Near IR Spectral Imaging of the Micro-Jets of T Tauri Stars

Tracy L. Beck (STScI)
Peter J. McGregor (Australian National University)

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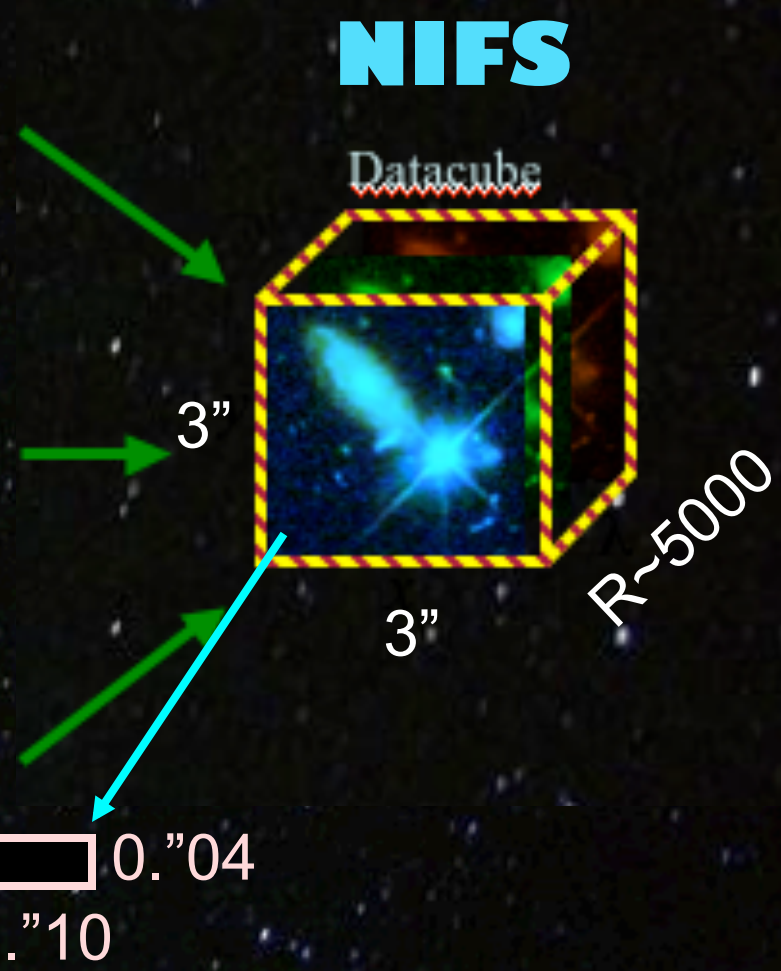
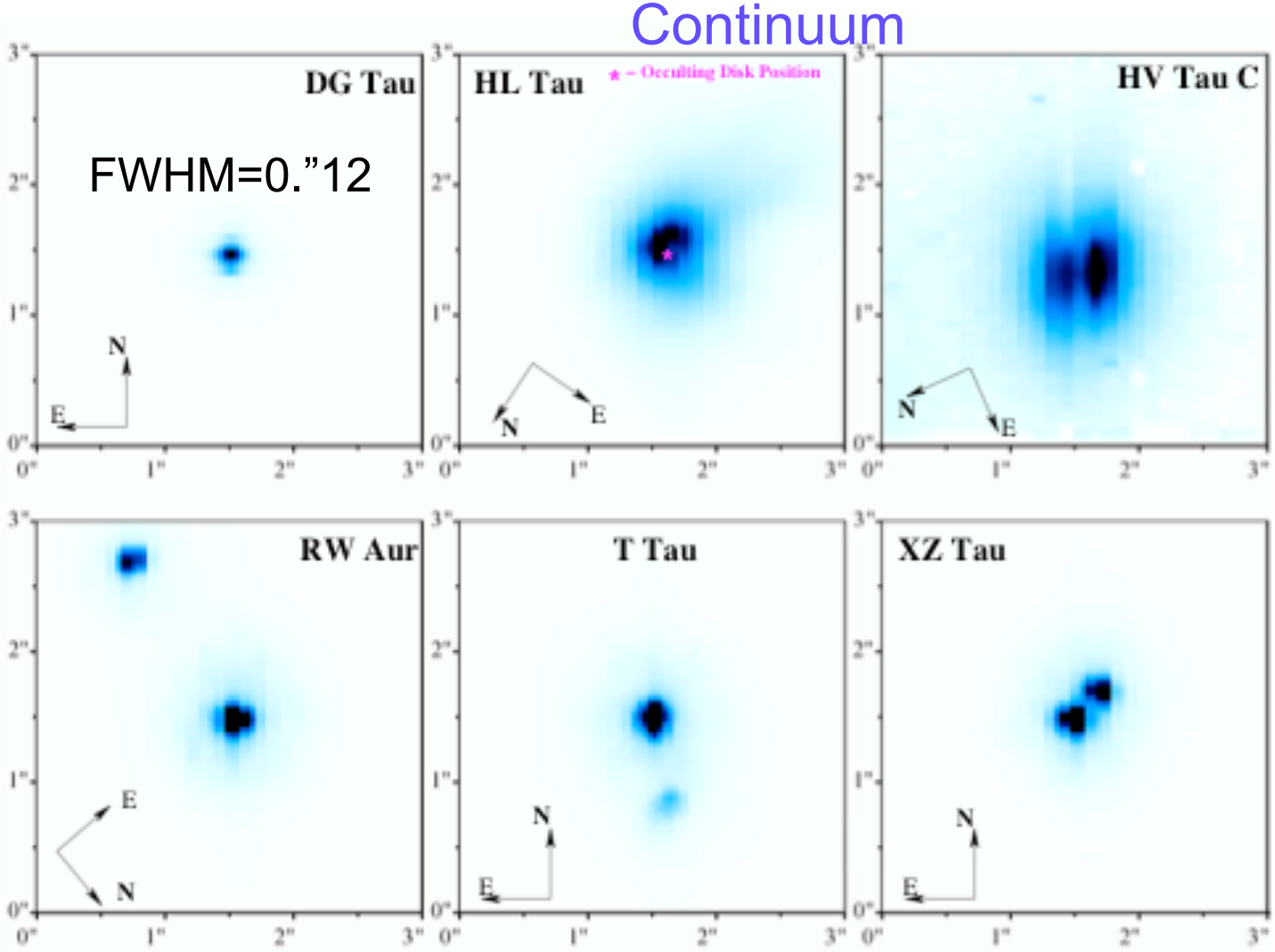
The Near Infrared Integral Field Spectrograph (NIFS) at Gemini North Observatory

