PROBING PROTOPLANETARY DISK WINDS WITH FUV ABSORPTION LINES

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Christopher Johns-Krull (Rice University)

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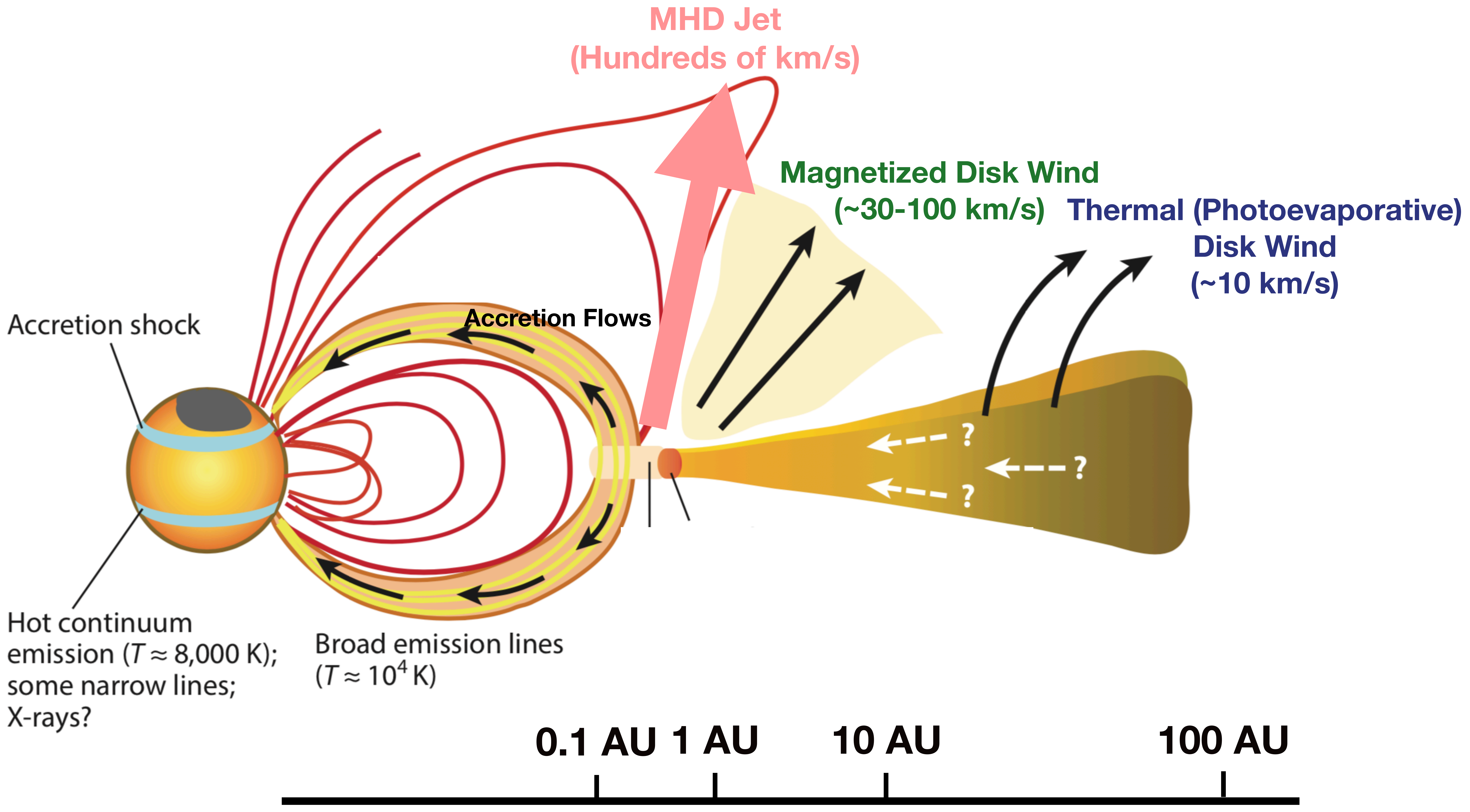
5th NUVA Workshop

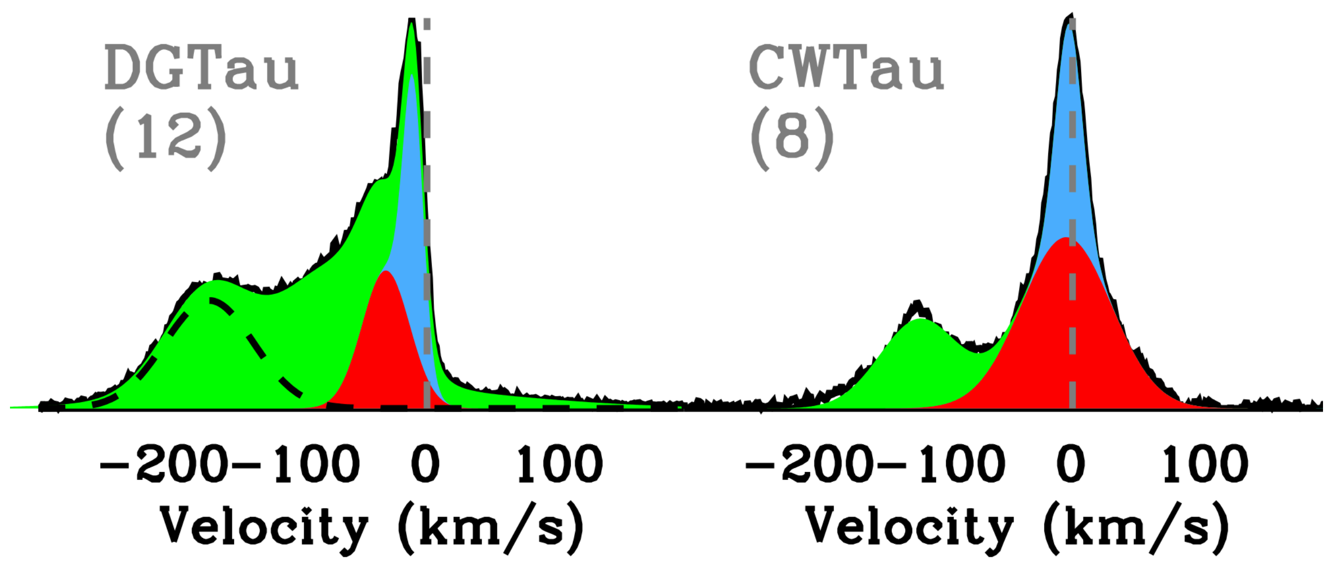
Accretion Onto Young Stars



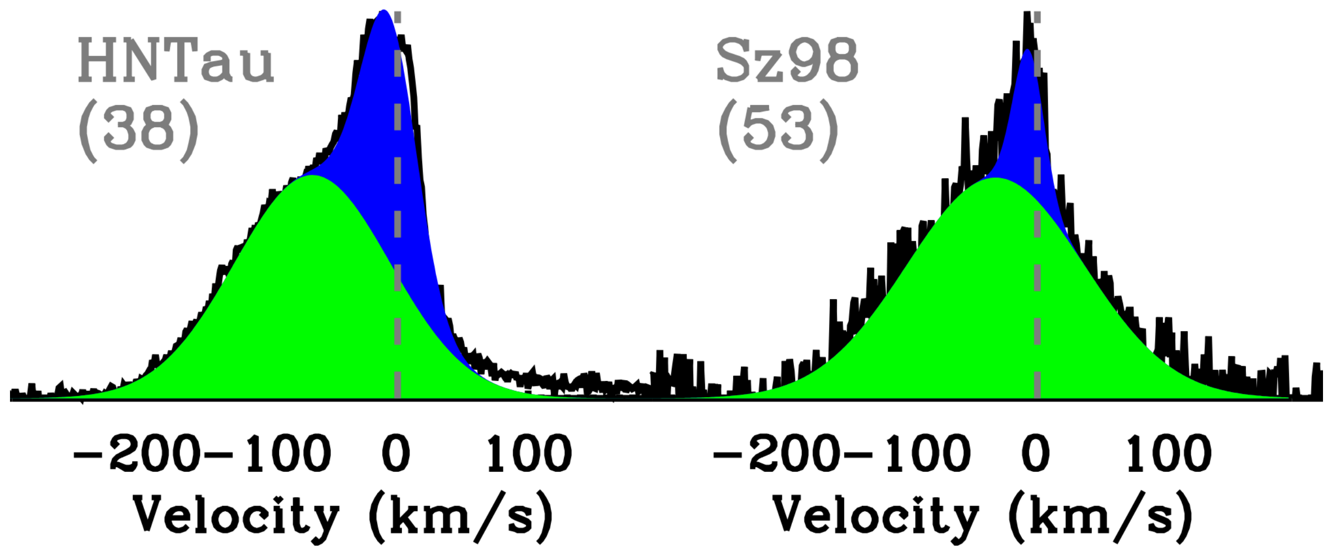
(Hartmann, Herczeg, & Calvet 2016)

