Star Formation and Outflow Research with a Large Optical-UV Space Telescope

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SIG 2 Workshop
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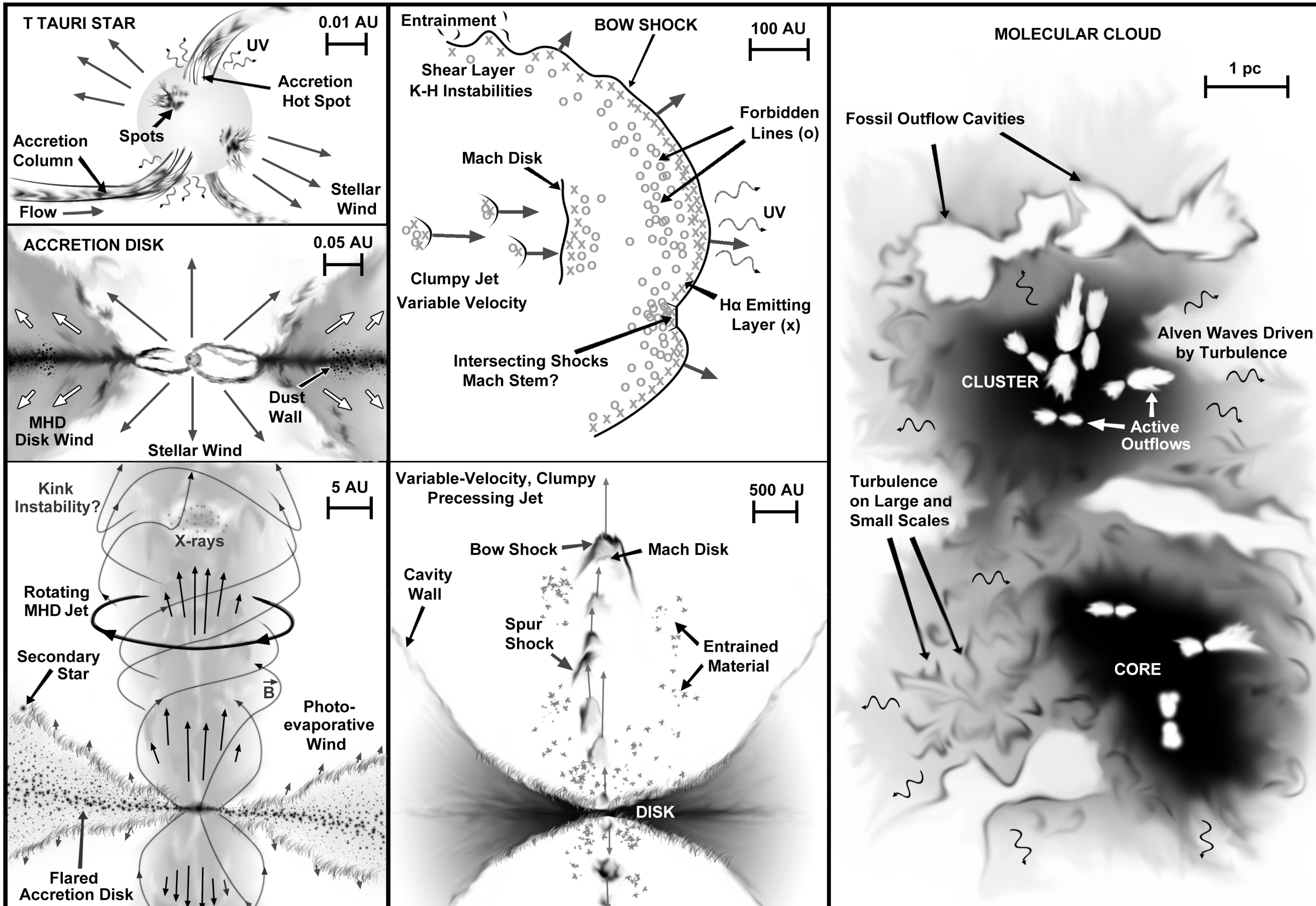
1. Overview of Star Formation
2. Spatial Scales
3. Spectral Resolution
4. Spectral Range
5. Example Science Project