- Near IR, AO-fed image slicing IFU for 1.0-2.5 micron spectra, fed by the Gemini North facility AO system, Altair
- R~5000 spectroscopy
- 3” x 3” field with 0.”1x0.”04 (rectangular) Spatial Sampling
- 1 pointing gives IFU datacube spectra over *one* full IR band (Z, J, H or K)



NIFS Spectroscopy of Young Stars
2.12 micron Continuum Emission

Continuum



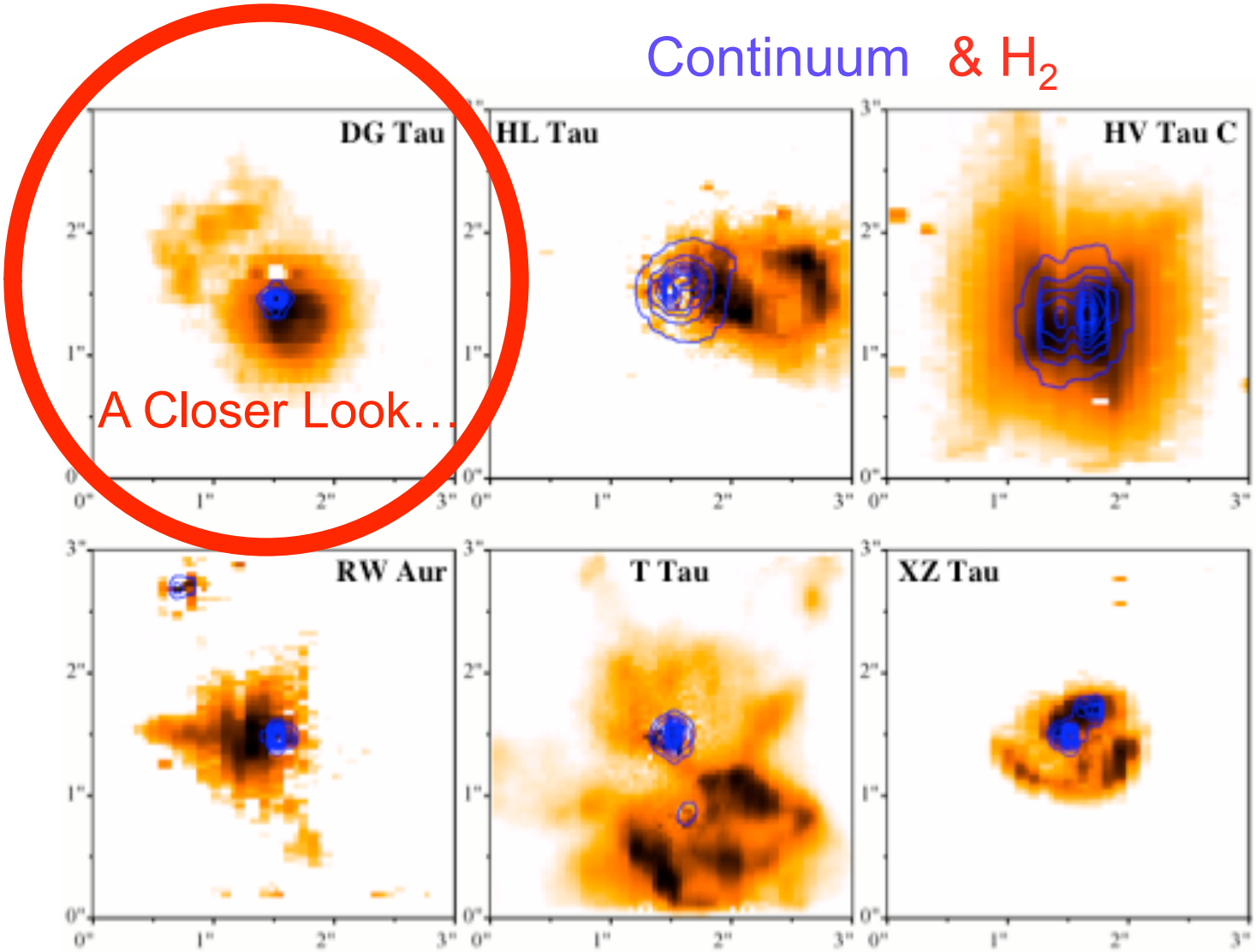
DG Tau is a point source

0.”25 XZ Tau Binary easily resolved

Beck et al. 2008

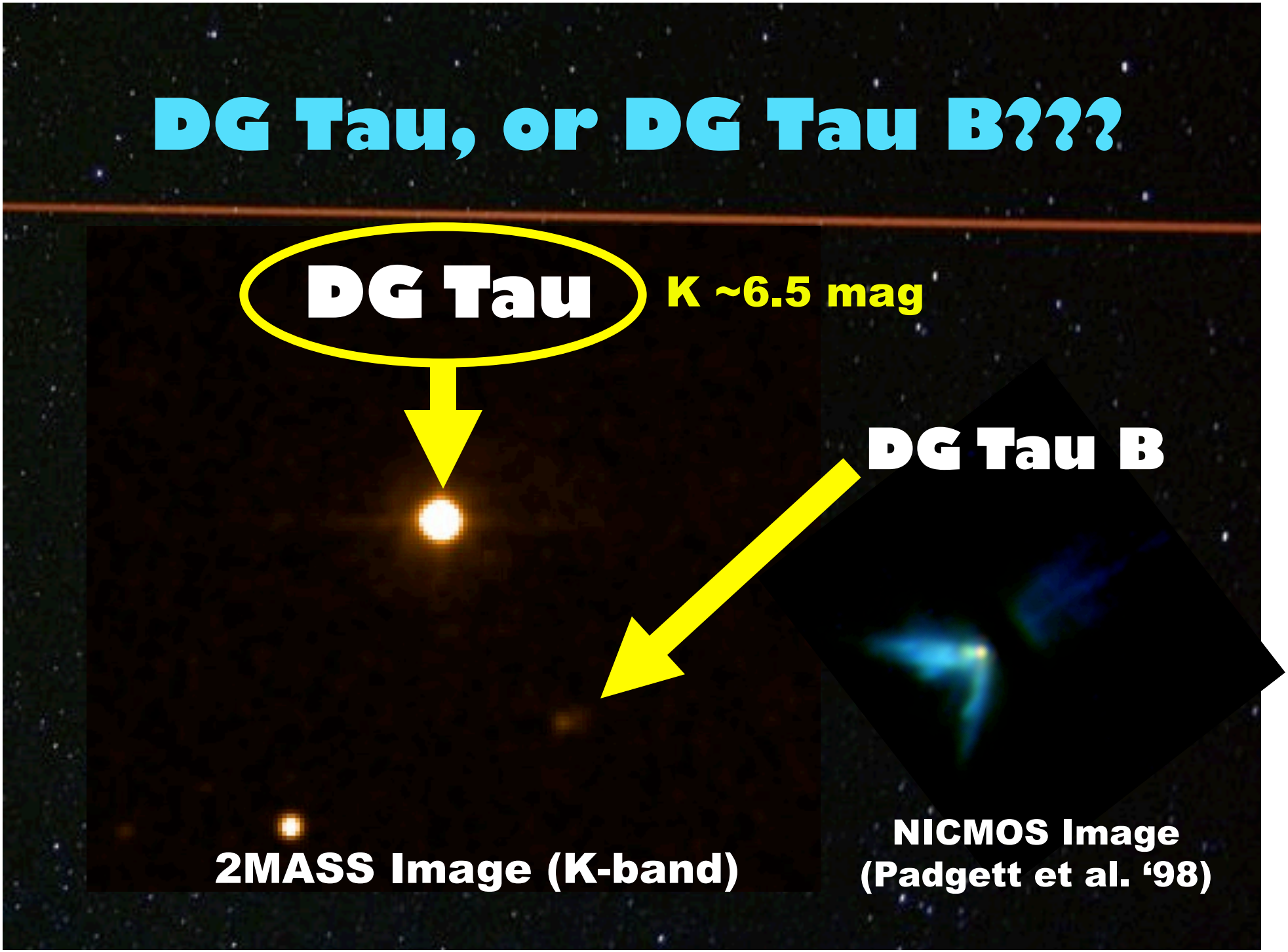
2.12 micron Continuum Emission/ 2.12 micron H_2 Emission