Winds Detection by Emission Lines

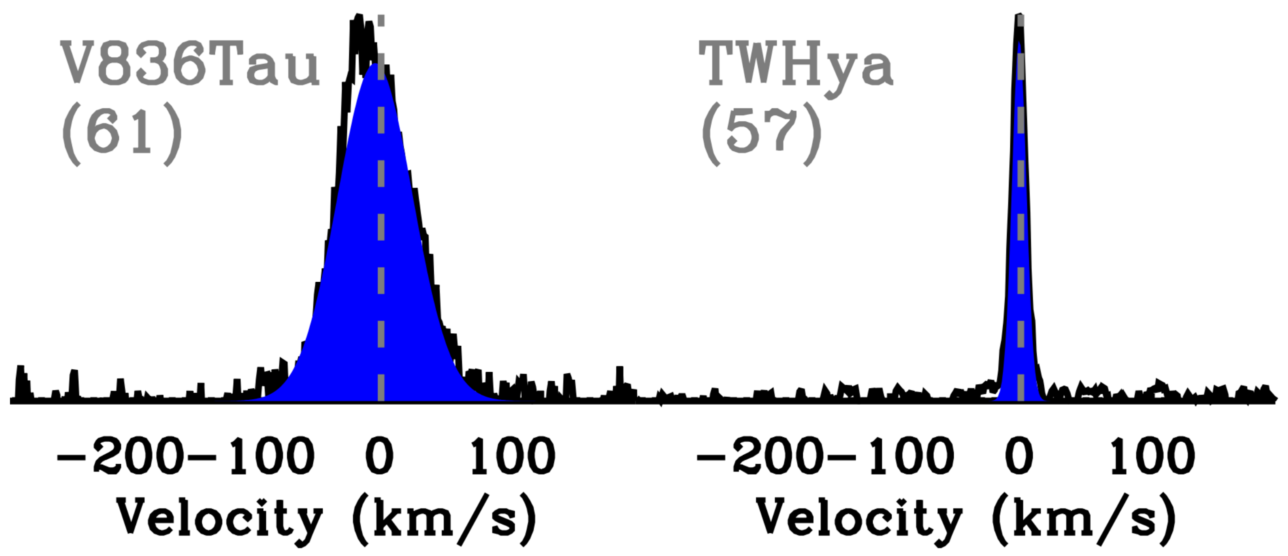
Fast + Slow Broad + Slow Narrow



Fast + Slow Components



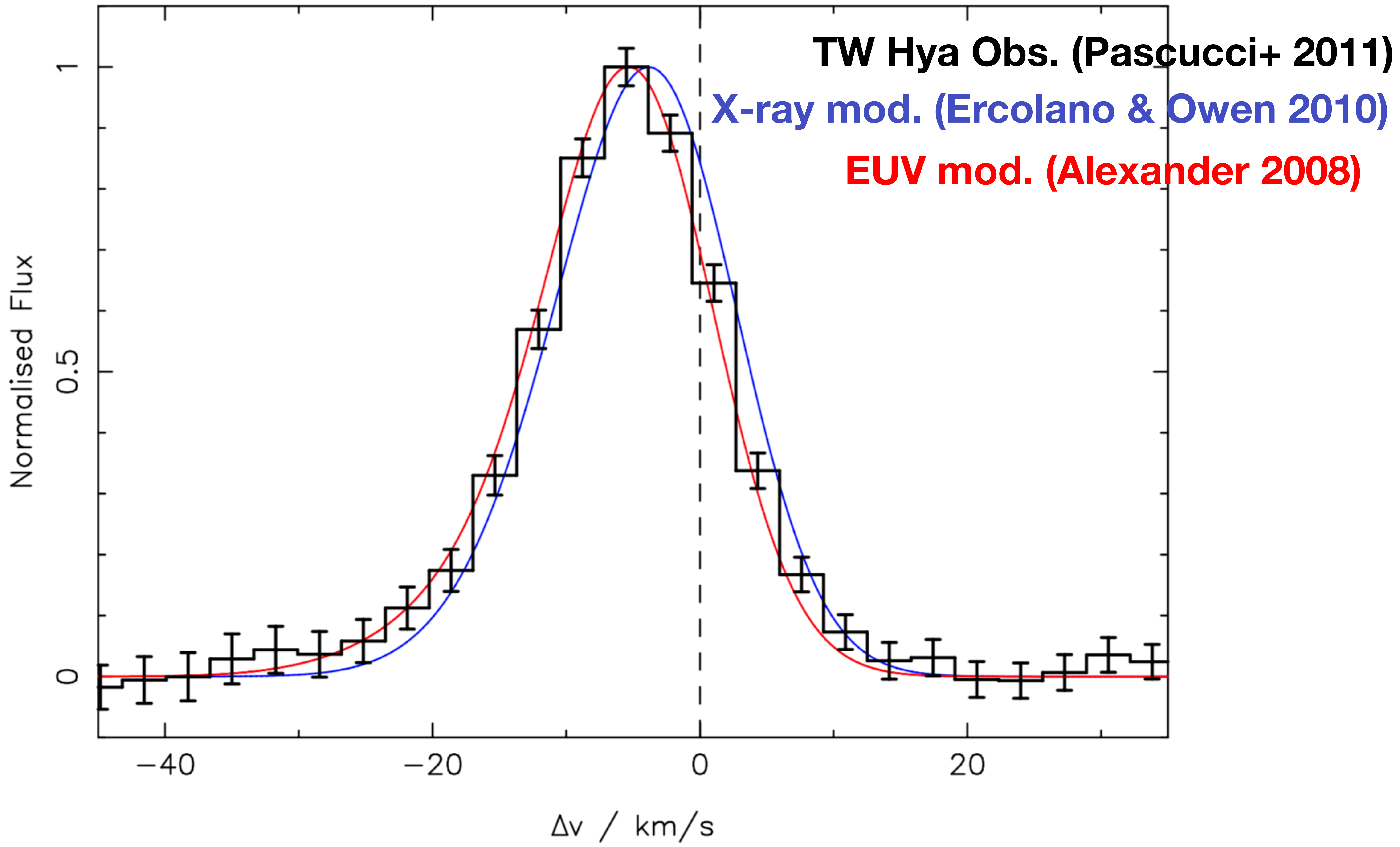
Slow Component Only



[O I] emission lines

(Banzatti+ 2019)

Emission lines vs. photoevaporative wind model prediction



[Ne II] emission lines

(from Alexander+ 2014)

Winds Detection by Emission Lines

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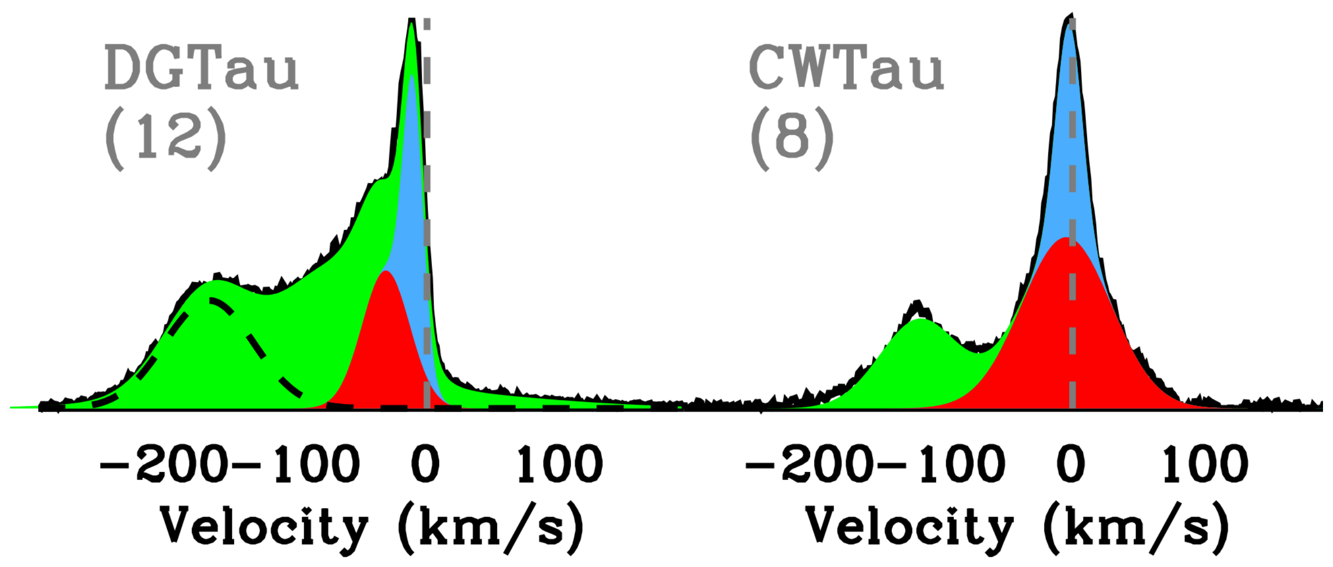
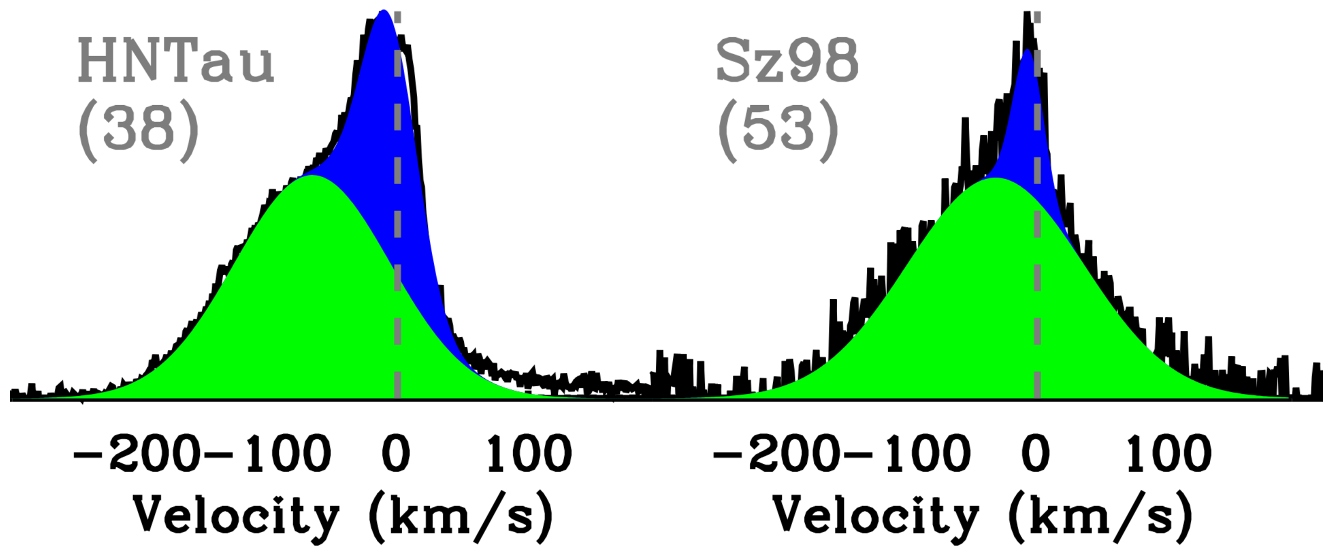
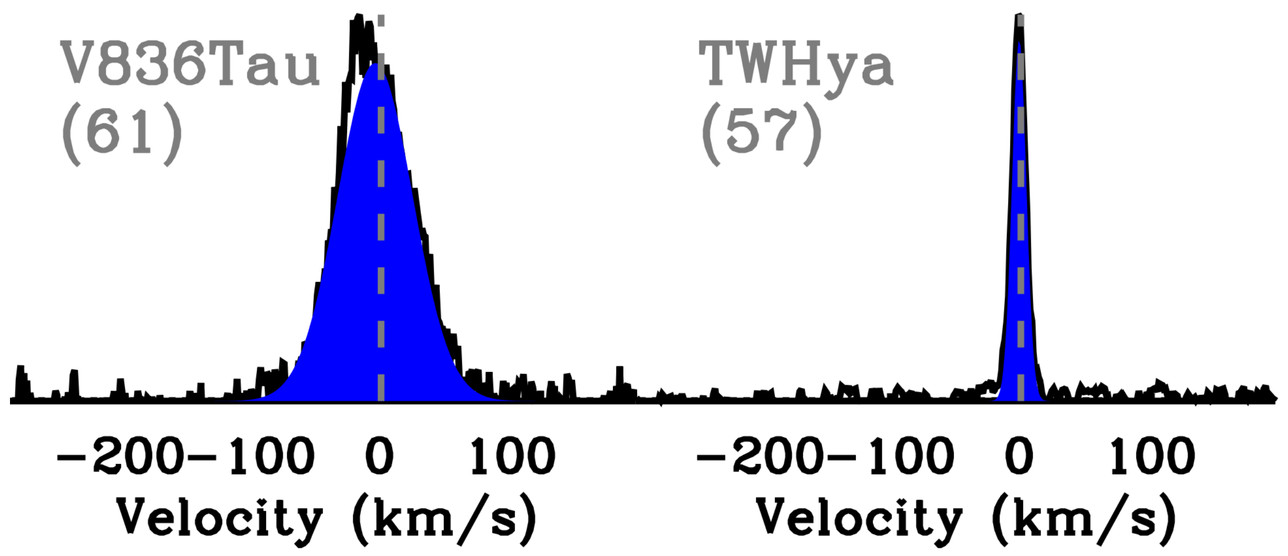