Star Formation Overview

Frank et al. 2014 PPVI



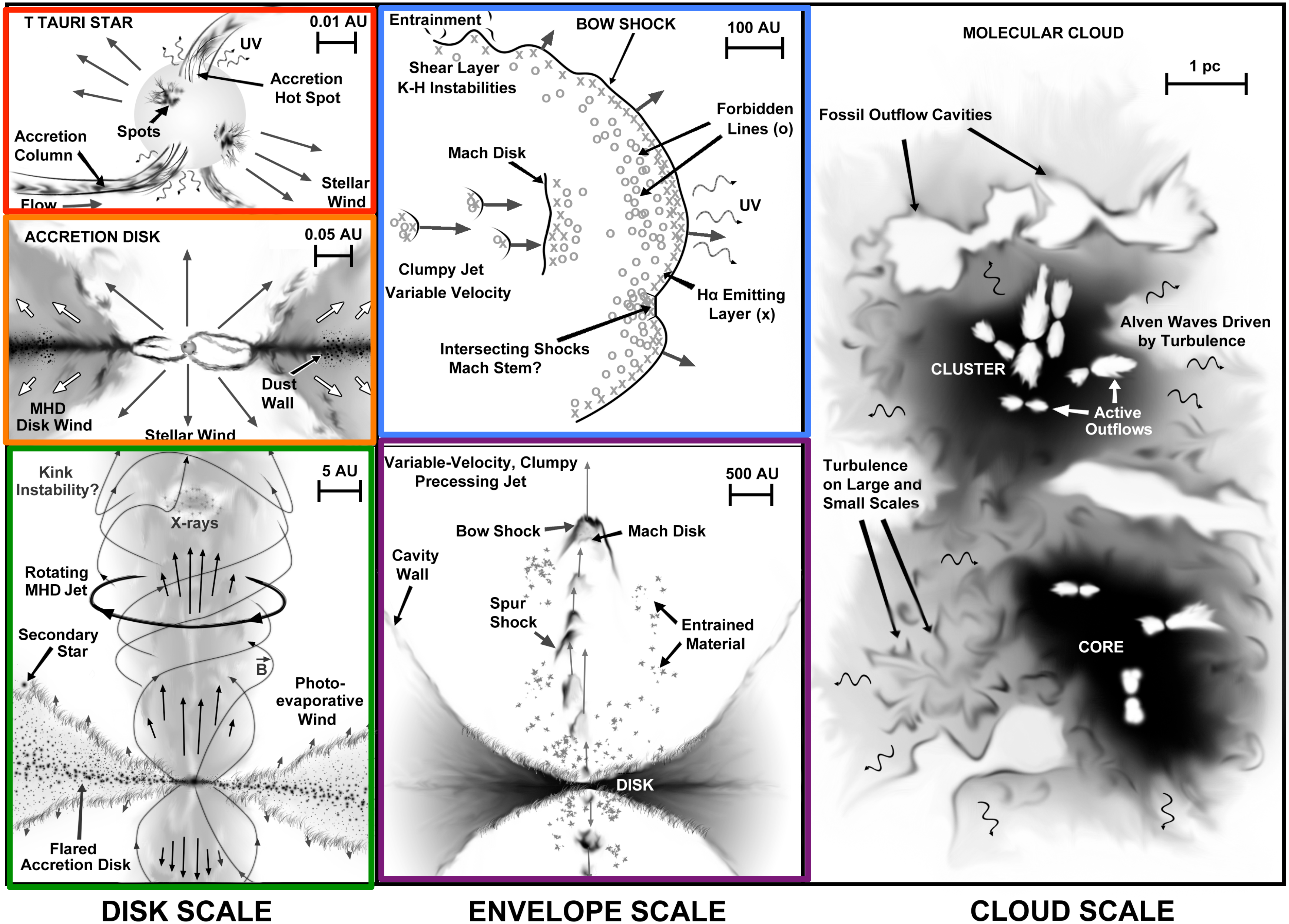
DISK SCALE

ENVELOPE SCALE

CLOUD SCALE

Star Formation Overview

Frank et al. 2014 PPVI



Spatial Scales

Increasing Mass/Size of Region →

Statistical Studies Possible →

	Gas Disk	Cloud with Dusty Accretion Disks	Cluster with a few O stars	Cluster with >~100 of O stars	Starburst Cluster
Nearest Example:	TW Hya	Taurus/Auriga	Orion	Carina	30 Doradus (LMC)
Distance:	54 pc	140 pc	410 pc	2.3 kpc	49 kpc
# of Stars in Group:	Isolated	50	1000	30000	>30000
1.2 λ / D HST UV (2000 A):	**1.1** AU	**2.9** AU	**8.5** AU	**50** AU	1000 AU
HST Optical (5000 A):	**2.8** AU	**7.2** AU	**21** AU	**120** AU	2500 AU
1.2 λ / D 12-m UV (2000 A):	**0.22** AU	**0.58** AU	**1.7** AU	**9.5** AU	**200** AU
12-m Optical (5000 A):	**0.56** AU	**1.4** AU	**4.2** AU	**24** AU	**500** AU

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Considerations

- What emits/absorbs in UV/opt
- Extinction
- Spectral information can be more important than spatial resolution especially in red and orange zones

UV

Accretion Columns
Chromospheres
Gas Fluorescence/Absorption
Photoevaporation
Jet Bow Shocks
HII Region dust distribution

Optical

Accretion Columns
Inner Disk Wall
Jet Acceleration
Jet Collimation
Resolved Disk Imaging
Binary Disk Interactions

Photoevaporation
Jet Rotation
