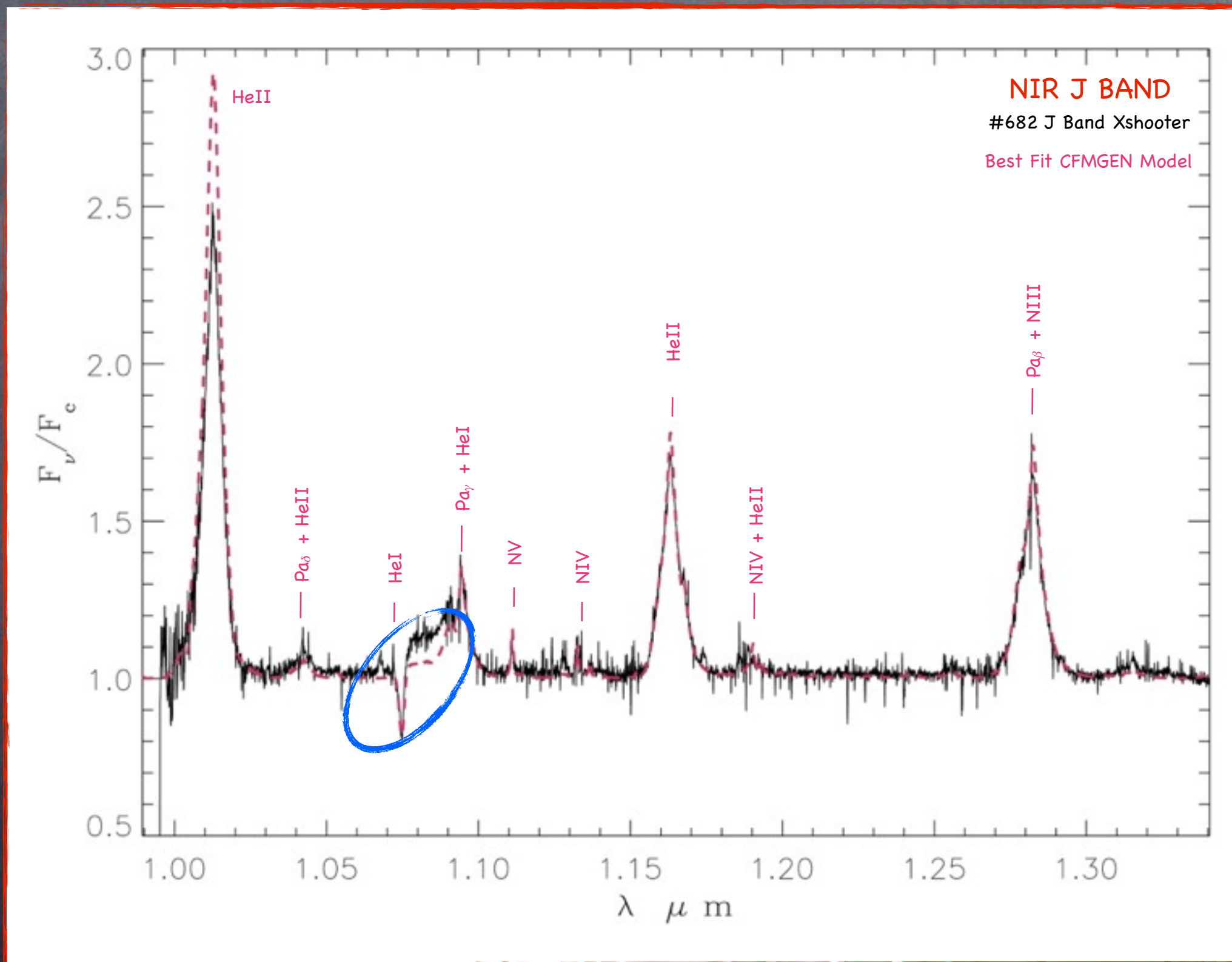
Preliminary Analysis

CFMGEN model atmosphere #682



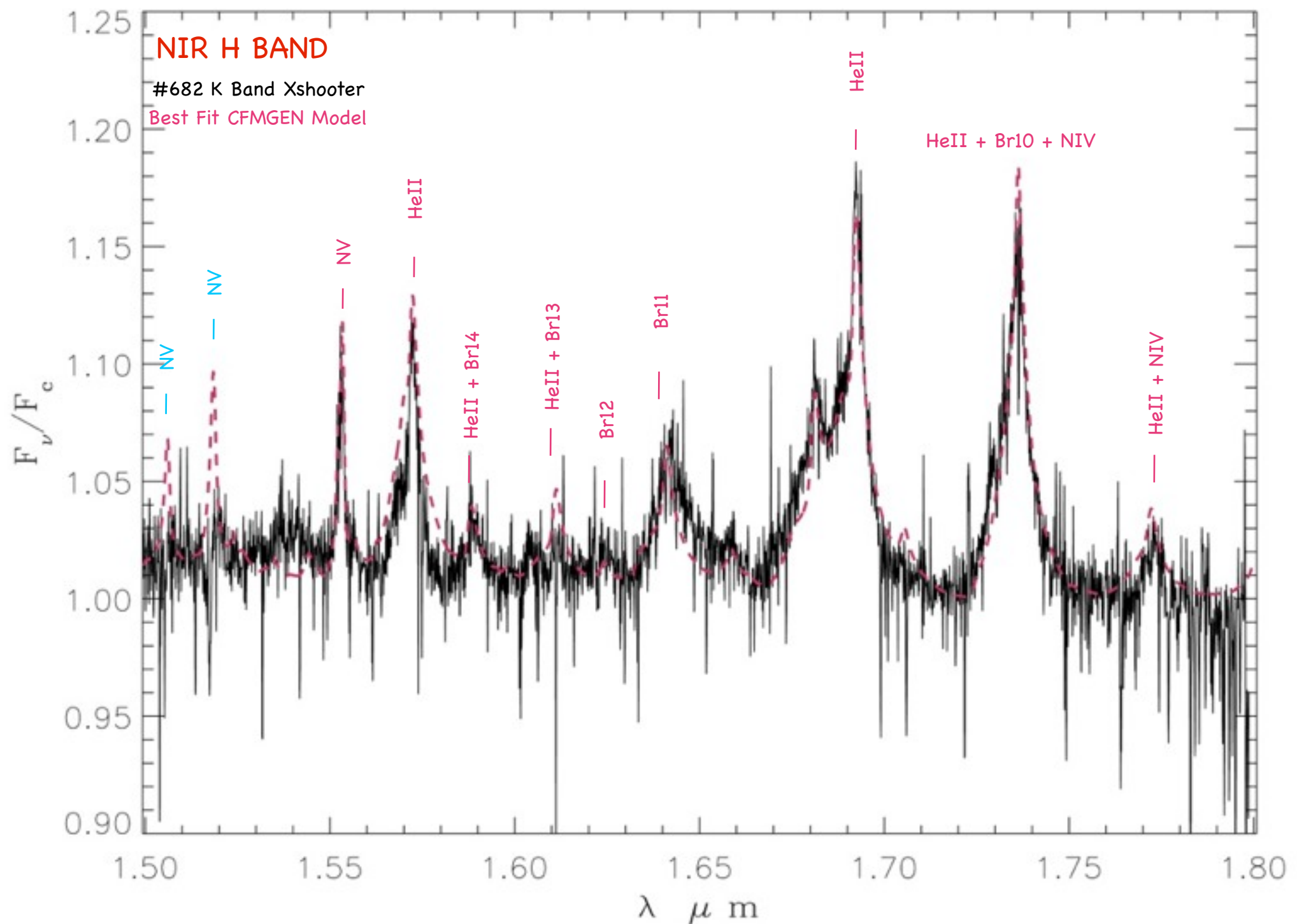
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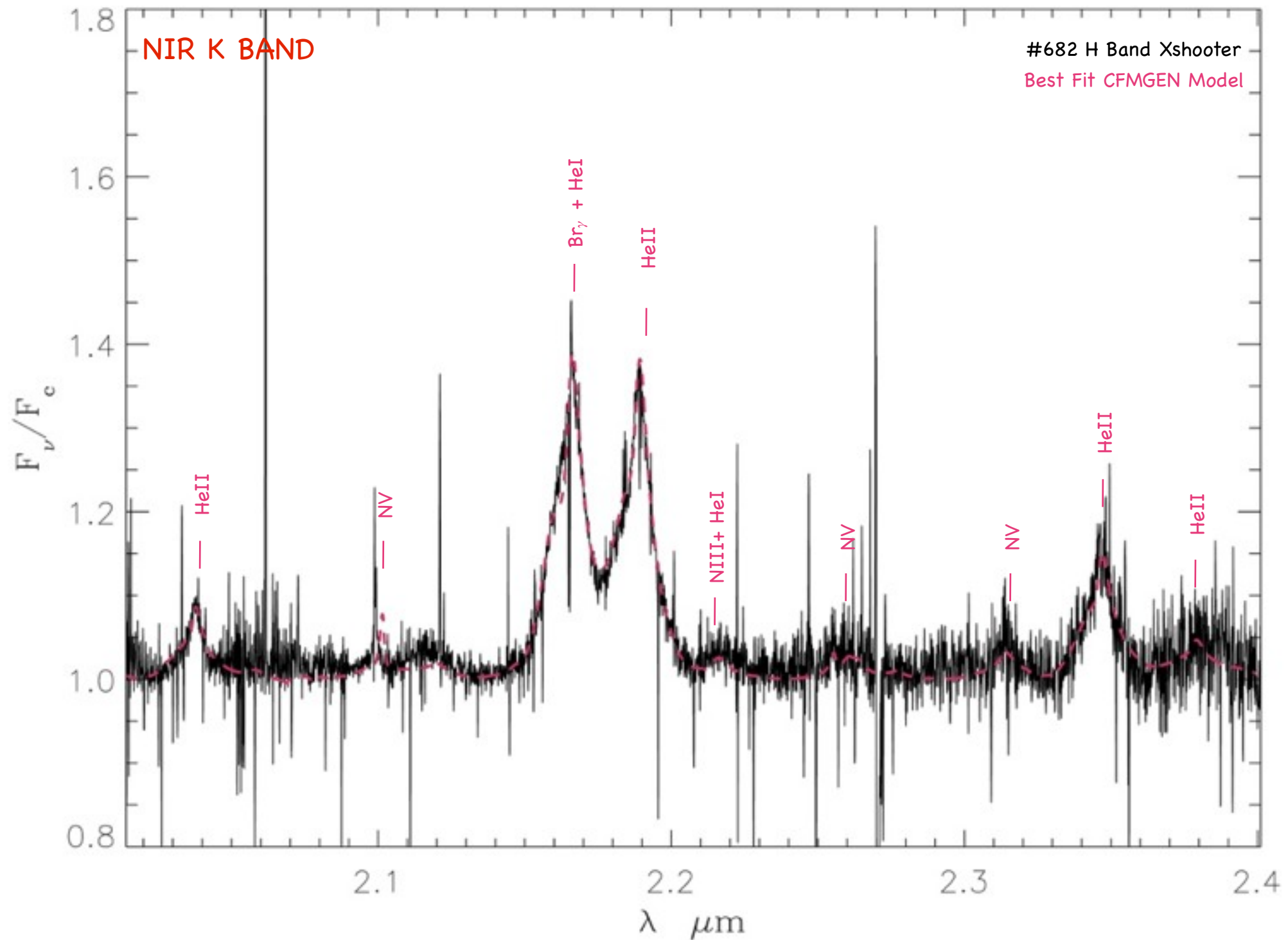