Continuum & H_2

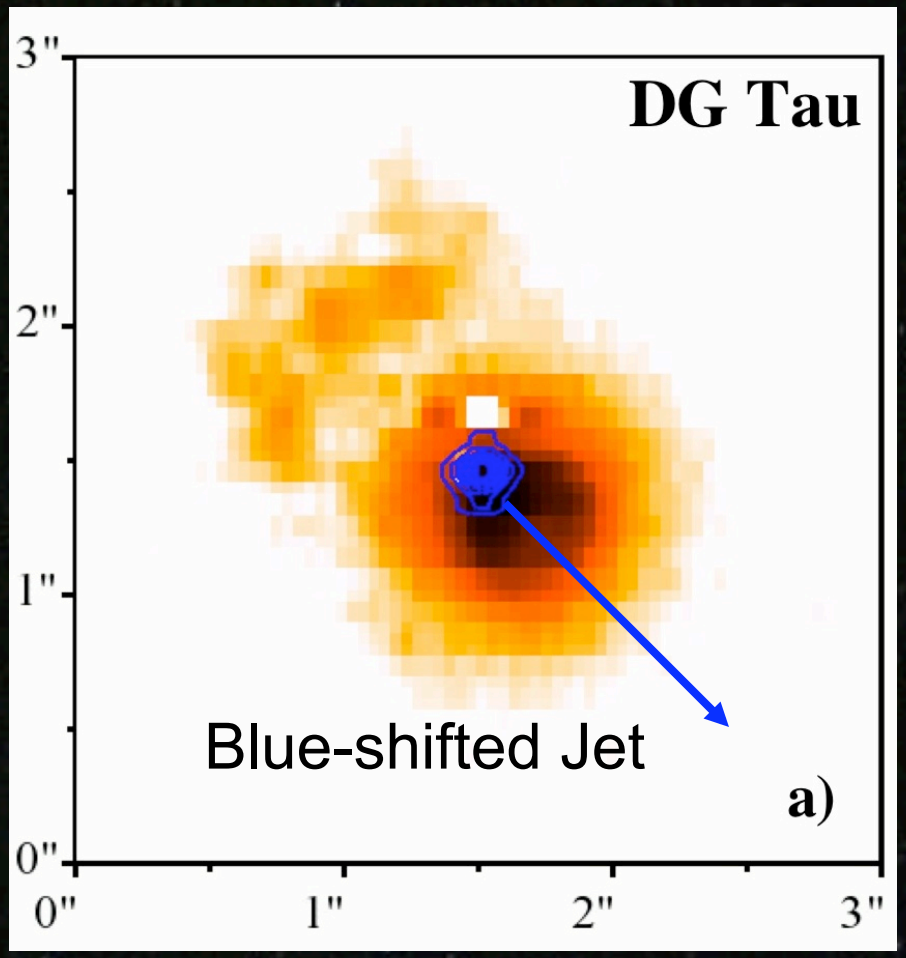


spatially extended H_2 detected in ALL stars, and most is not coincident with continuum emission - arises from outflows, mainly

DG Tau, or DG Tau B???