Fast + Slow Components



Slow Component Only



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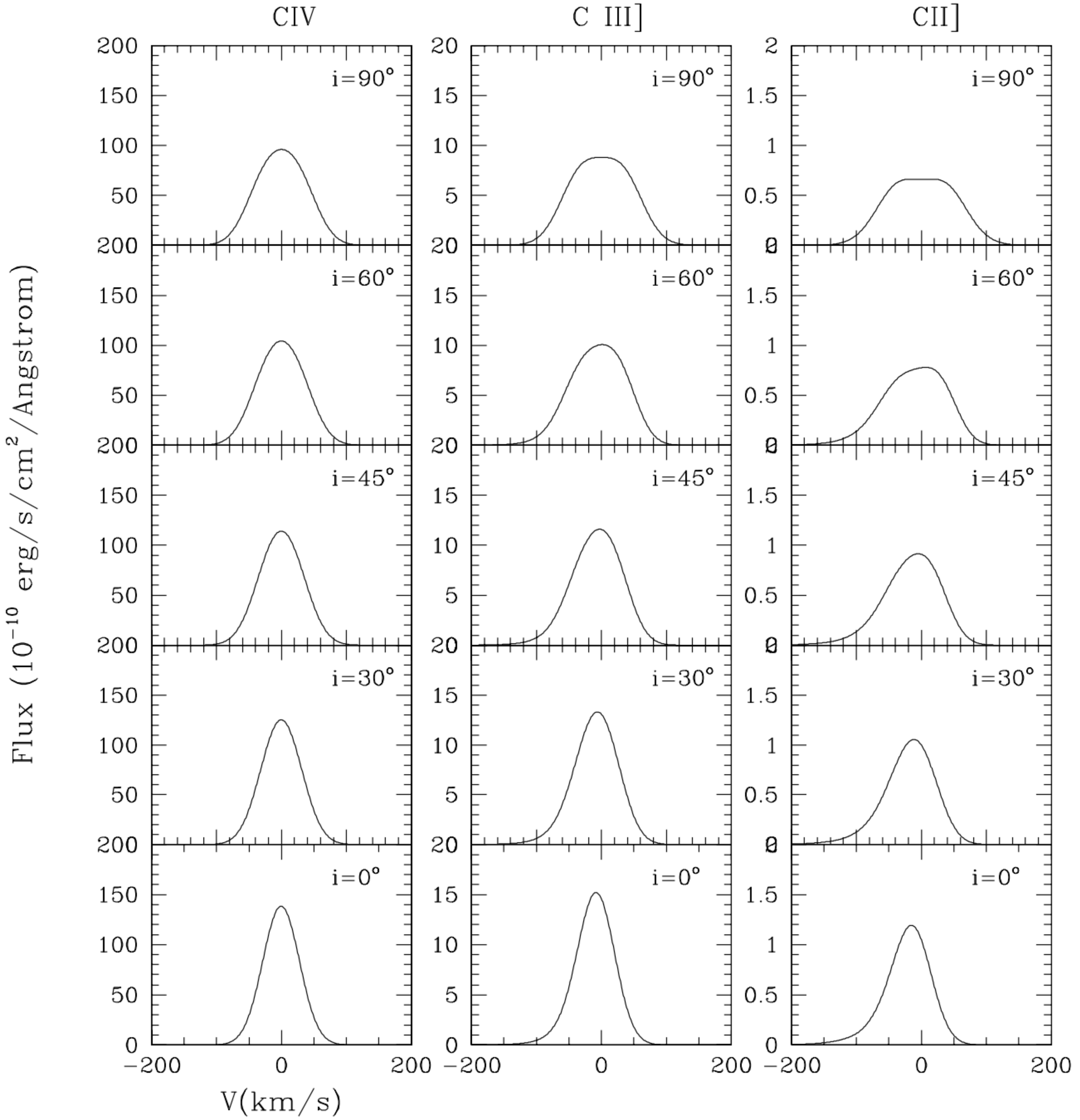
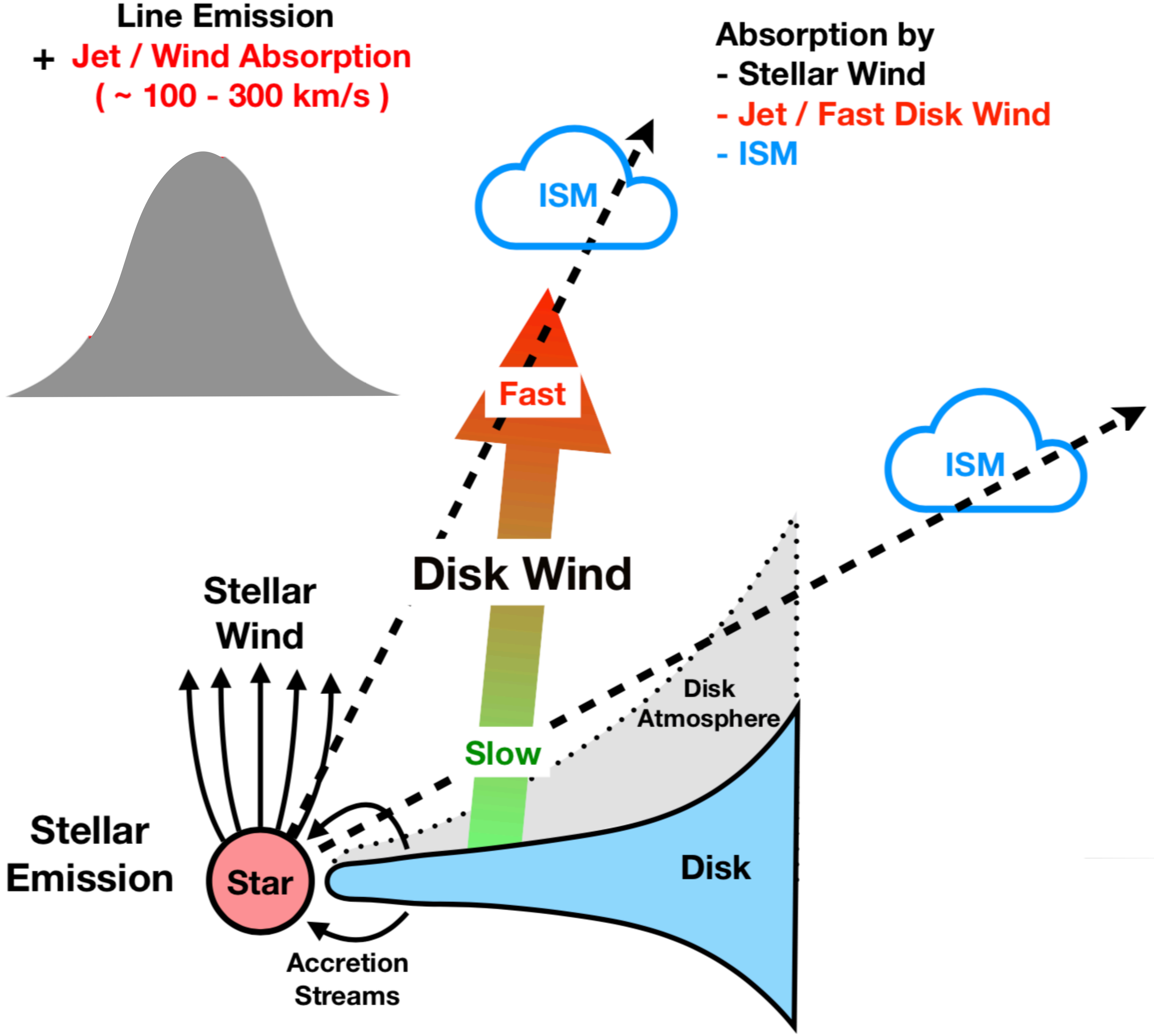
(Banzatti+ 2019)

Modeling UV lines with warm MHD disk winds.
(also Gómez de Castro & von Rekowski 2011 for models of jets)



(Gómez de Castro & Ferro-Fontán 2005)