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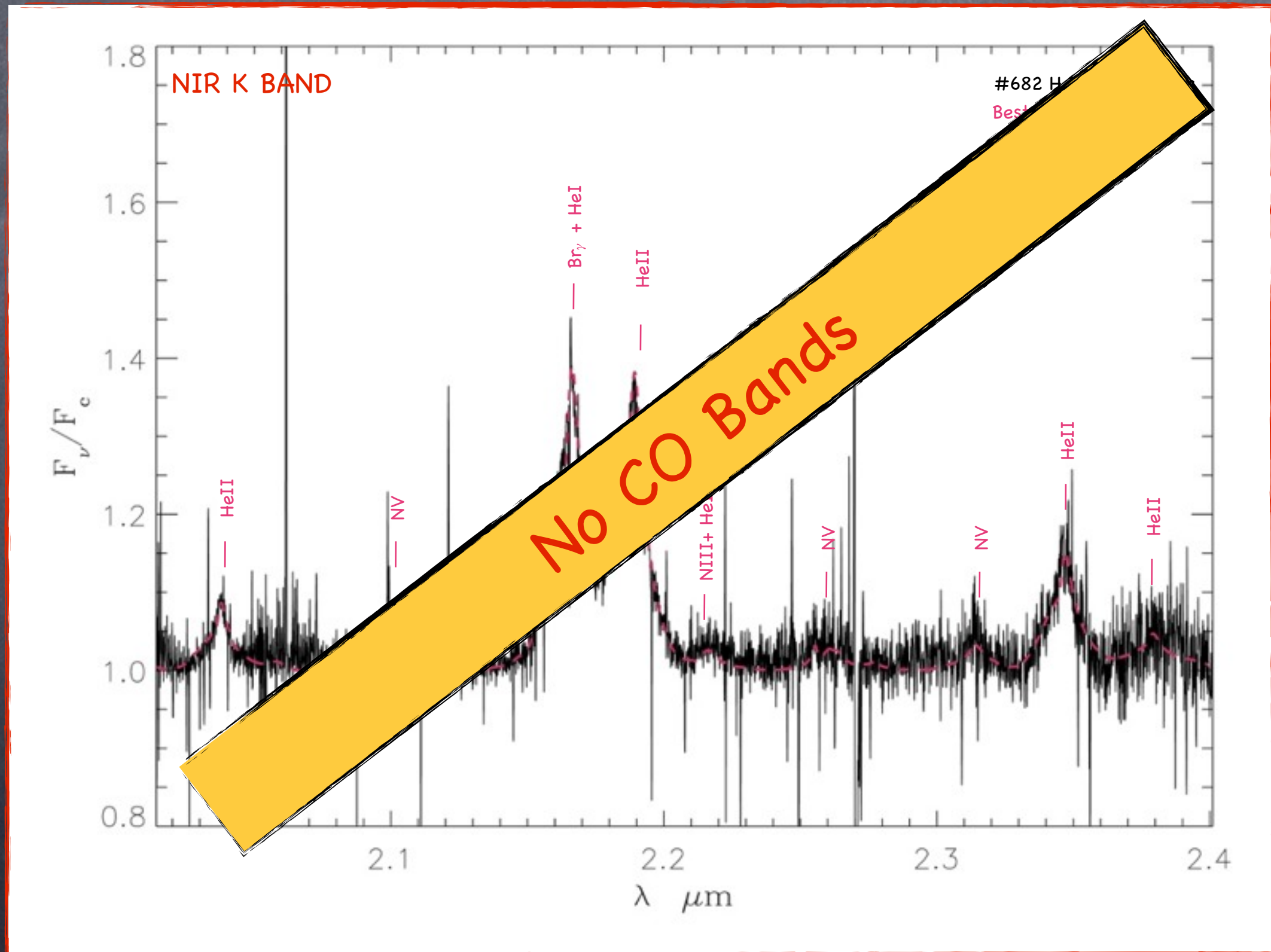
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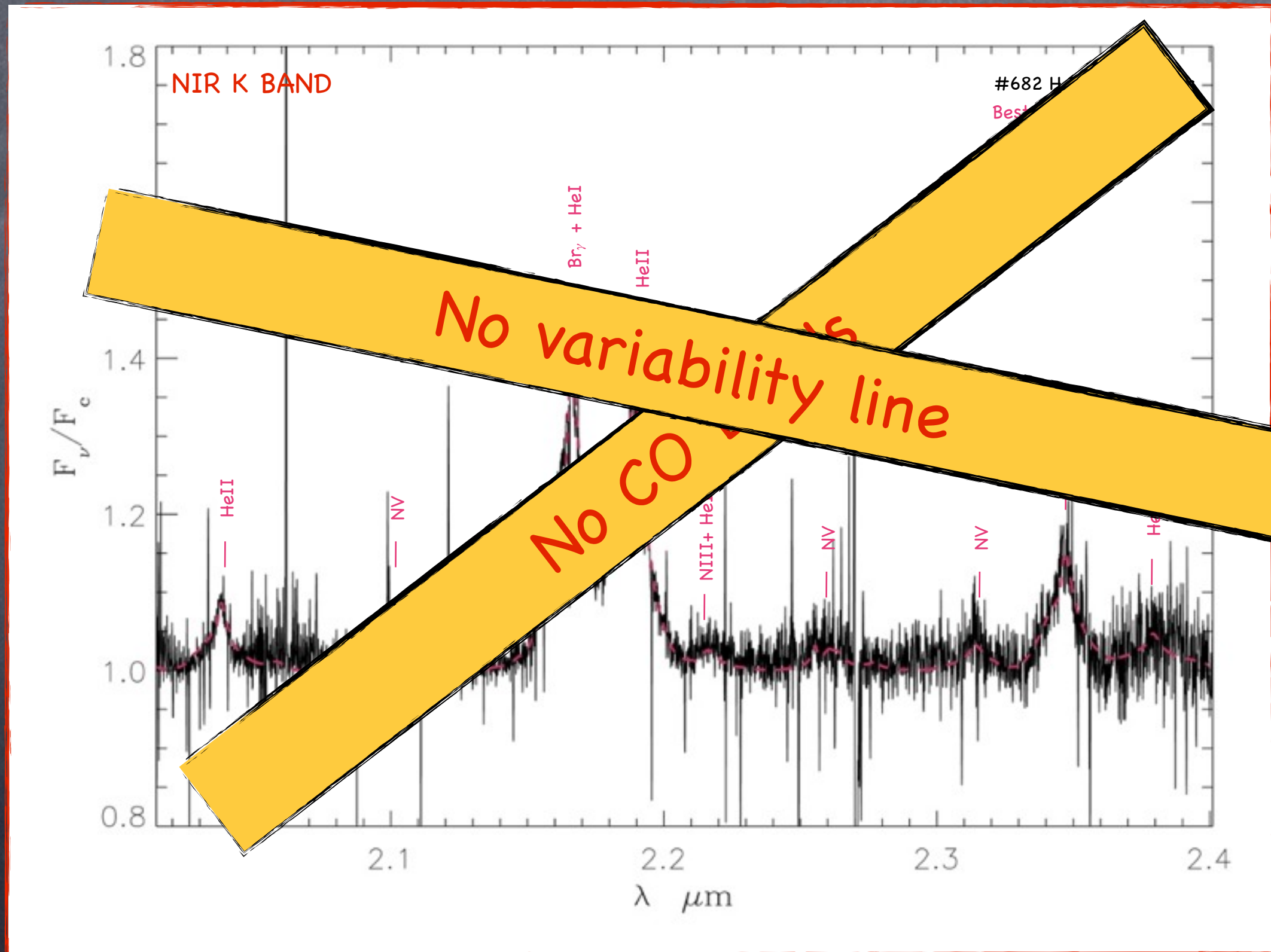
Preliminary Analysis