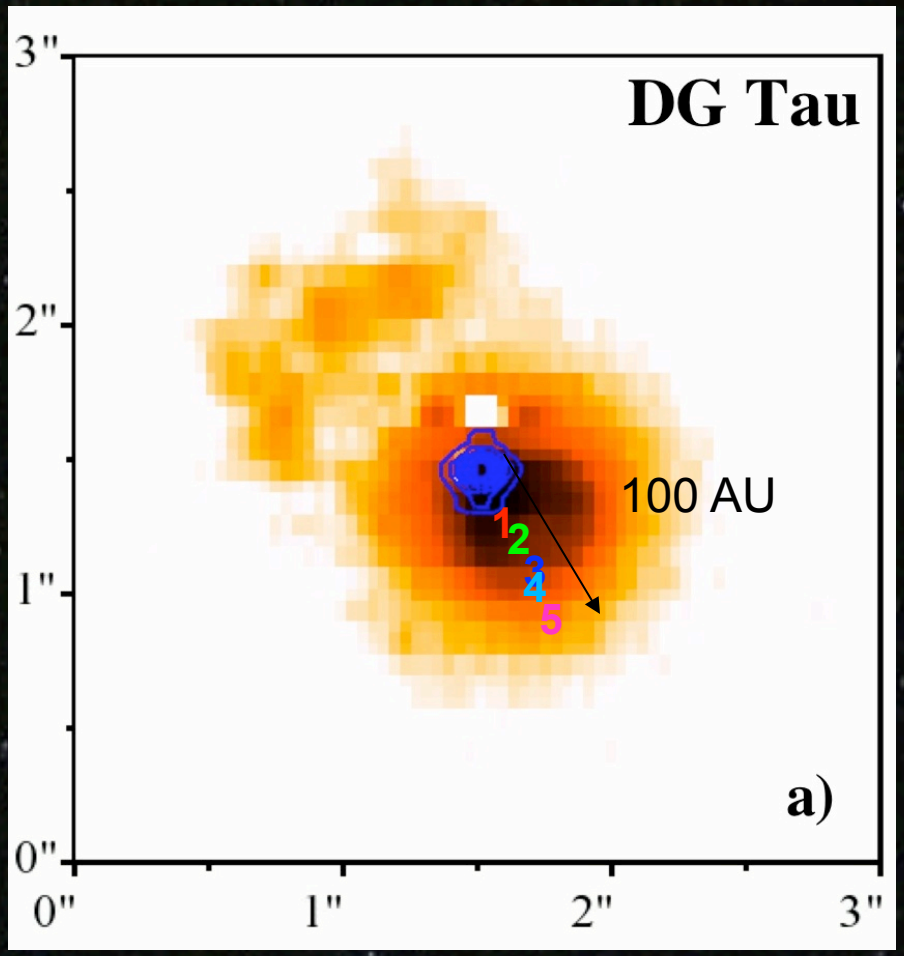


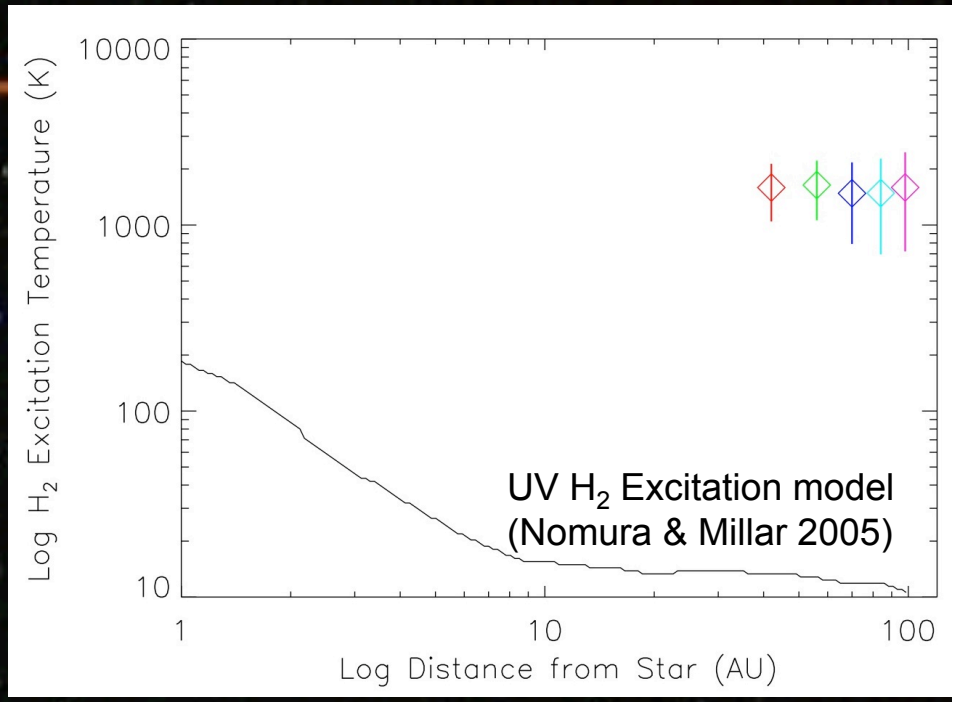
H_2 Emission from DG Tau



- DG Tau in 2.12 μm H_2 emission:
- A brighter "v-shaped" nebula encompassing the blue-shifted atomic jet, and a fainter "ridge" of emission on the red-shifted side of a "dark lane".
- Very reminiscent of "edge-on disk" morphologies seen in scattered light in young YSOs!