PROBING DISK WIND WITH ABSORPTION LINES



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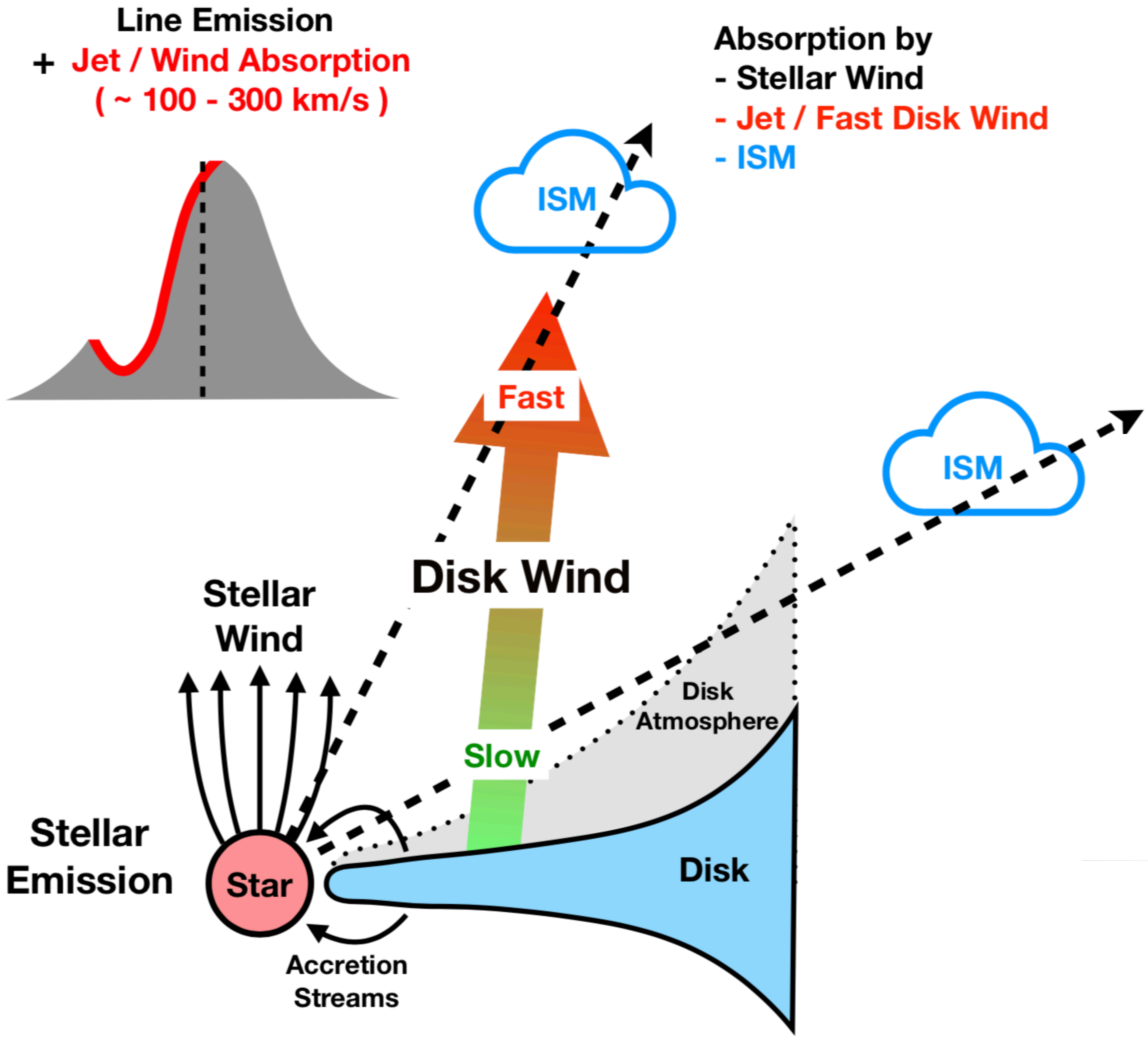

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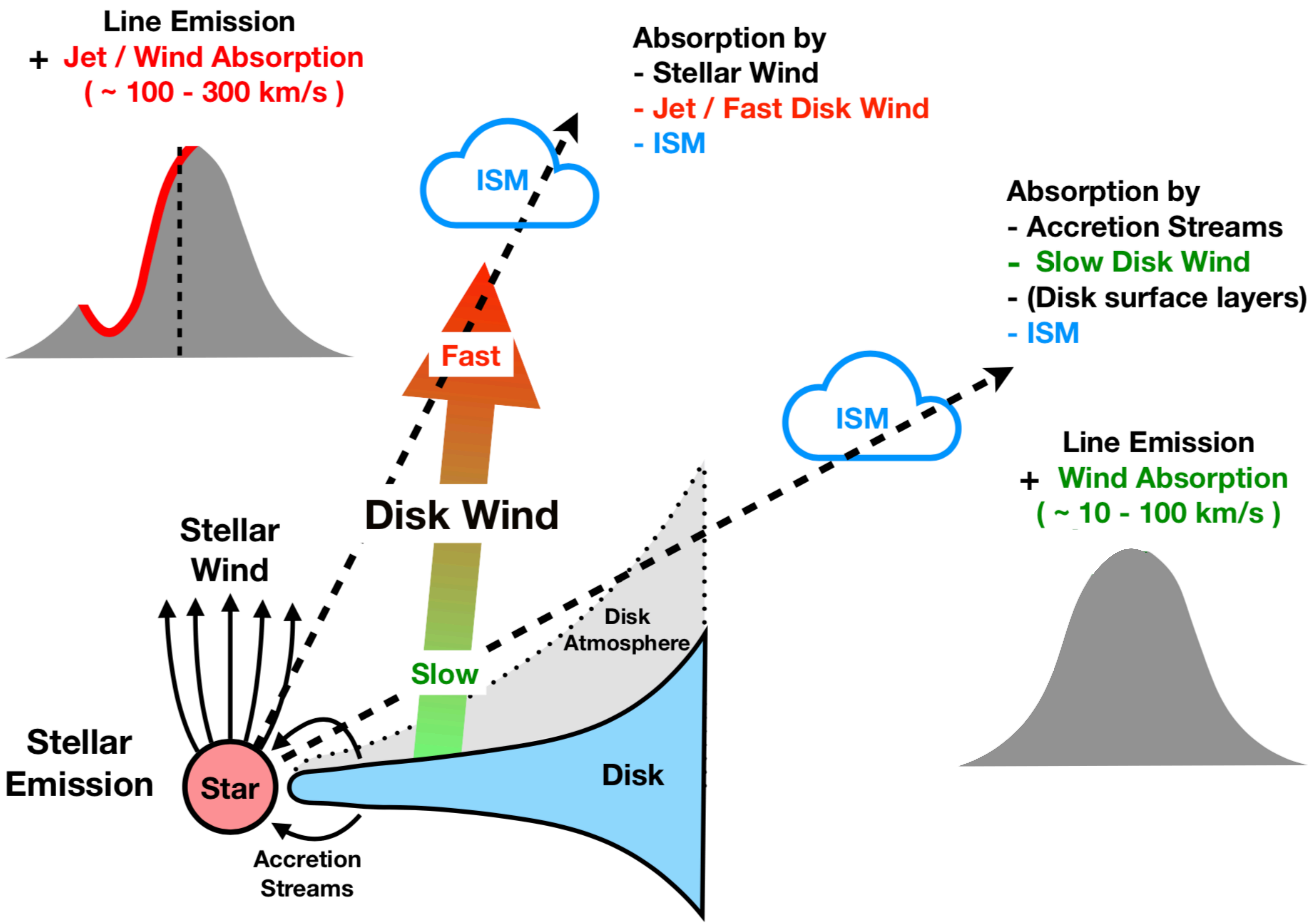

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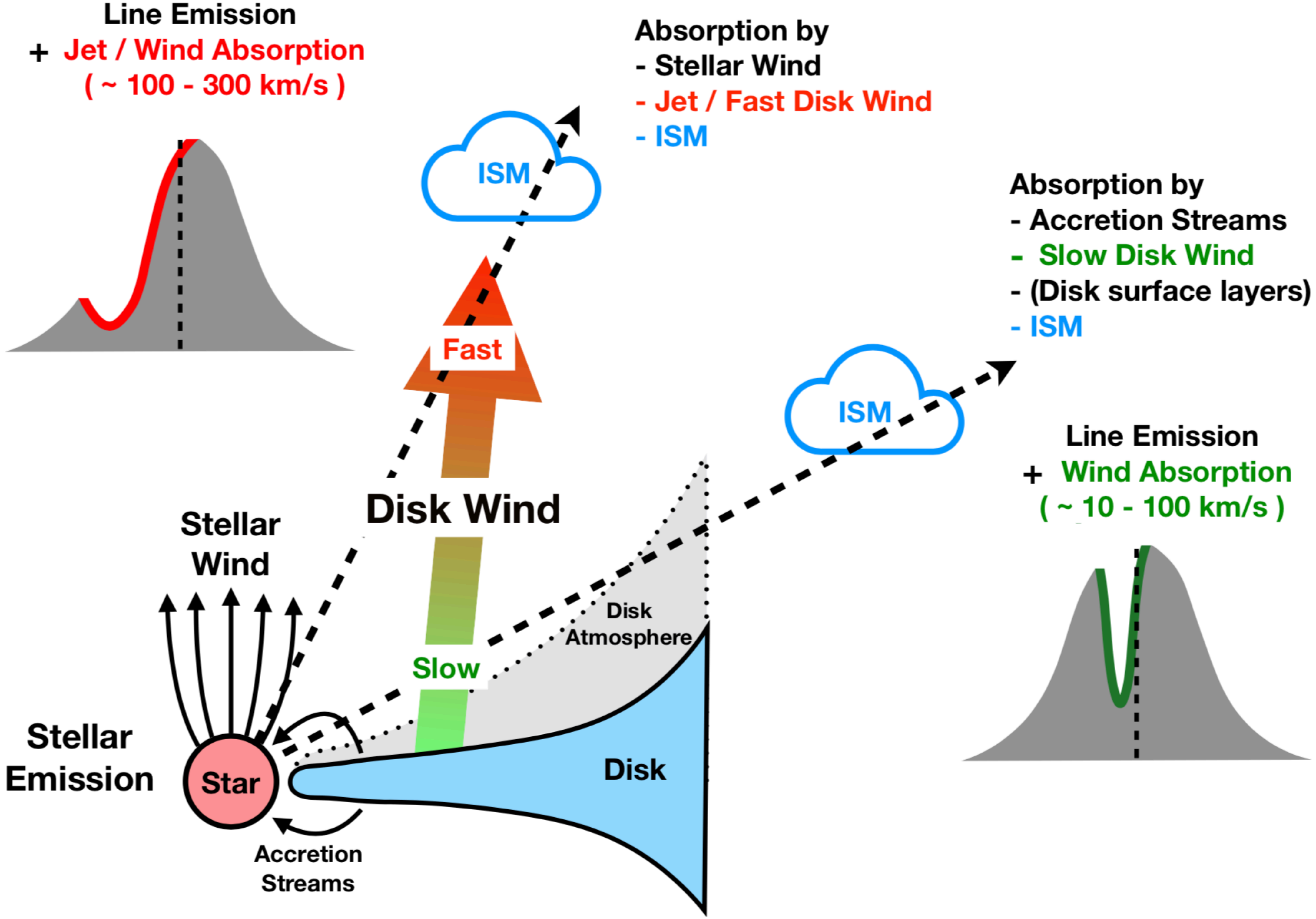
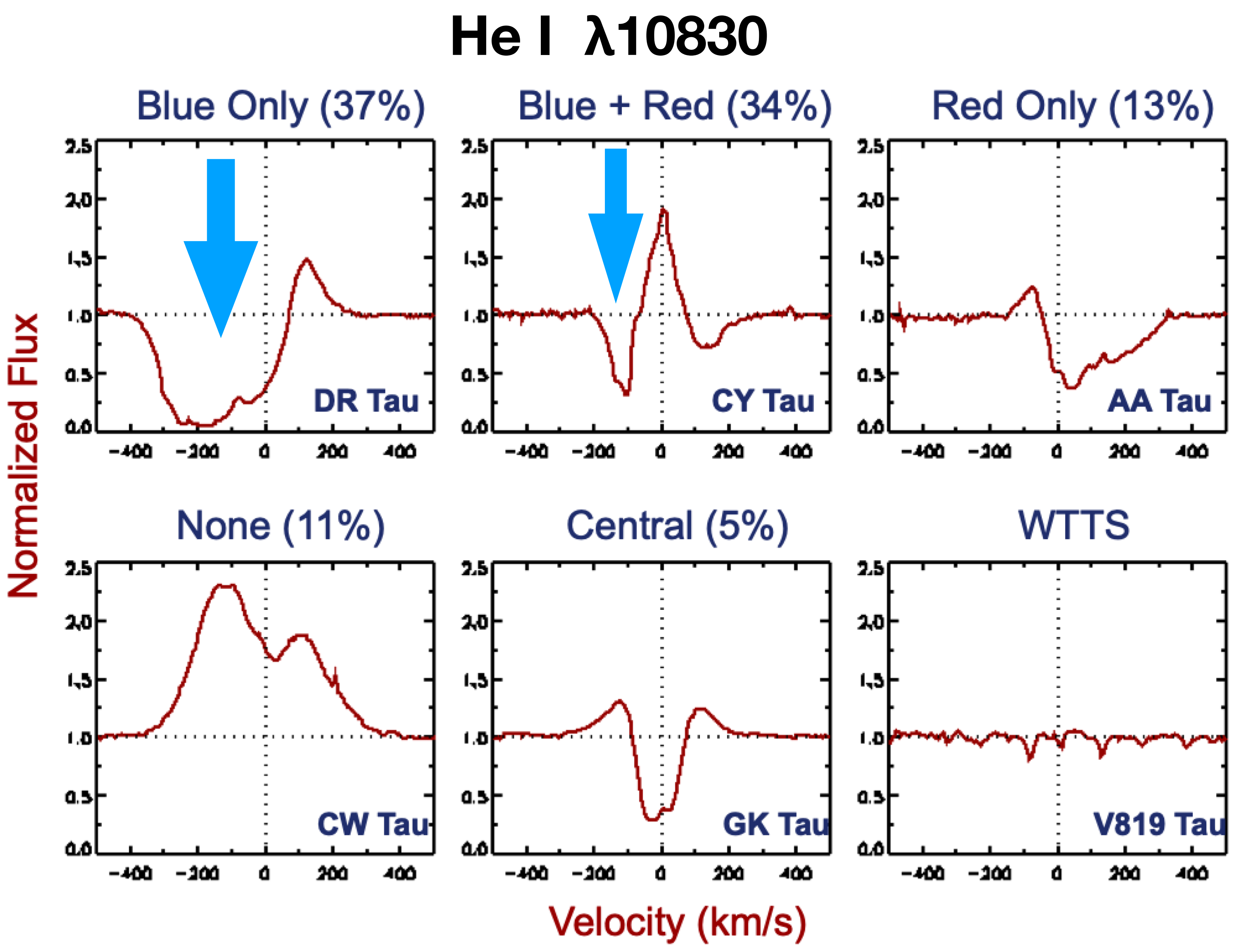