Cooling Distances in Jets
Jet Bow Shocks
Disk Imaging/Detection
HII region cavities

Spectral Resolution

Keplerian Motion

	Stellar Size	Disk Wall	Earth	Jet Rotation
Distance	**0.01** AU	**0.1** AU	**1** AU	**100** AU
Orbital Velocity (1 M_o)	300 km/s	95 km/s	30 km/s	3 km/s
Spectral Resolution	10^3	3×10^3	10^4	10^5

Thermal Broadening

Example	Warm Disk	HII Region	Strong Shock
Temperature	10^3 K	10^4 K	10^5 K
H Sound Speed	3.7 km/s	12 km/s	37 km/s
Spectral Resolution	8×10^4	2.5×10^4	8000

UV

- Accretion Columns
- Chromospheres
- Gas Fluorescence/Absorption
- Photoevaporation
- Jet Bow Shocks
- HII Region cavities

Optical

- Accretion Columns
- Inner Disk Wall
- Jet Acceleration
- Jet Collimation
- Resolved Disk Imaging
- Binary Disk Interactions
- Photoevaporation
- Jet Rotation
- Cooling Distances in Jets
- Jet Bow Shocks
- Disk Imaging/Detection
- HII region cavities

Spectral Range

Temperature	$3x10^3$ K	10^4 K	$3x10^4$ K	$1.5x10^5$ K	$4x10^5$ K	$1.5x10^6$ K
Tracer	[S II], [Fe II]	many	[O III]	N V	O VI	X-ray
Wavelength	6720A, 1.6μ	optical	5007A	1240A	1038A	10A

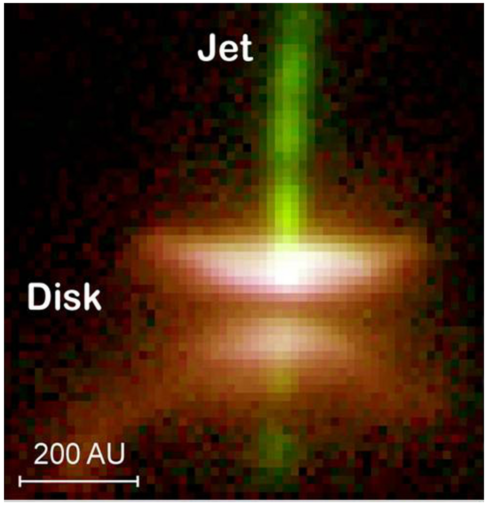
- Wavelengths shorter than Ly α are important to bridge temperatures to X-rays
- Broad UV coverage needed for any complete temperature/ionization analysis
- O VI provides a unique means to study coronae, shocked interfaces, and hot winds