- Orientation of "dark lane" completely consistent with known disk orientation from mm observations (Testi et al. 02)

H_2 from DG Tau

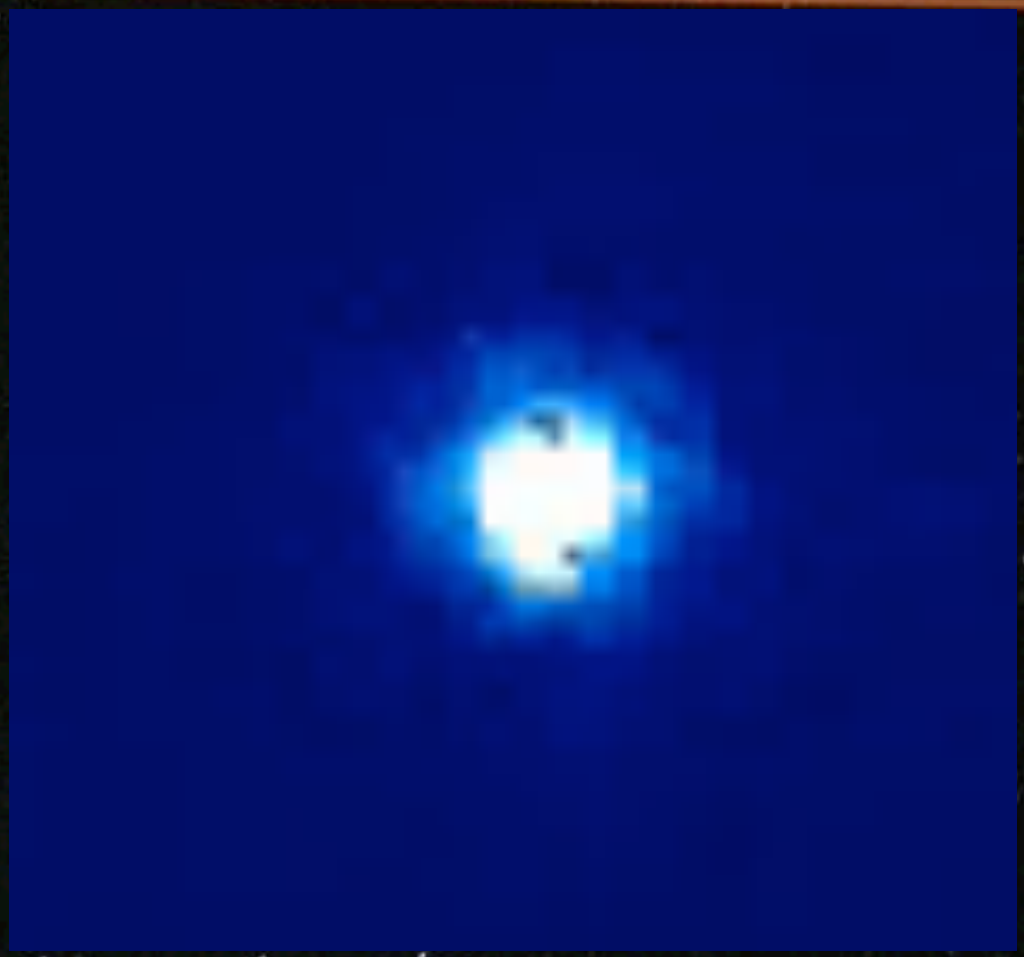




1D Spectra extracted in ~12 AU Steps from ~34 to ~98 AU

H_2 Excitation Temp ~1500K
H_2 is likely shock excited in a wide-angle outflow

DG Tau MicroJet in 1.644micron [Fe II]