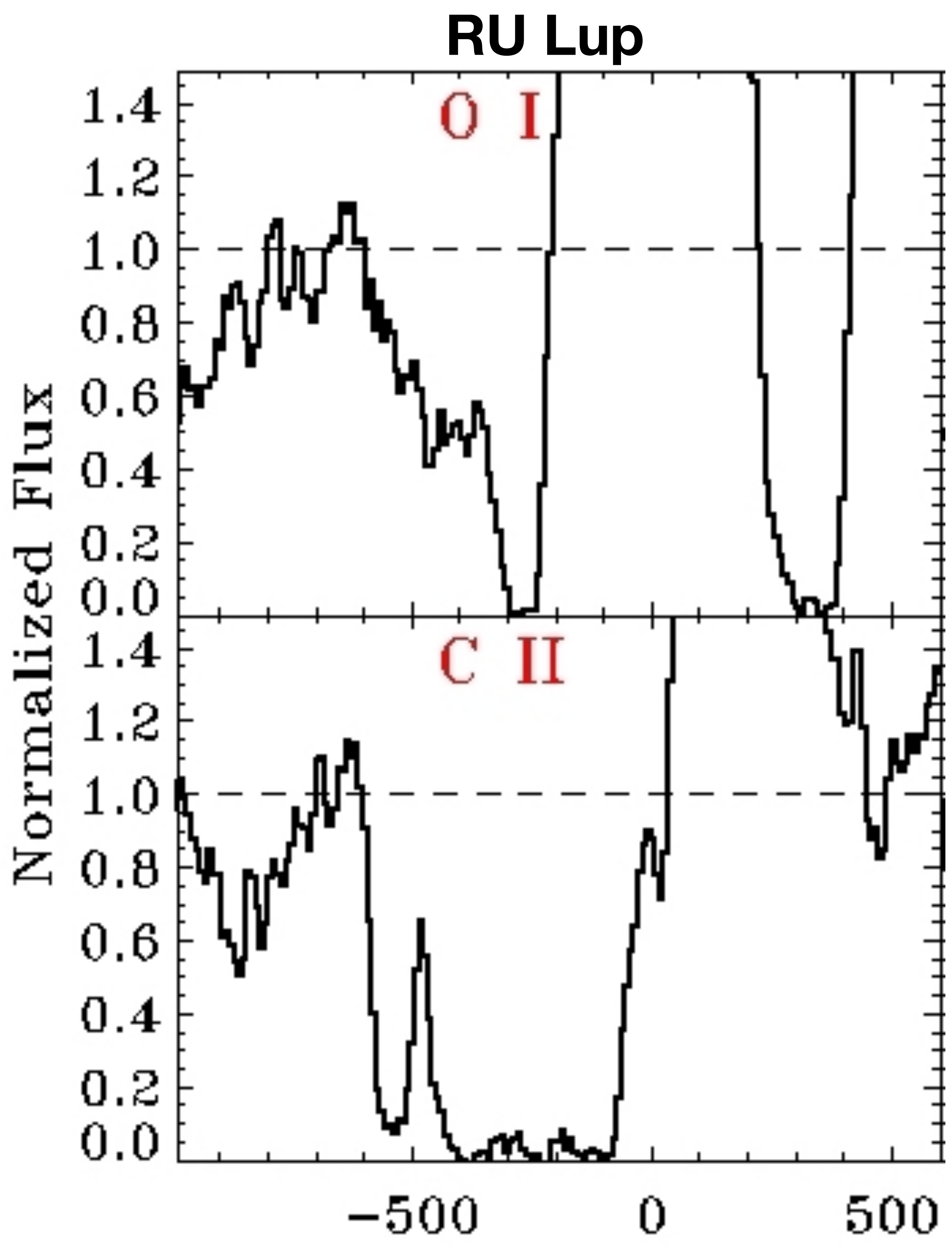
Evidence of Wind From Absorption Lines

- **He I absorption survey reveals fast & slow wind components**



(Edwards+ 2006)

- **FUV lines: fast absorption in neutral & singly-ionized lines**



(Herczeg+ 2005)

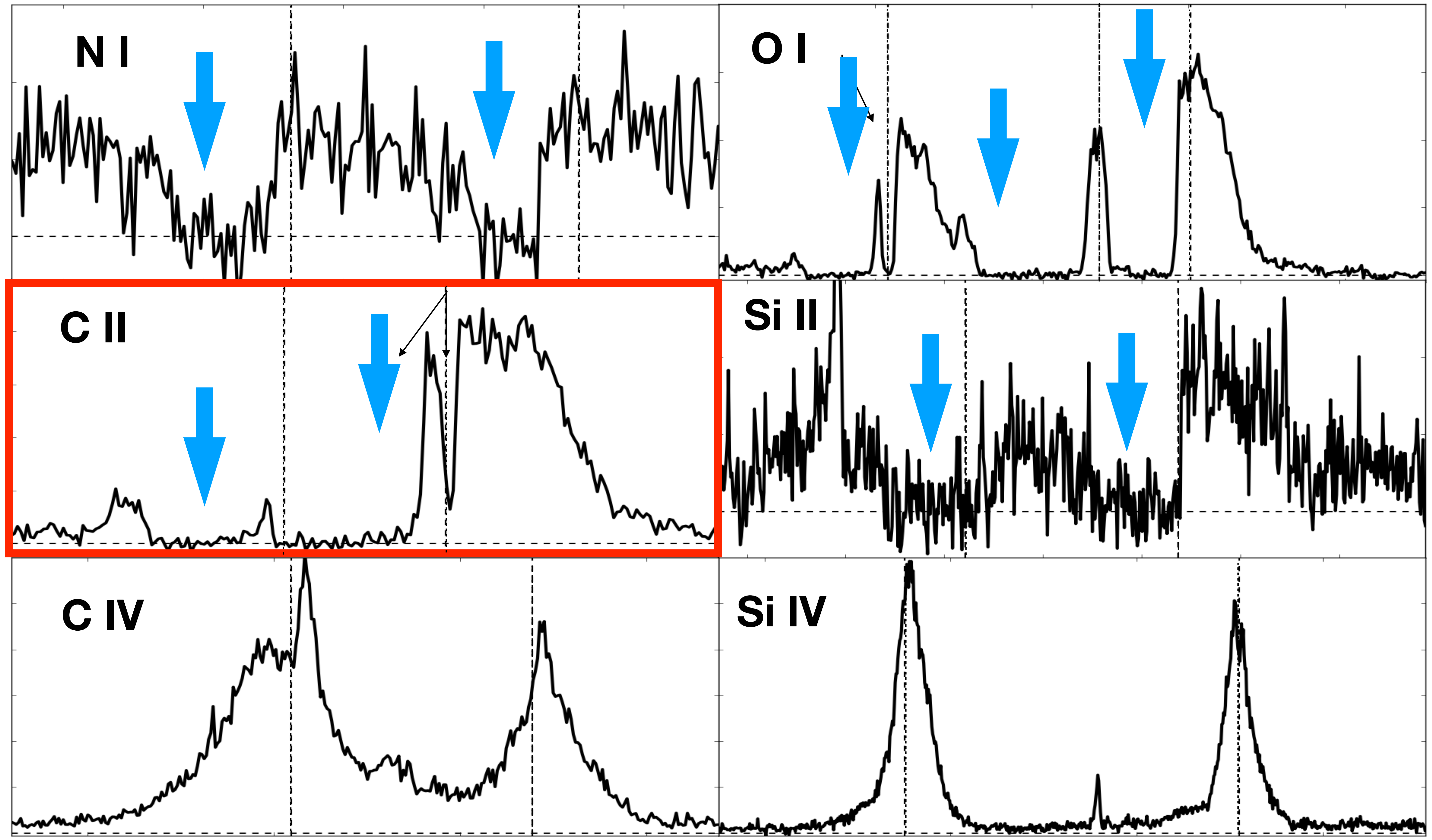
FUV Spectroscopy With HST STIS/COS

Survey of 40 disk hosting stars (CTT & Herbig)