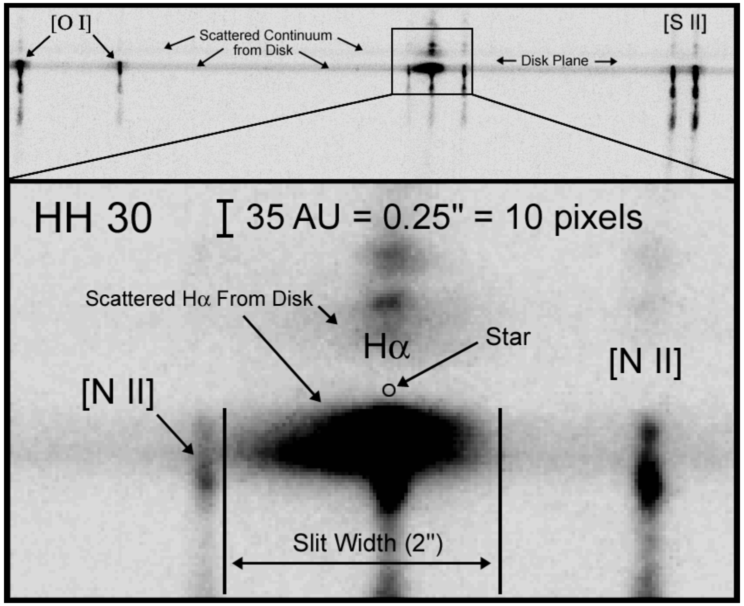
HST and FUSE went for high-resolution and small apertures in the UV.
A larger telescope should have a long-slit capability to make use of spatial resolution and to detect extended diffuse emission