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Preliminary Analysis

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Preliminary Results

CFMGEN model atmosphere #682

Besterlehner 2011

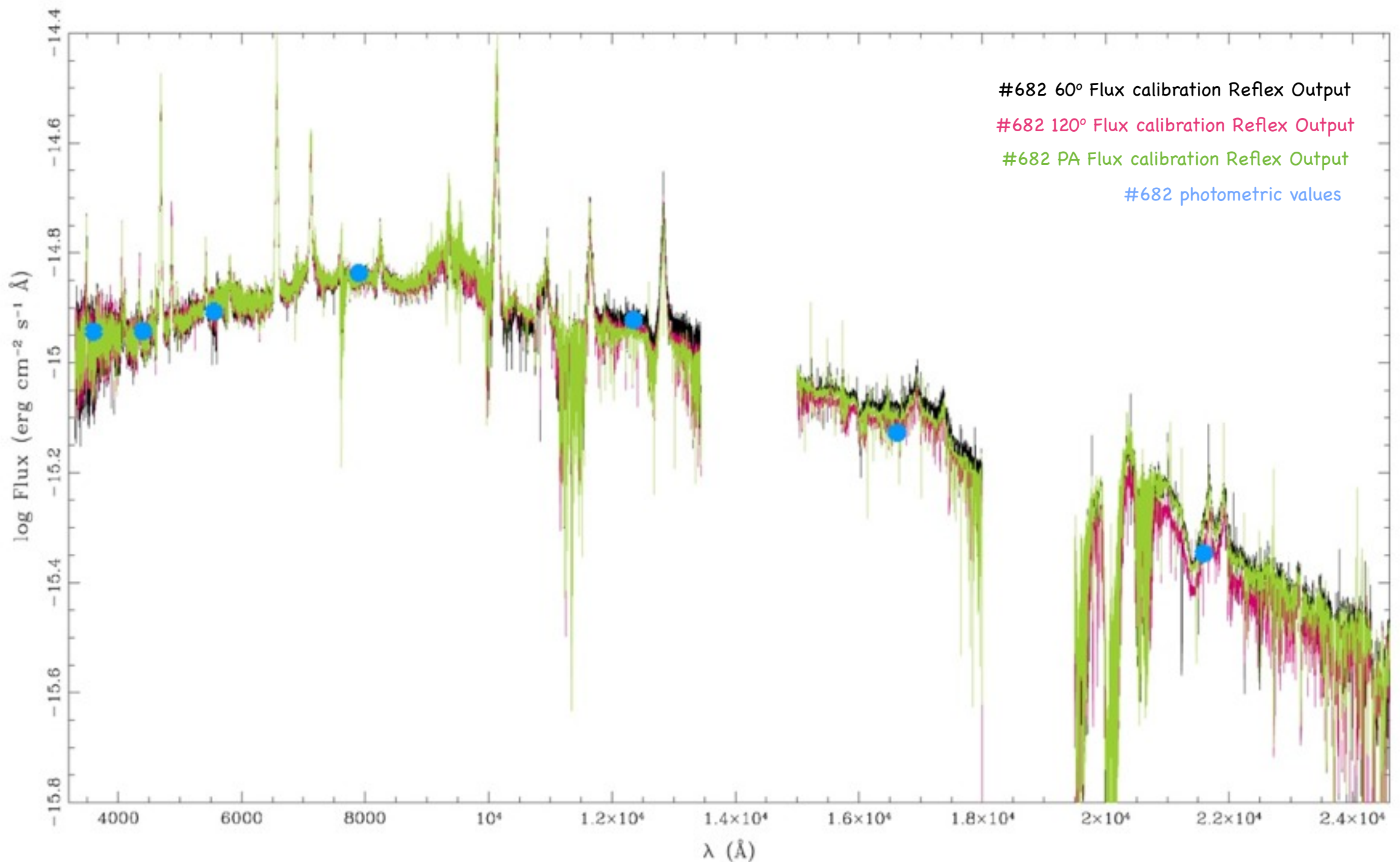
- $T_{\text{eff}}(\tau_{\text{Ross}}=2/3) \sim 52.2 \pm 2.5 \text{ kK}$
- $T_{*}(\tau_{\text{Ross}}=10) \sim 54 \pm 3 \text{ kK}$
- $L_{*} \sim 2.56 \cdot 10^6 L_{\odot}$
- $\dot{M}_{\text{dot}} \sim 3.65 \cdot 10^{-5} M_{\odot}/\text{yr}$
- $\text{Cl_factor} = 0.25$
- $\text{He}/\text{H} = 0.2$ (44%)
- $\beta = 1.55$
- $v_{\infty} \sim 2600 \text{ Km/s}$

Present Work

- $T_{\text{eff}}(\tau_{\text{Ross}}=2/3) \sim 52.5 \pm 3 \text{ kK}$
- $T_{*}(\tau_{\text{Ross}}=10) \sim 53.2 \pm 3 \text{ kK}$
- $L_{*} \sim 2.50 \cdot 10^6 L_{\odot}$
- $\dot{M}_{\text{dot}} \sim 2.35 \cdot 10^{-5} M_{\odot}/\text{yr}$
- $\text{Cl_factor} = 0.1$
- $\text{He}/\text{H} = 0.25$ (49%)
- $\beta = 1.25$
- $v_{\infty} \sim 2350 \text{ Km/s}$