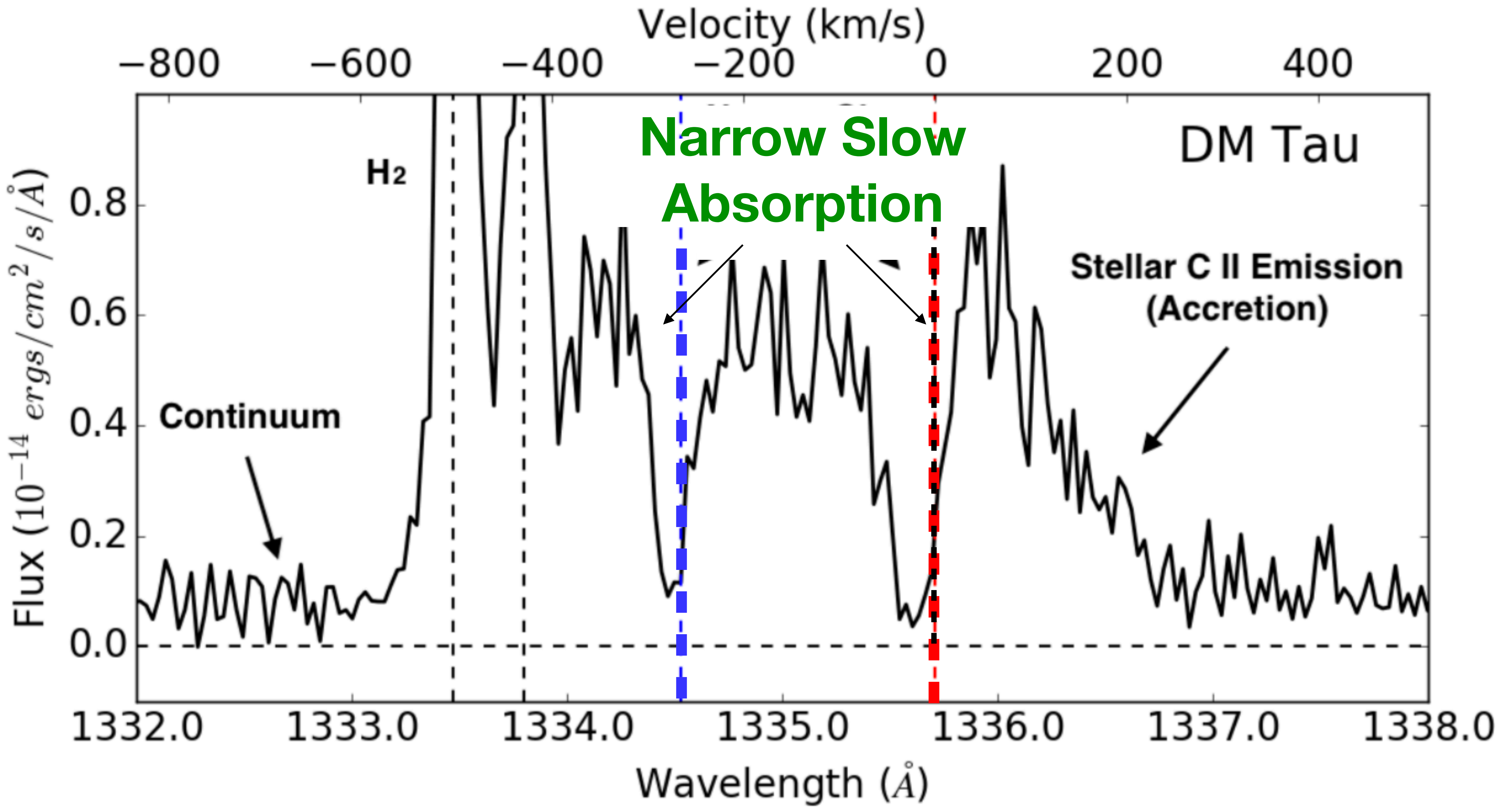
Blue shifted absorption detected mostly in neutral & singly ionized lines.

More UV spectra available soon with the ULLYSES Program!

RU Lup

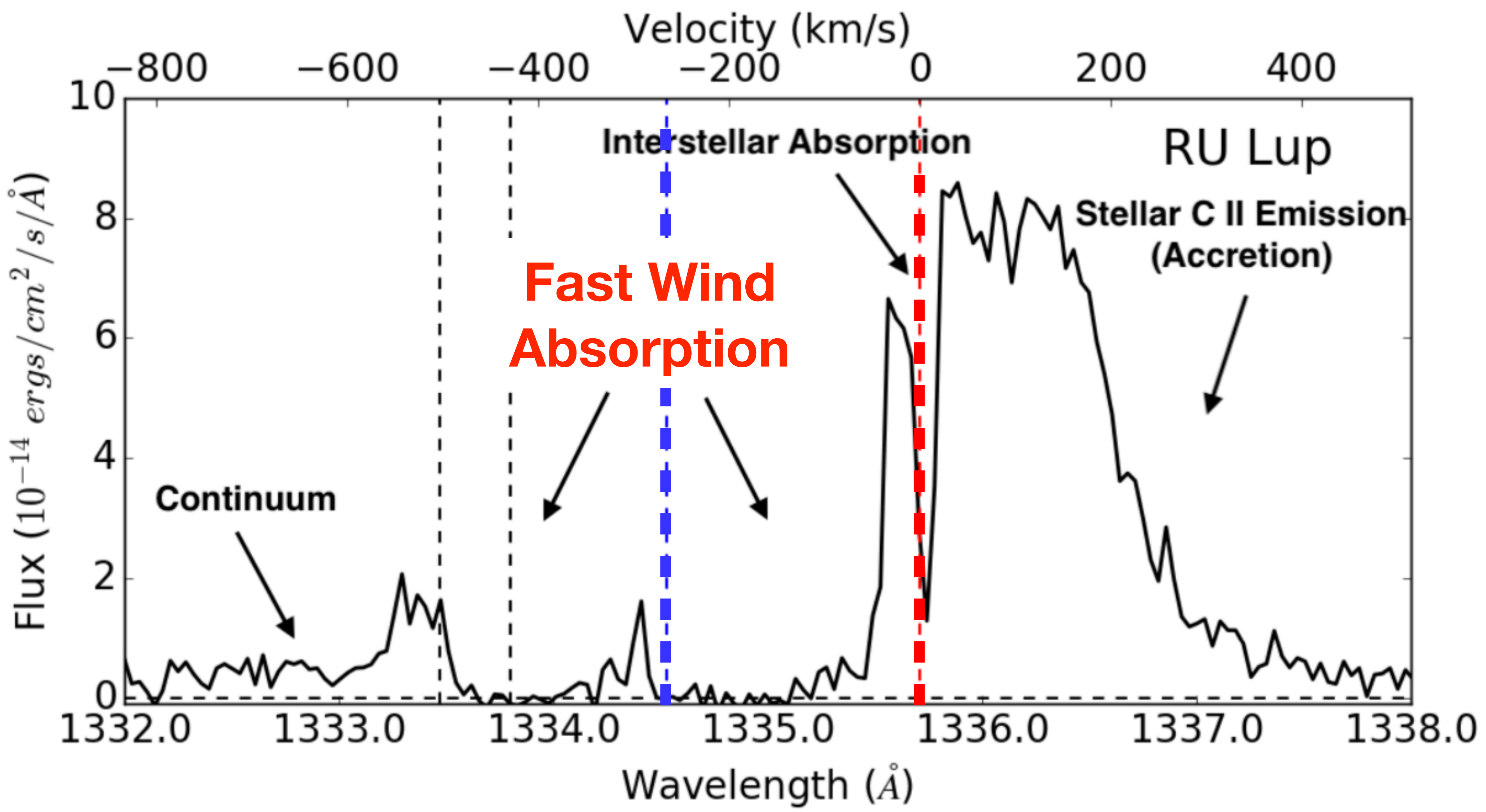


Absorption Lines in C II λ1335 Doublet



18/40 with narrow slow absorption

Wind absorption is common (36 out of 40) in our sample.



19/40 with fast absorption

(4/40 without wind absorption detected, but likely due to lack of sufficient signal.)

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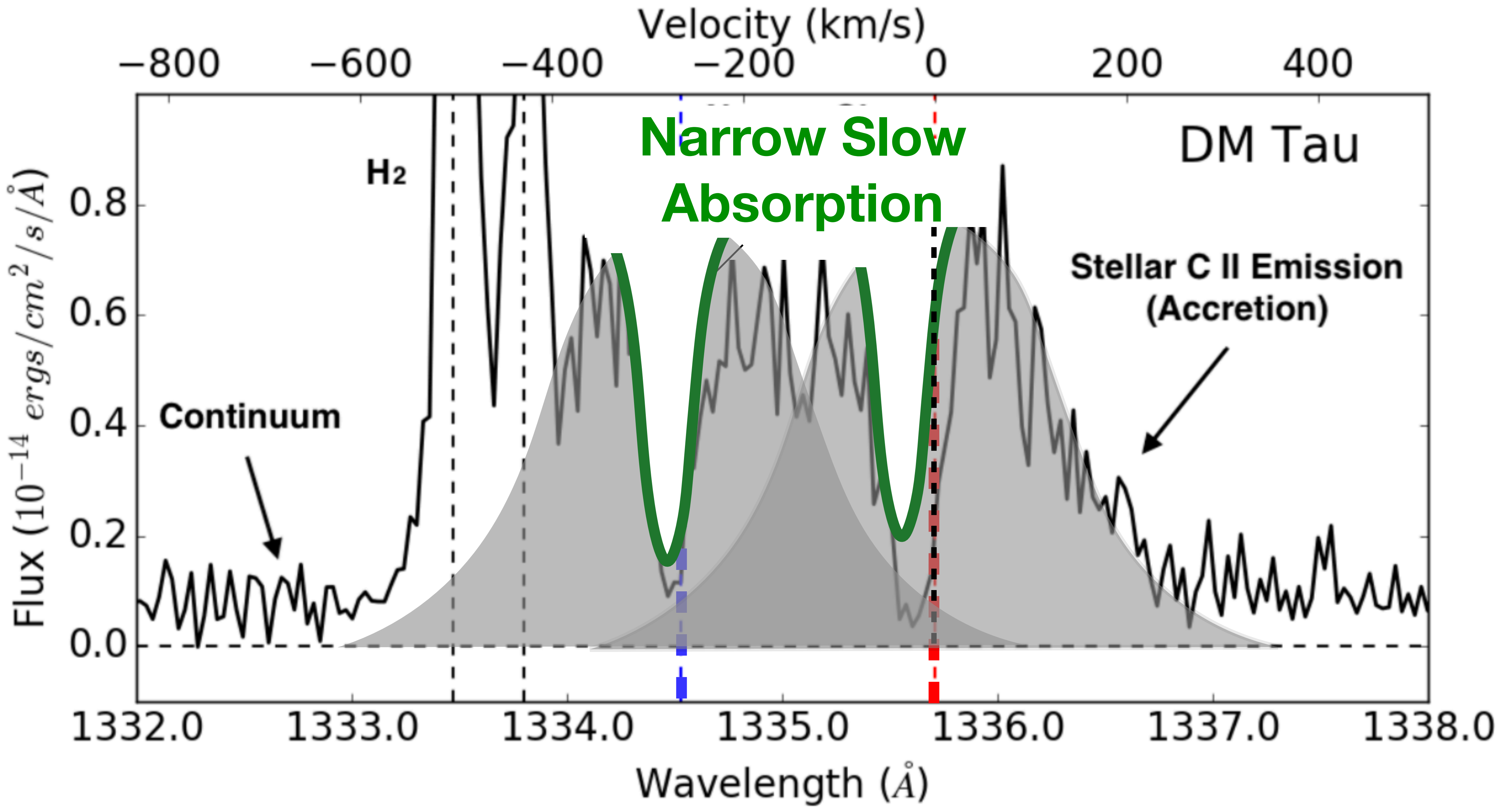