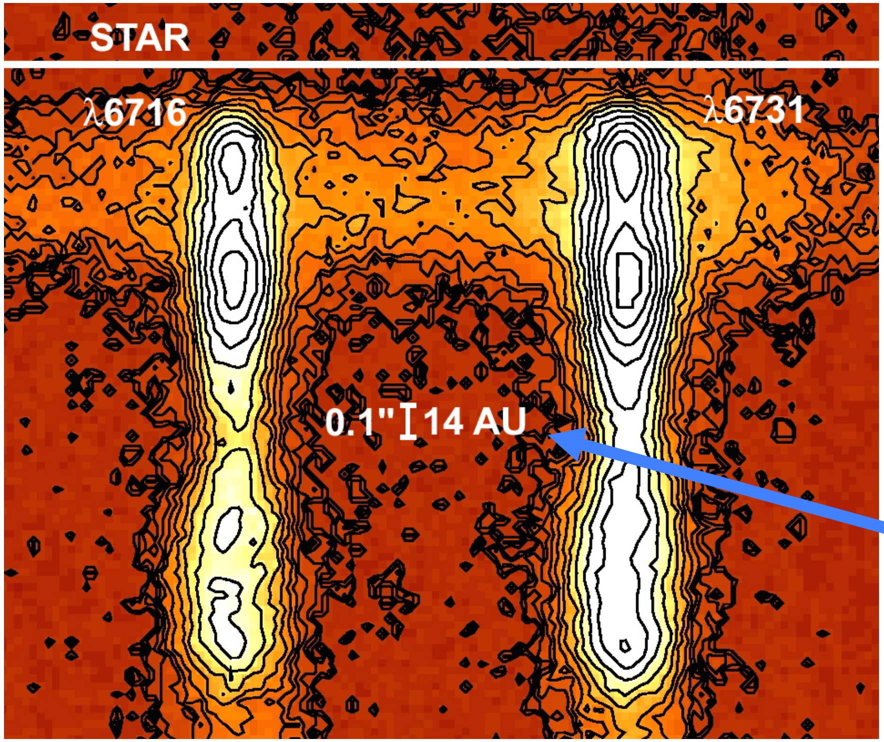
Sample Project

HST Slitless Spectra
of a Stellar Jet

Hartigan & Morse 2007

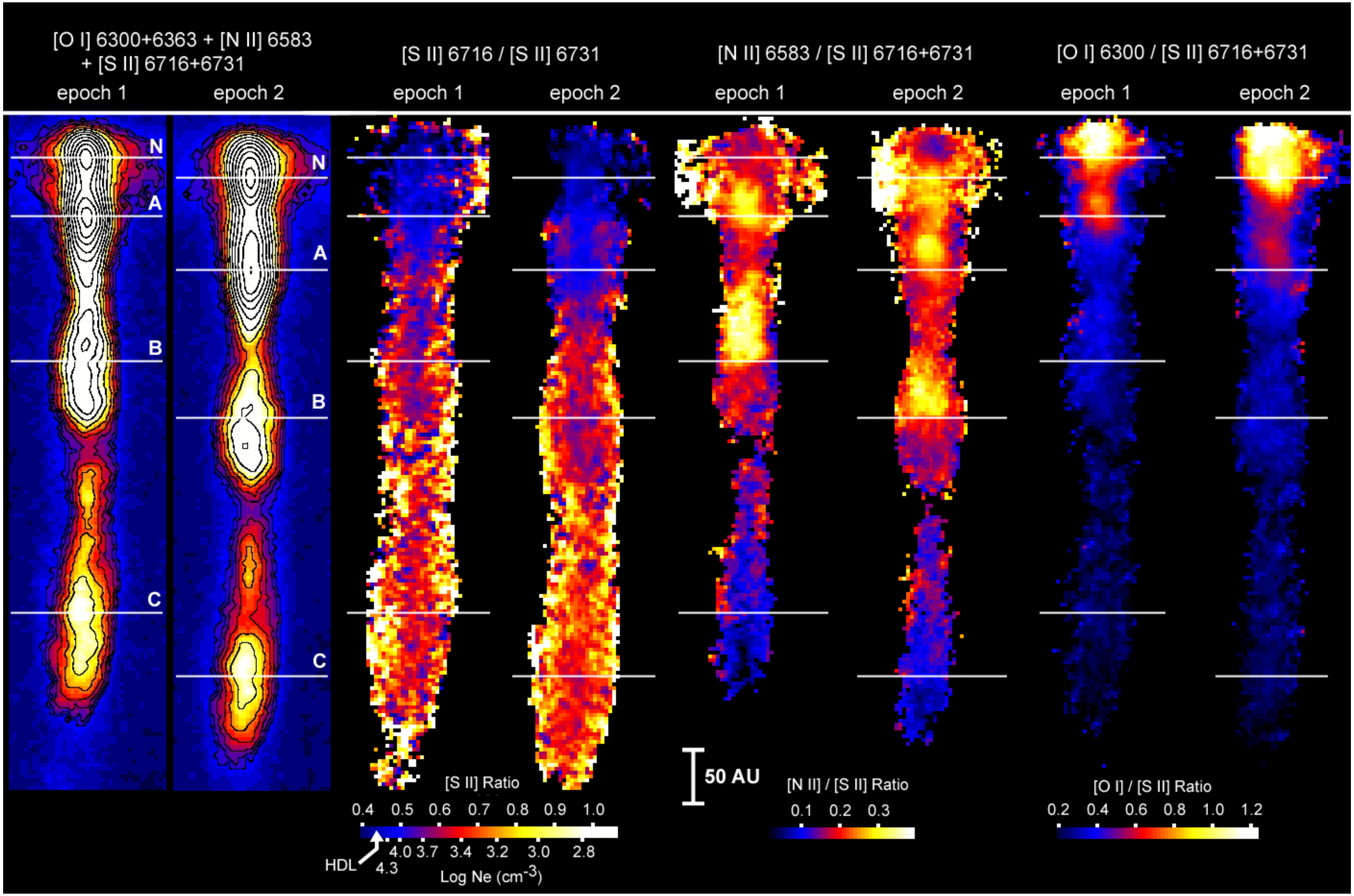






Note Spatial Scale!