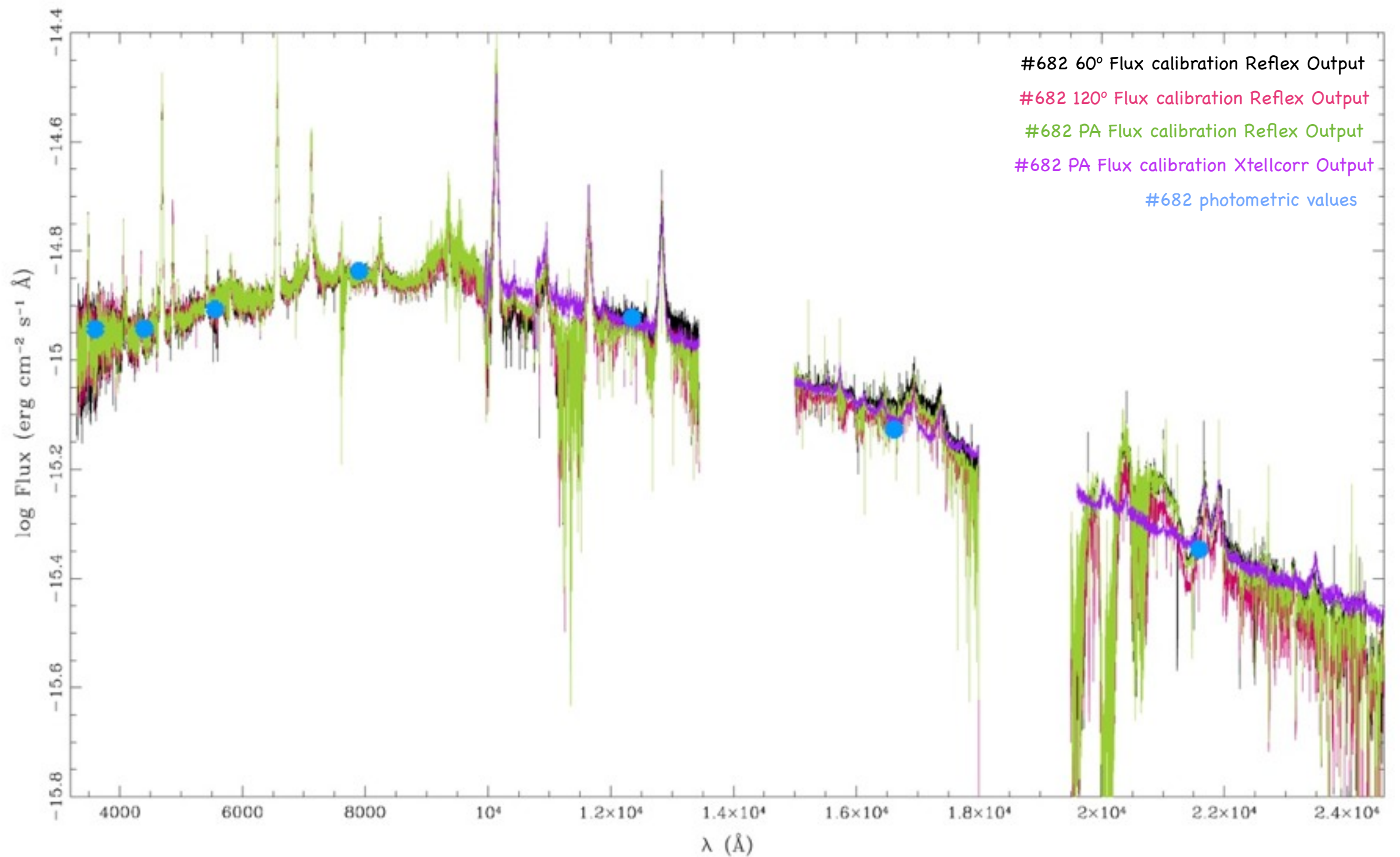
Preliminary Results

Flux Calibration

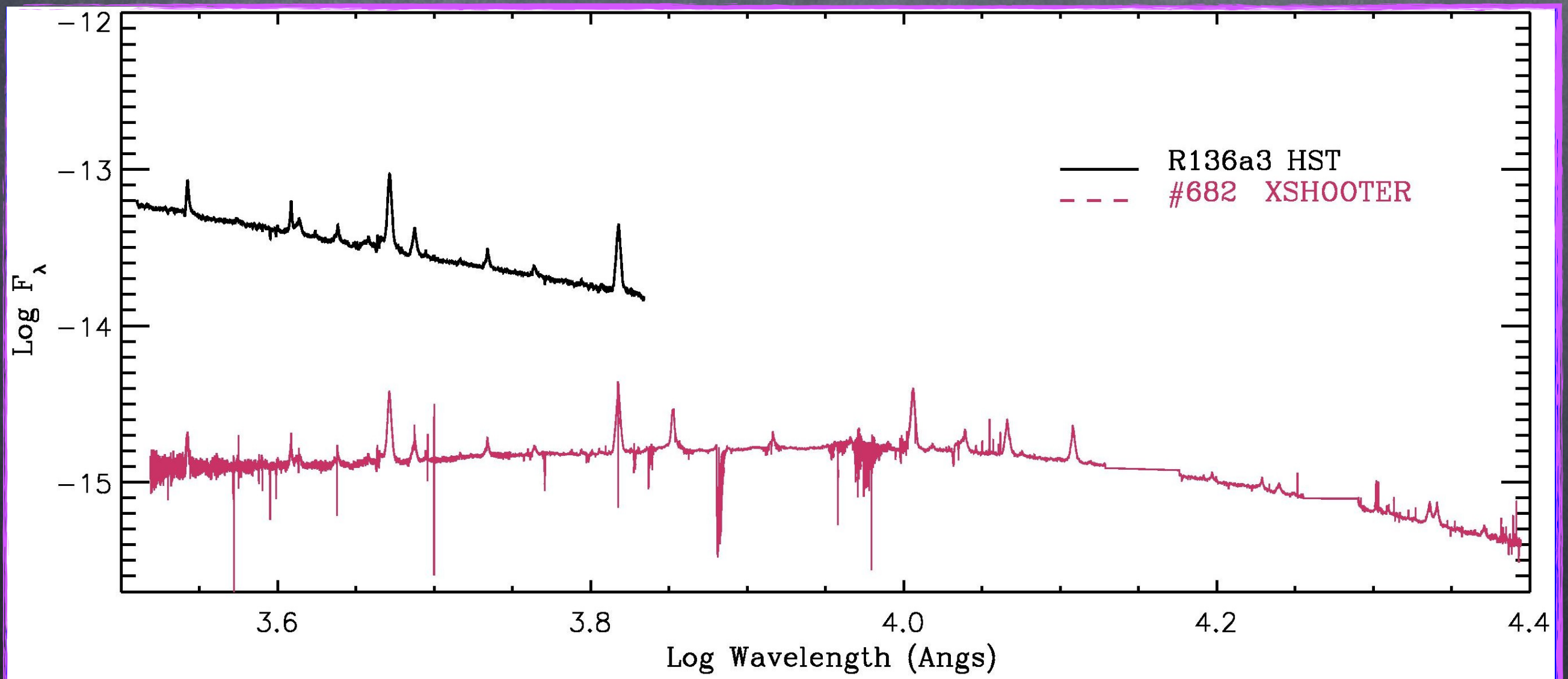


Preliminary Results

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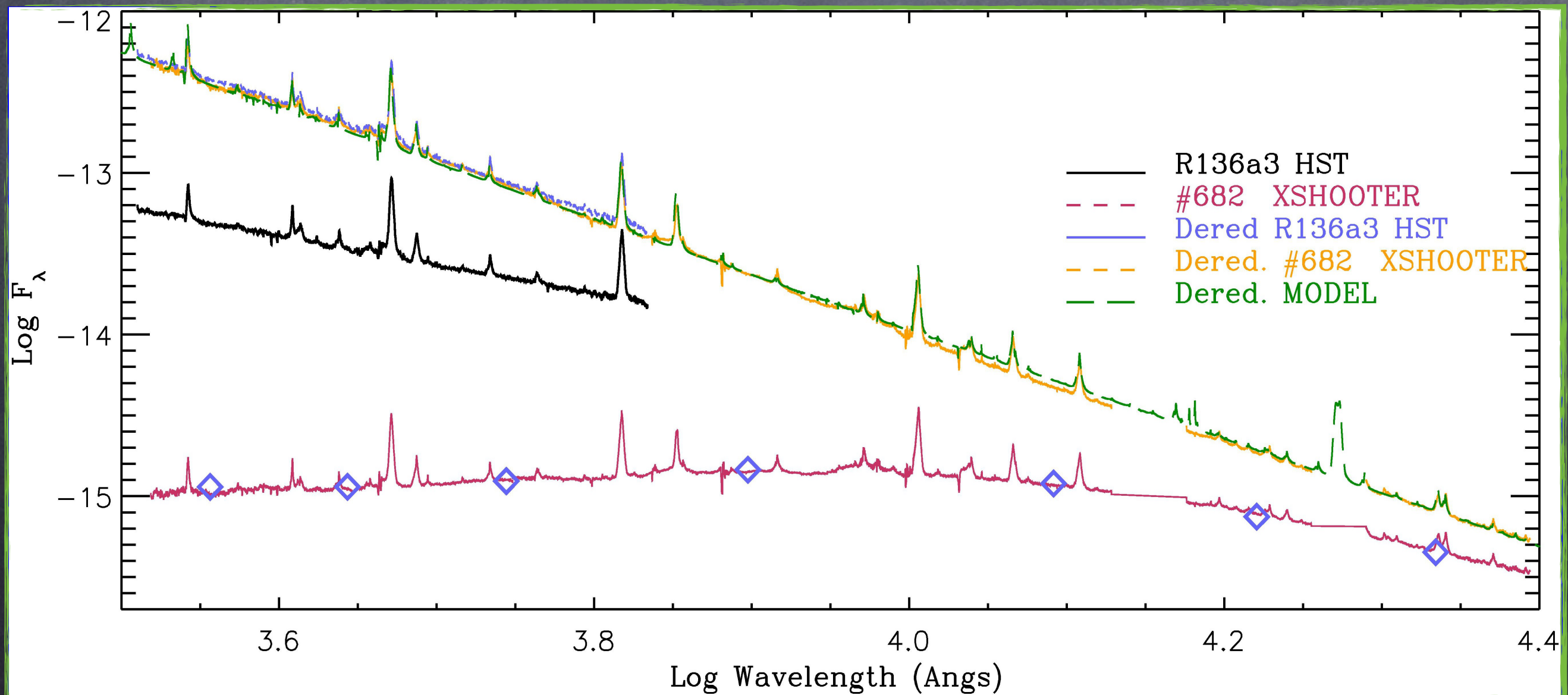