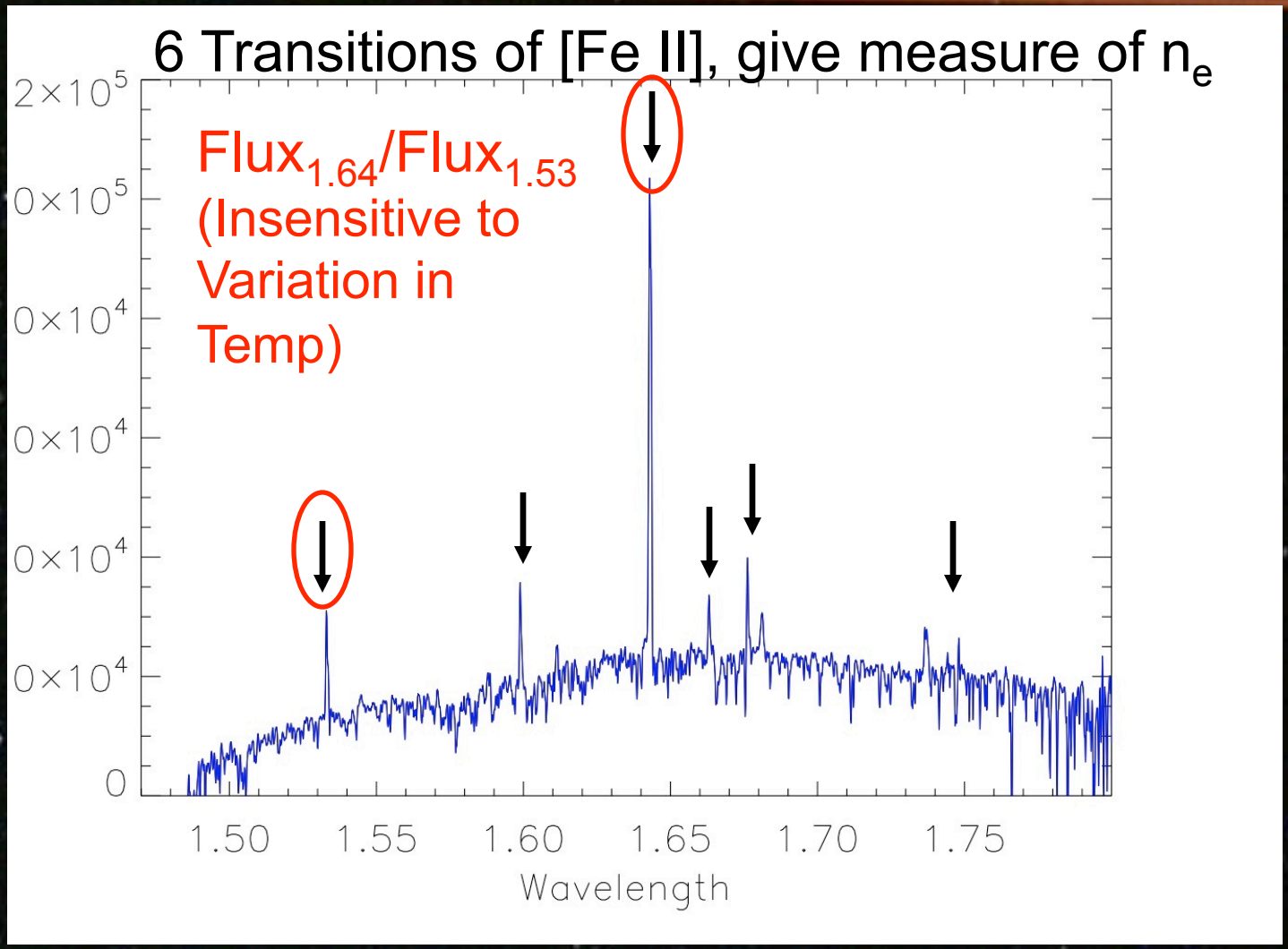
- Velocity Movie in [Fe II] Emission from -270 km/s to +250 km/s, blueshifted outflow to redshifted, in steps of +30km/s (1 spectral pixel)

- The blueshifted outflow has a fast, on-axis component and a surrounding lower velocity "shell"
- The redshifted flow shows a bow-shock structure