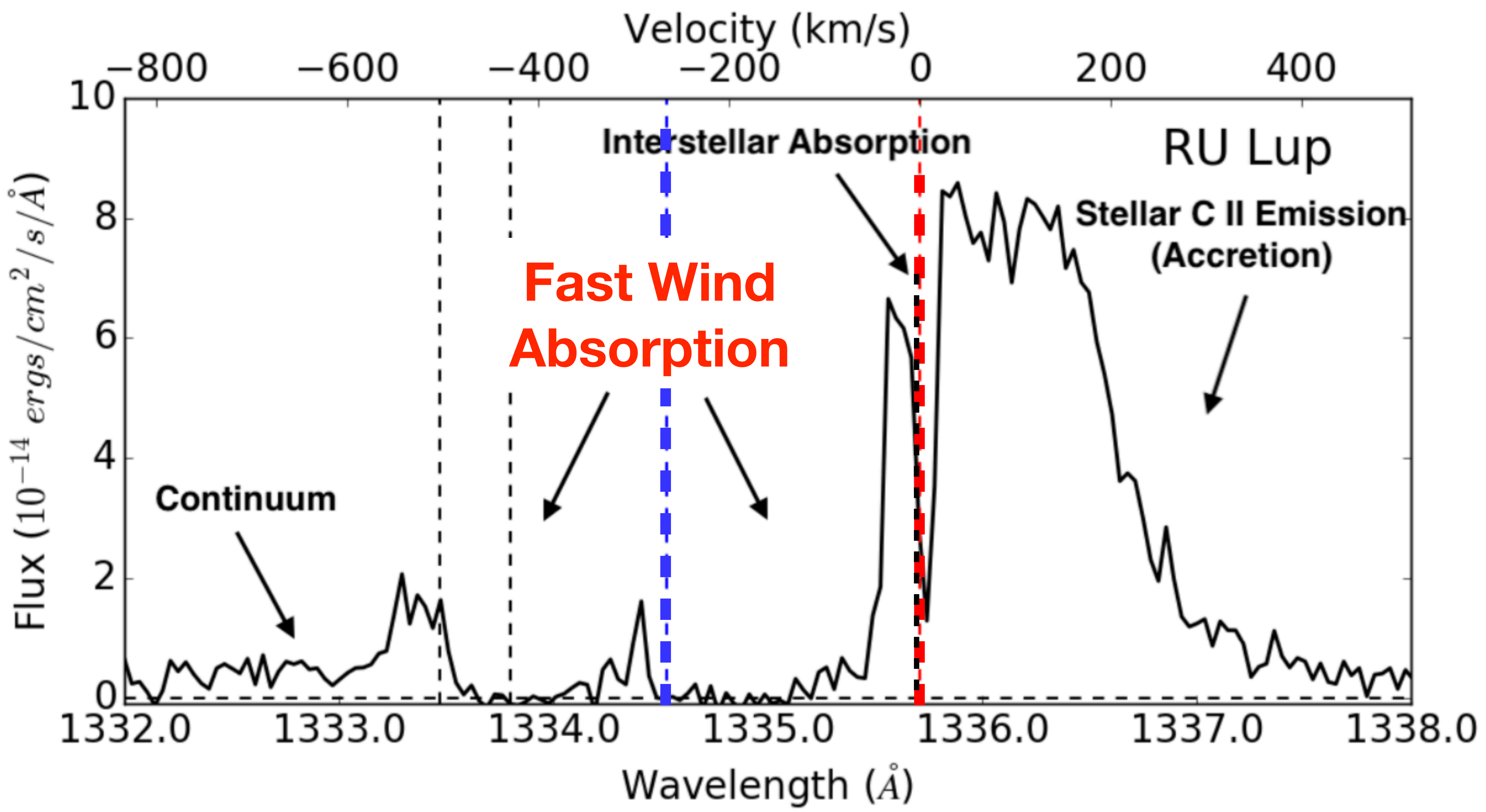

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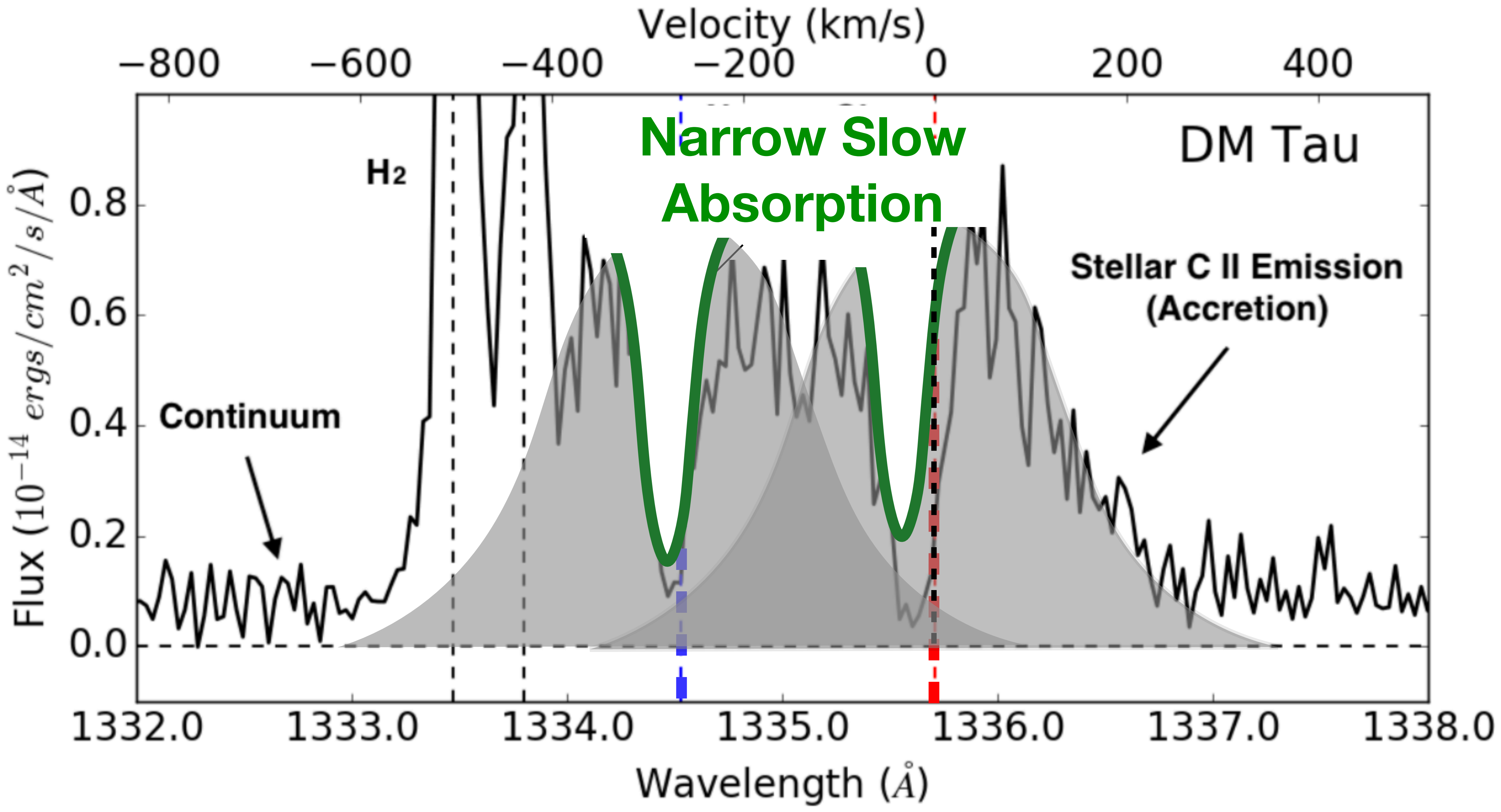