TWINS IN LUMINOSITY?



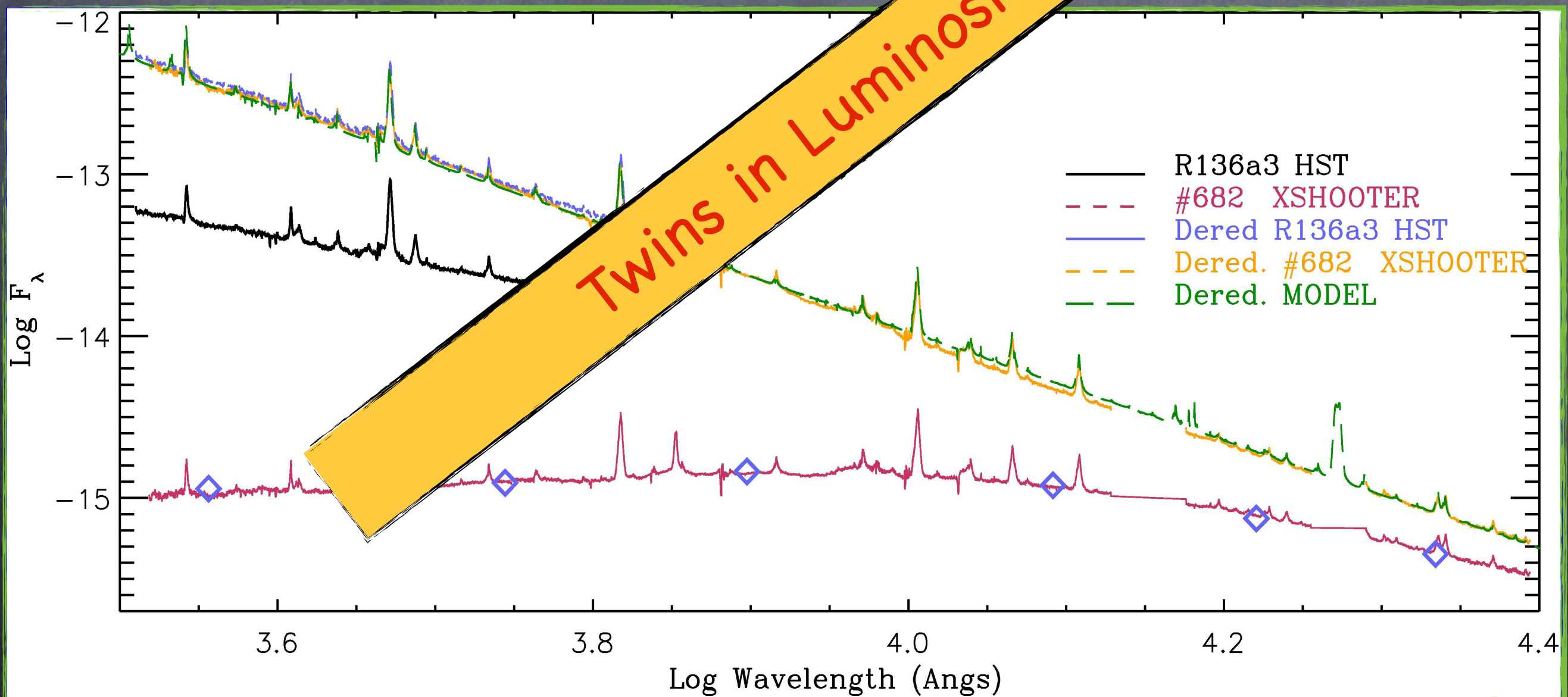
TWINS IN LUMINOSITY?

- **Dereddening #682:** $R_V = 4.7 \pm 0.1$ (Besterlehner et al. 2011),
 $E(B-V) = 0.98 \pm 0.03$ (CHORIZOS code, Maíz-Apellaniz 2007)
- **Dereddening R136a3:** $R_V = 3.1$ (Galactic average) + 4.0,
 $A_V = 1.7$ (Crowther et al. 2010),