Sample Project



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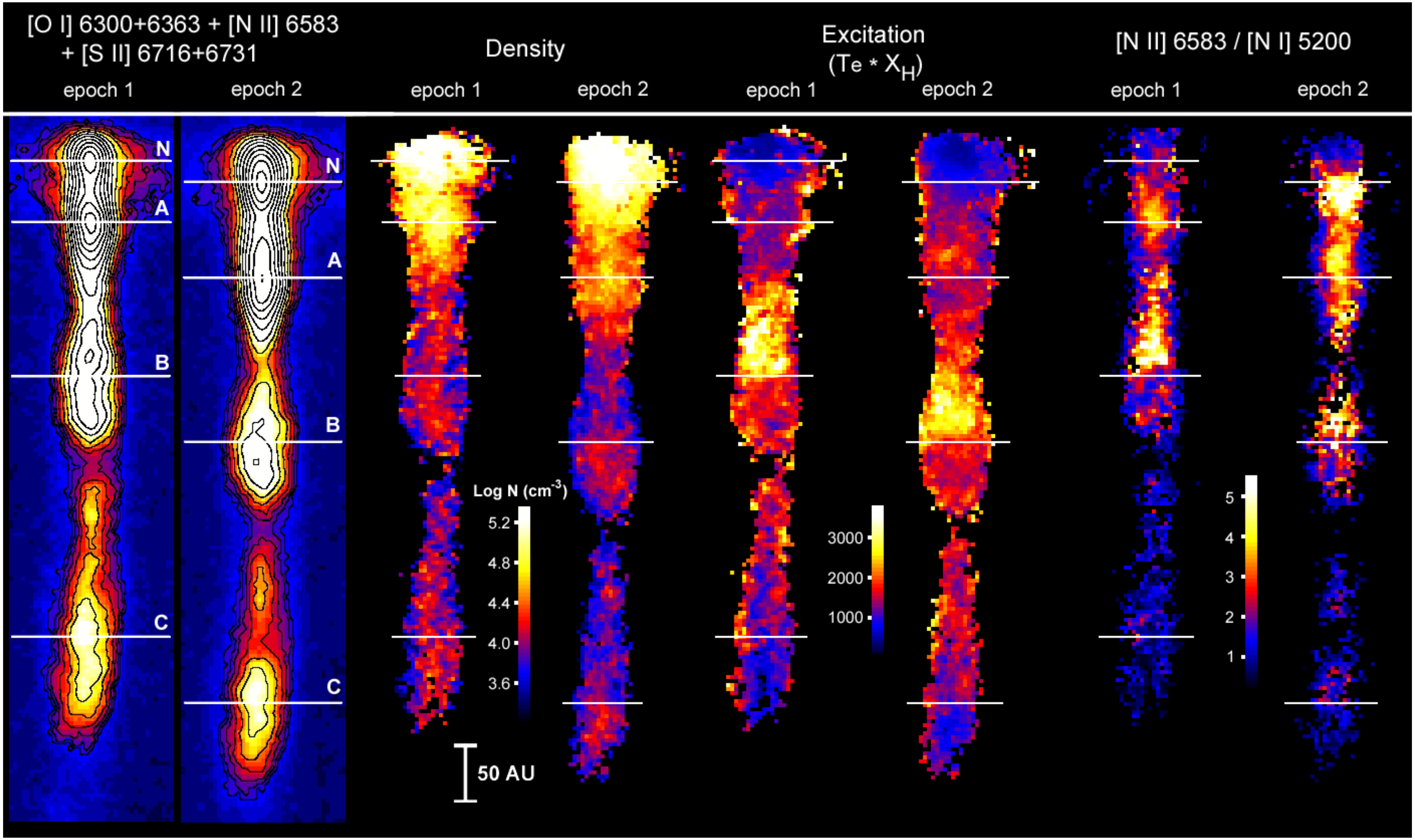

Do something similar, but with velocity-resolved images, and five times the spatial resolution