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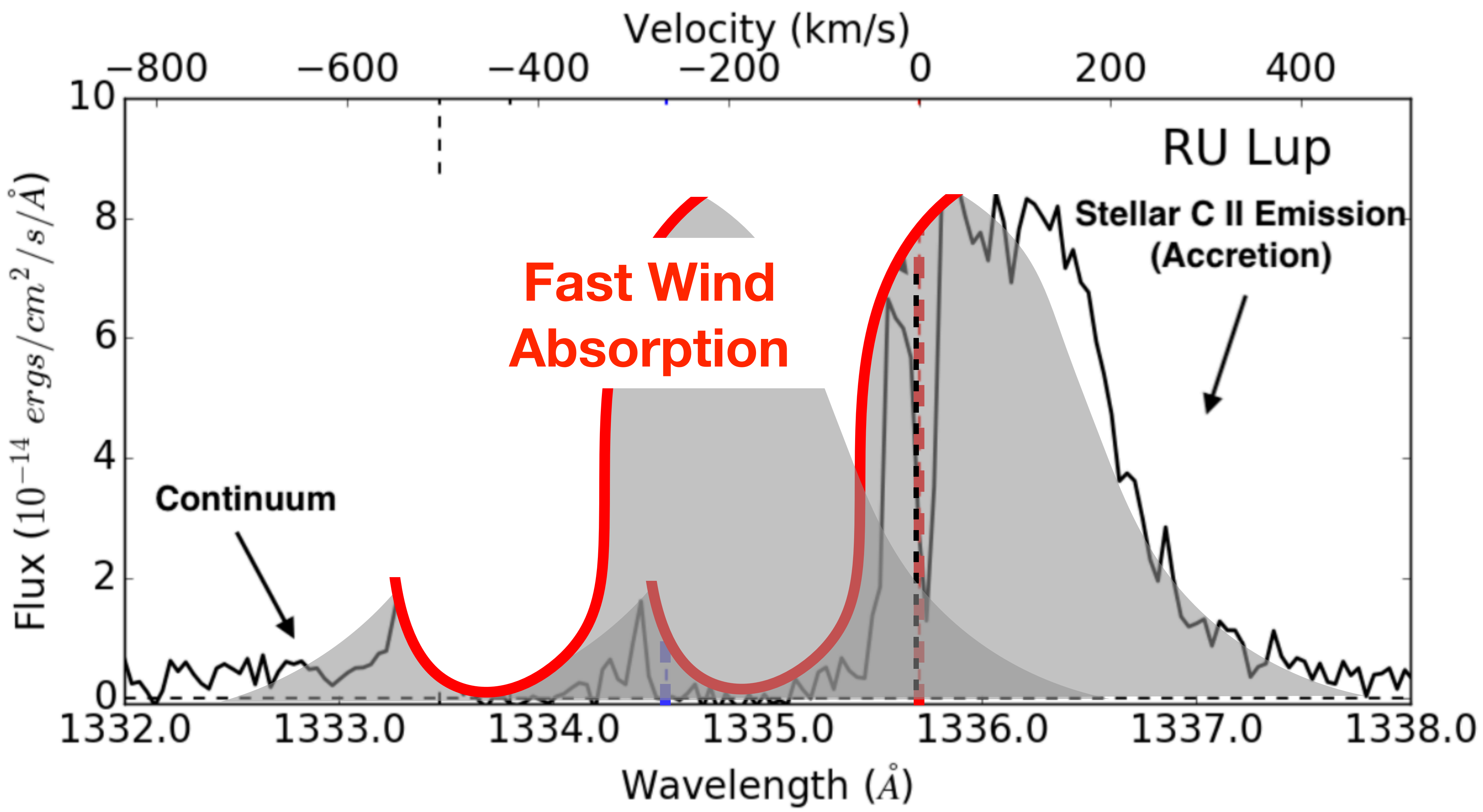

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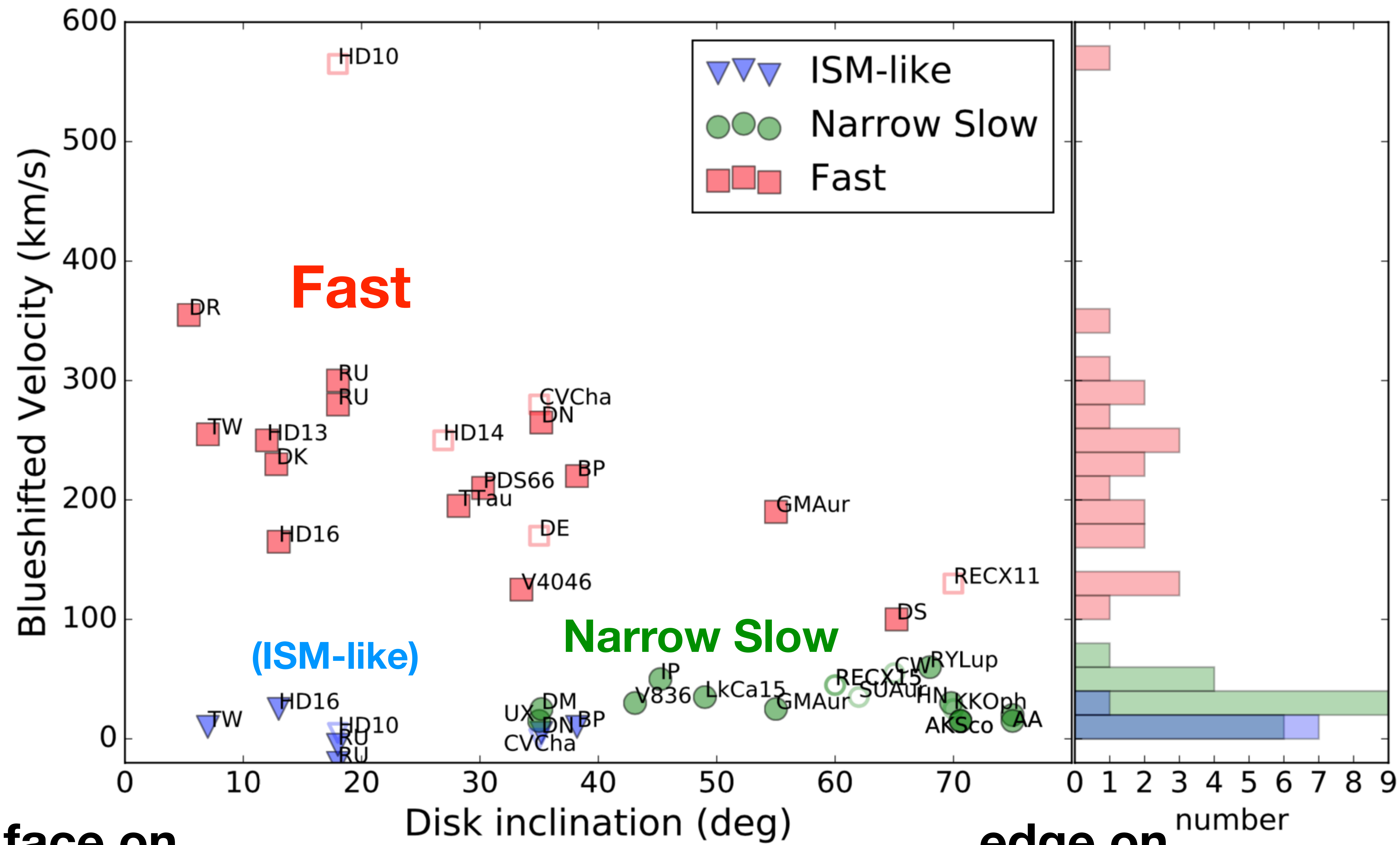
Higher Wind Velocity Towards Face-on Disks



face on

edge on

(adopted from ALMA / SMA)

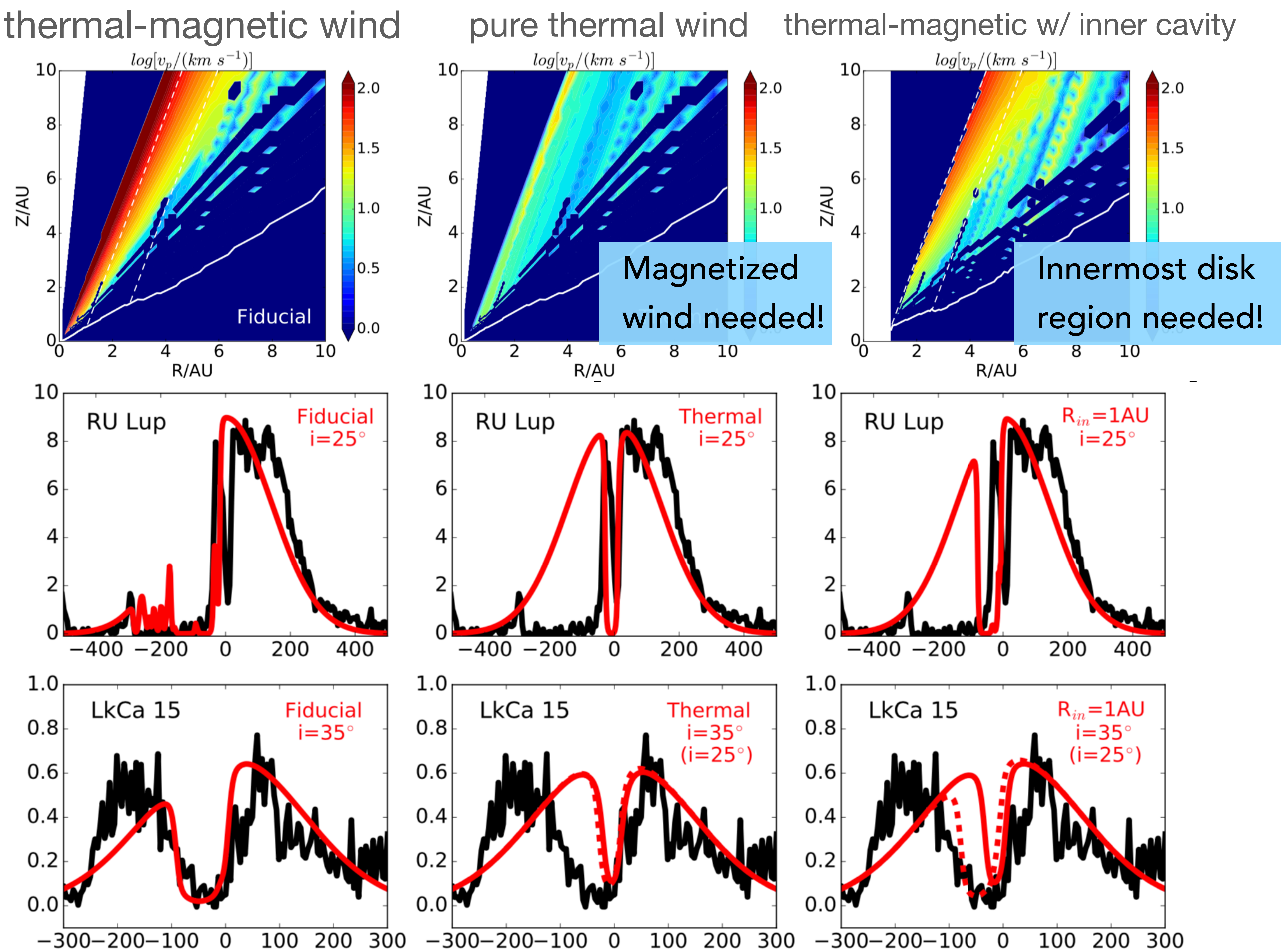
Absorption profiles well explained by thermal-magnetic wind model without inner cavity.

Wind Model (wind velocity)

Simplistic model in order to interpret observational absorption line profiles.

Fast wind (jet)

Slow wind



SUMMARY

Observations:

- ✳ **Fast and slow disk winds are commonly detected in FUV absorption lines.**
  - Wind absorption preferentially detected in neutral or singly ionized lines.
  - Higher wind velocity towards face-on disks, fast wind consistent with collimated jet.

Models:

- ✳ **Simplistic thermal-magnetic wind model explains the absorption lines.**
  - Magnetized wind needed for both fast and slow winds.
  - Innermost region (<1AU in model) important, especially for fast wind (jet).