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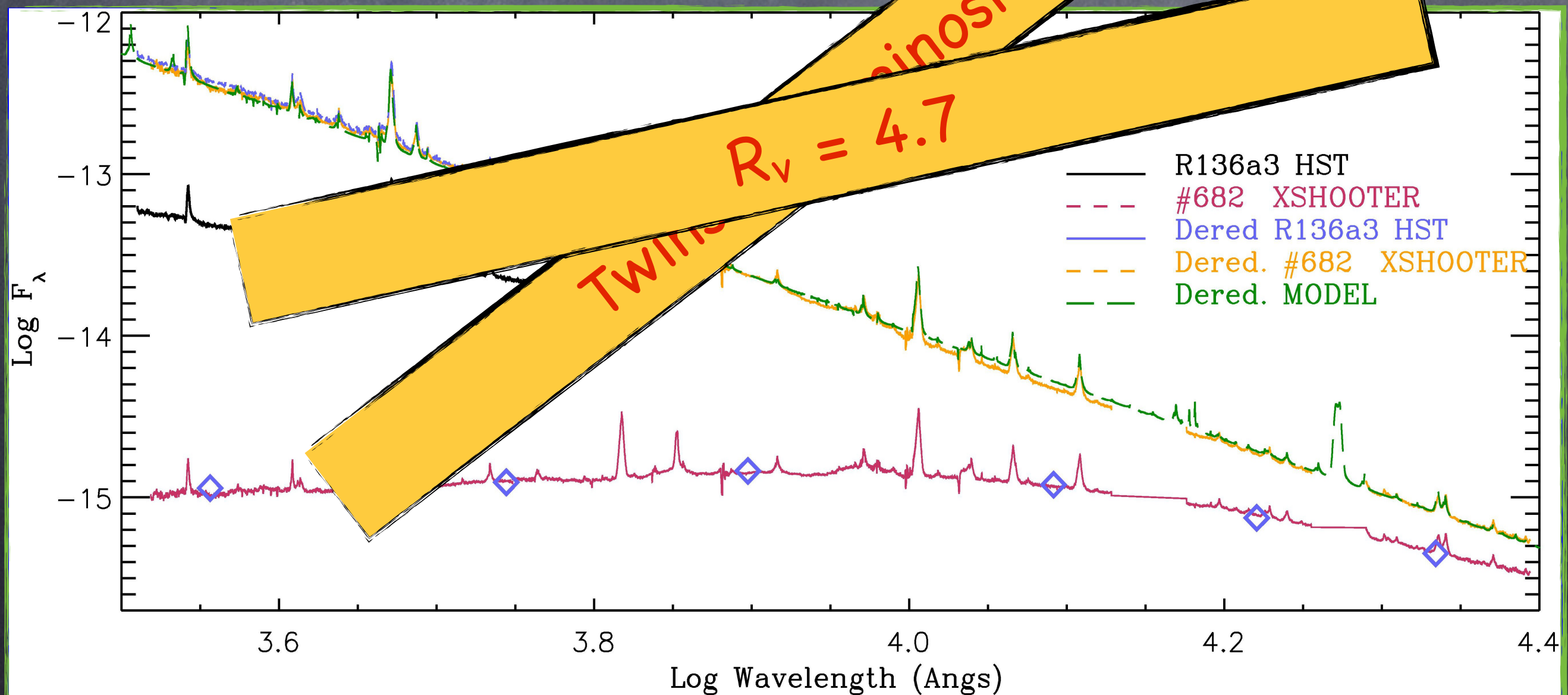
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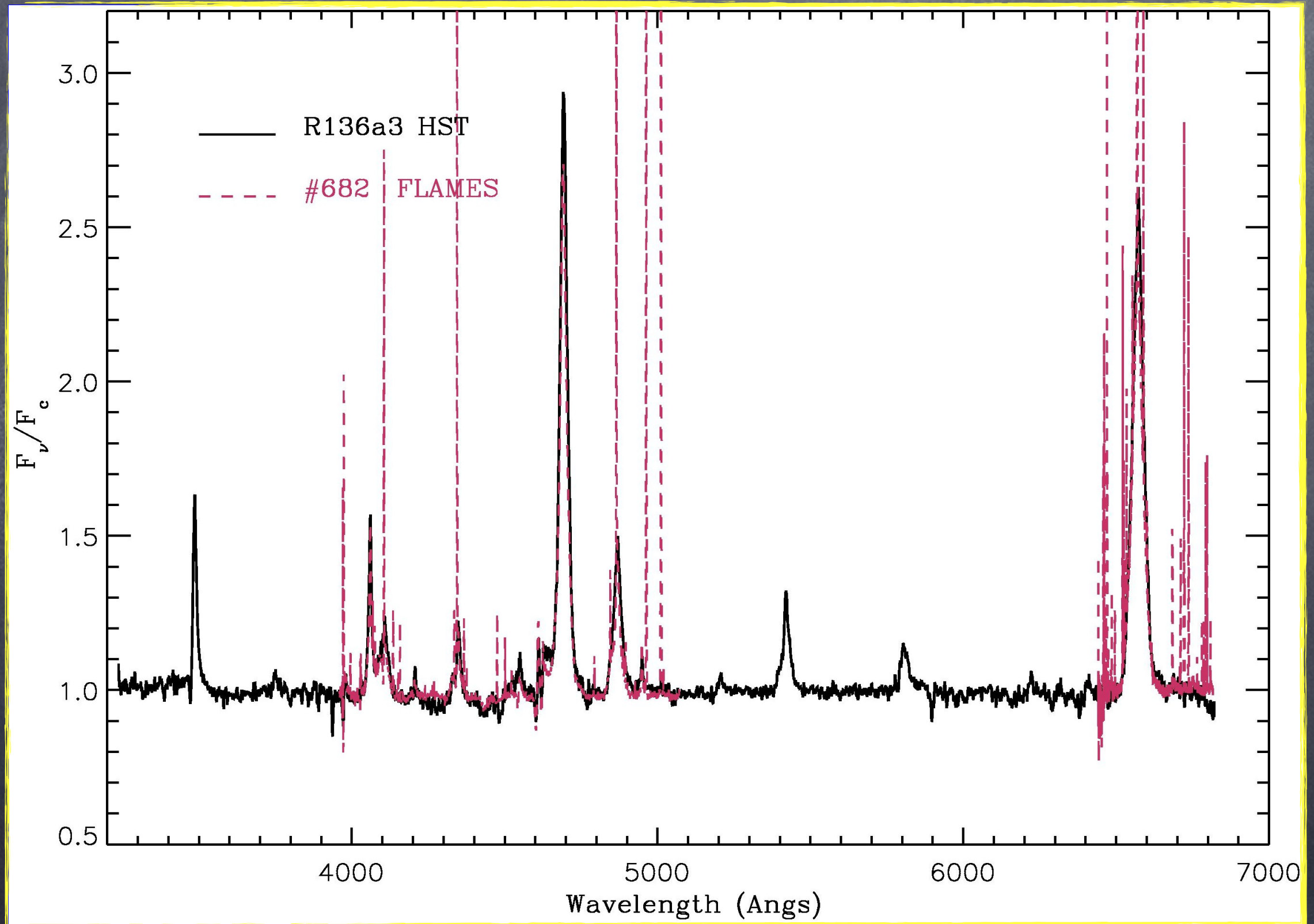
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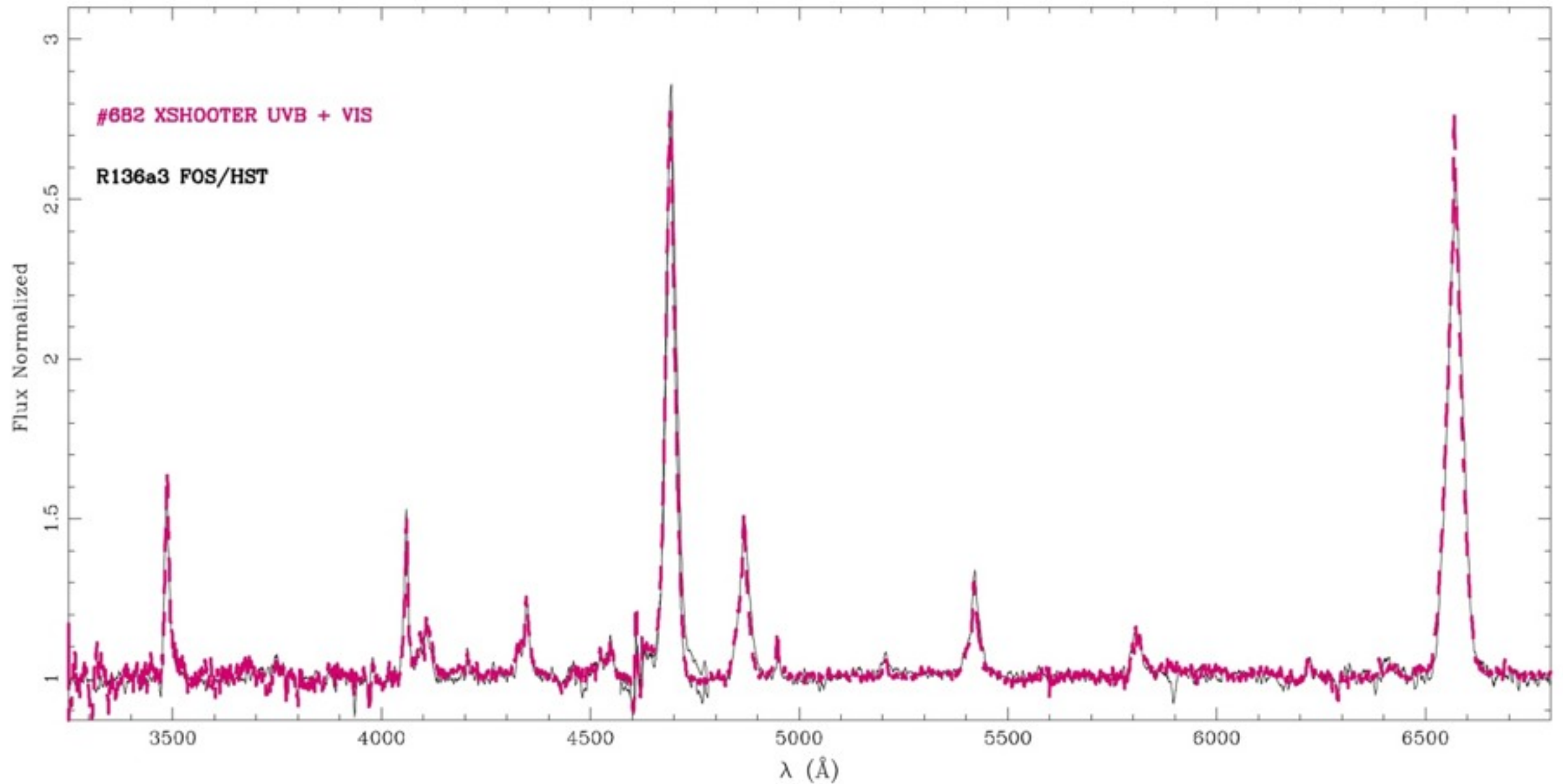
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TWINS IN THE OPTICAL?



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4000

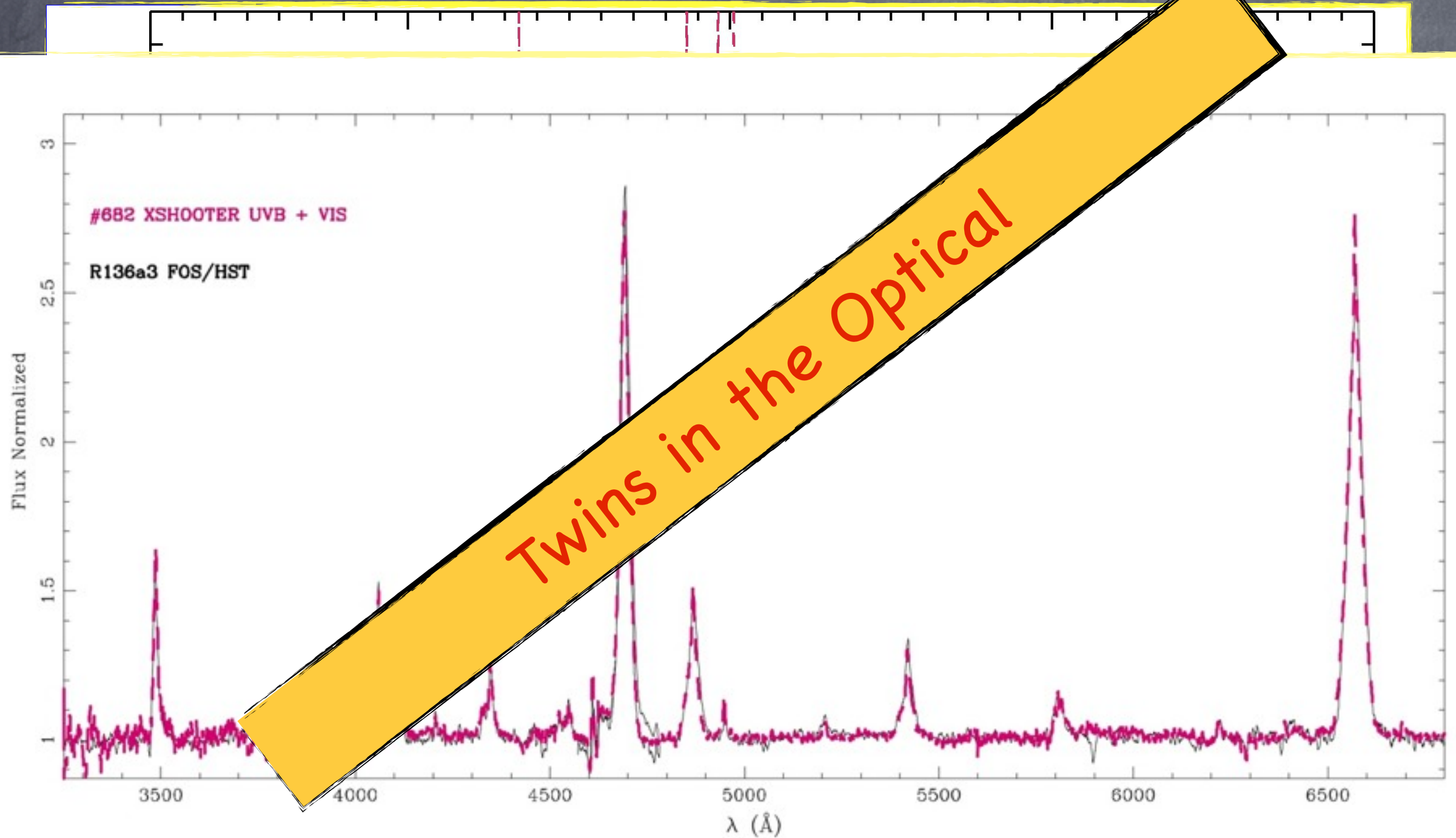
5000

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Wavelength (Angs)

TWINS IN THE OPTICAL?



4000

5000

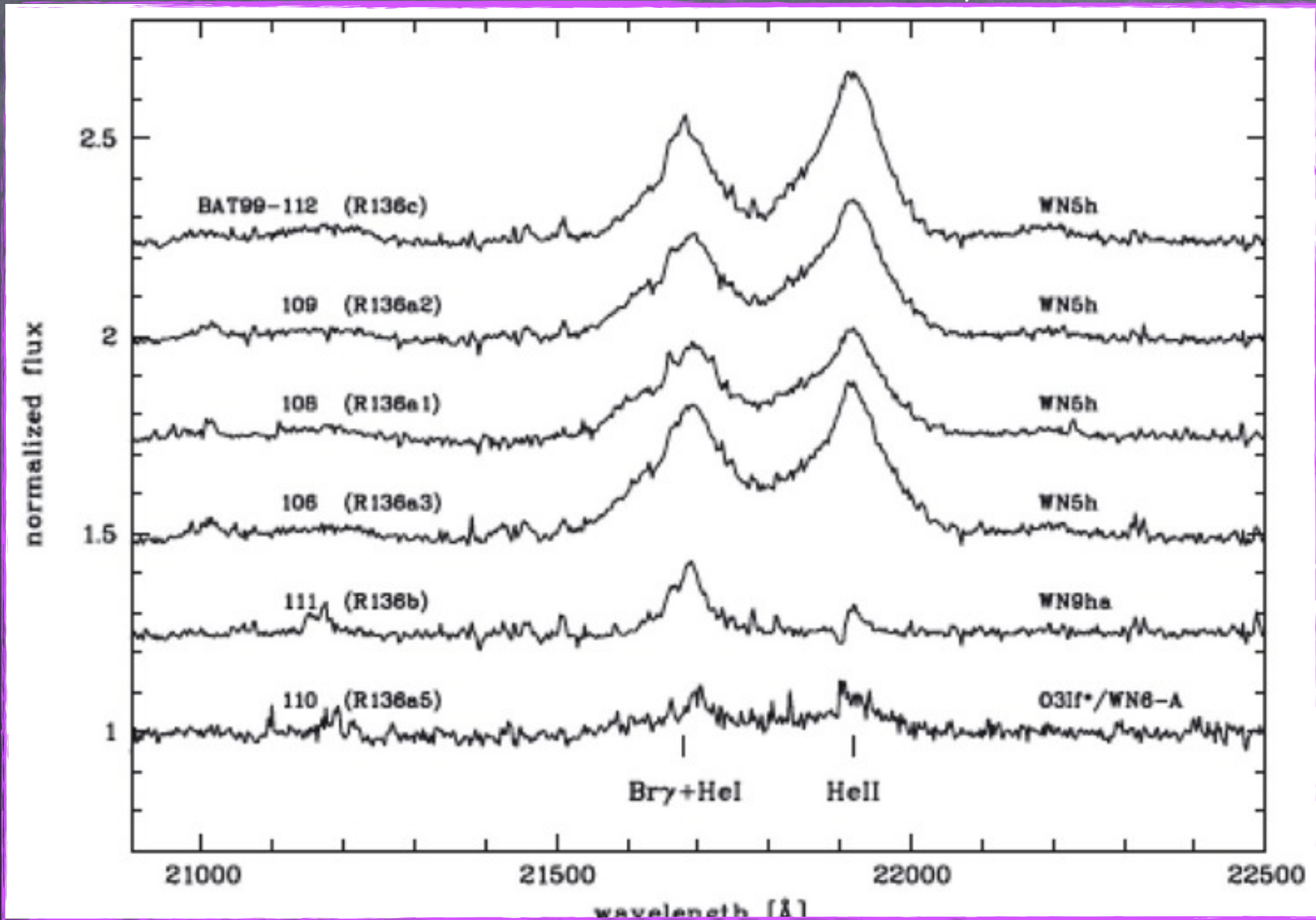
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TWINS IN THE NIR?

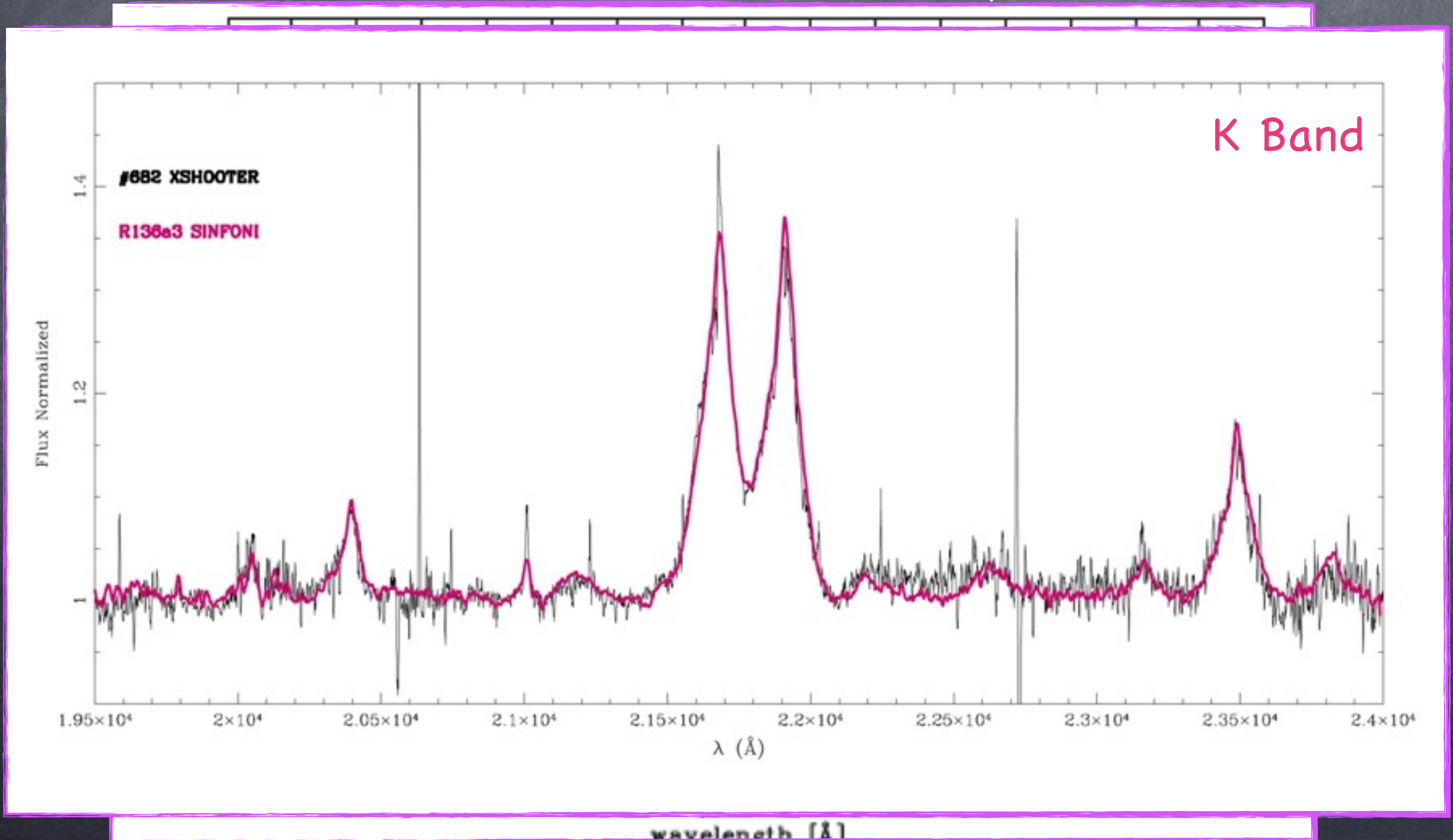
Schnurr et al. 2009, Crowther et al. 2010



TWINS IN THE NIR?

- K band-Sinfoni spectrum **R136a3** (Schnurr et al. 2009, Crowther et al. 2010):
WN5h star, $\log(L/L_{\odot}) = 6.58 \pm 0.09$, $T_{*}(\tau_{\text{Ross}}=10) \sim 53 \pm 3 \text{ kK}$, $M_{*} \sim 135 M_{\odot}$

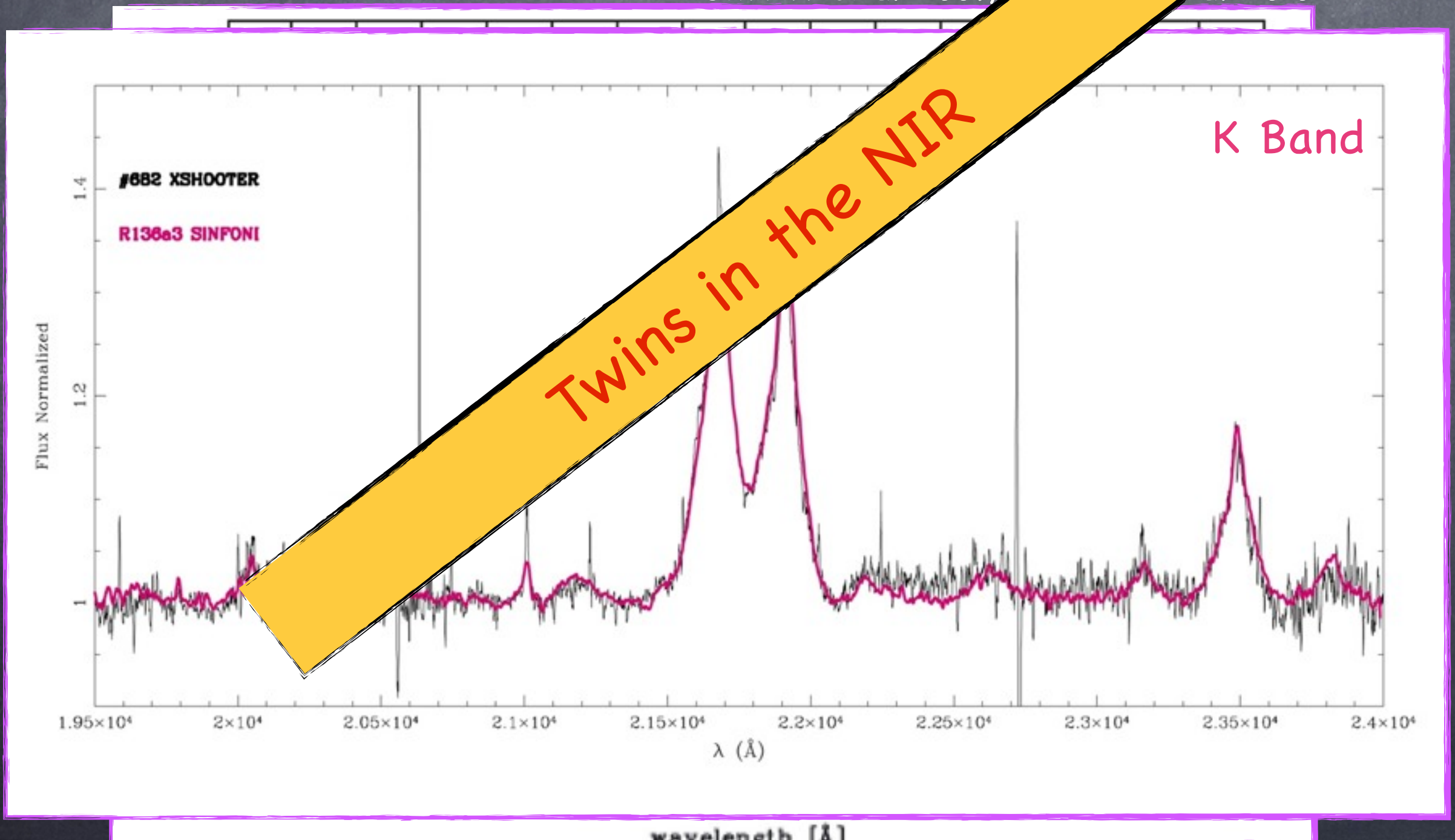
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Schnurr et al. 2009, Crowther et al. 2010



X-RAY EMISSION

- X-ray Chandra detection, ~ 18 counts, $kT \sim 4\text{keV}$
(L. Twonsley, 30Dor 2012 Workshop)
- $L_x \sim 10^{33.2} \text{ erg/s} \Rightarrow$ Colliding Wind binary or
Magnetic Field Single scenario
- Single Scenario \Rightarrow Strongly-confined wind \Rightarrow
Intense B?
- Binary Scenario \Rightarrow Similar to WR 20A \Rightarrow
Longer Period Binary?

What we know about VFTS#682

(Rubio-Díez, M. M. et al. in Prep)

- An Isolated twin of R136a3 star
- No spectroscopic or photometric evidences of Red Companion and/or short period variability
- $R_v = 4.7 \Rightarrow \log (L/L_{\odot}) = 6.5 \pm 0.2 \Rightarrow 150M_{\odot}$
- **X-ray emission** \Rightarrow Binary or Magnetic Star?
- Binary? (WN5h + WN5h, $\sim 75M_{\odot}$) \Rightarrow WR 20A
(Montes et al. 2013)



That's all Folks!