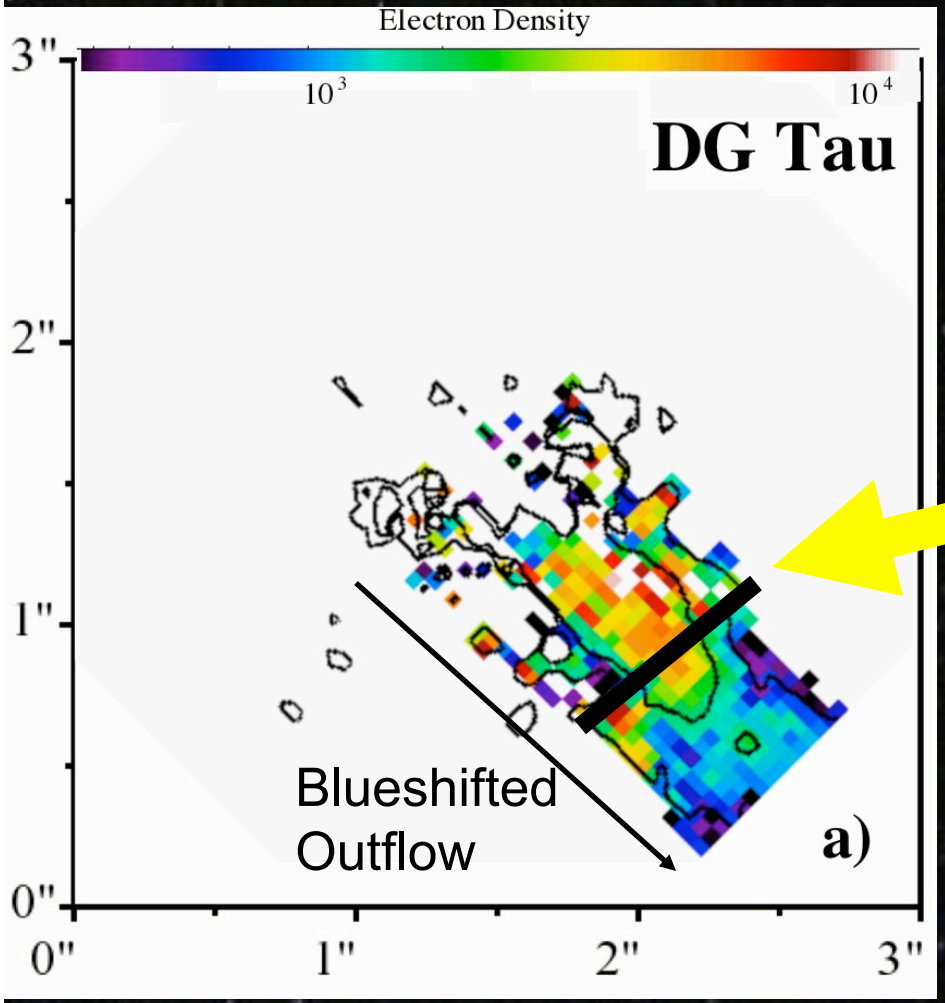
N

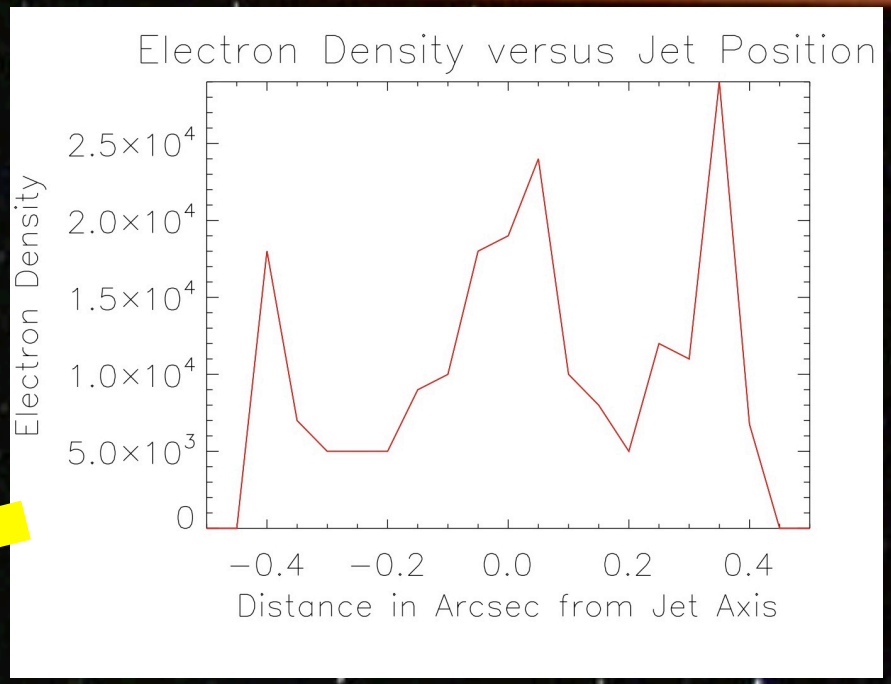
E

DG Tau, H-band Spectrum

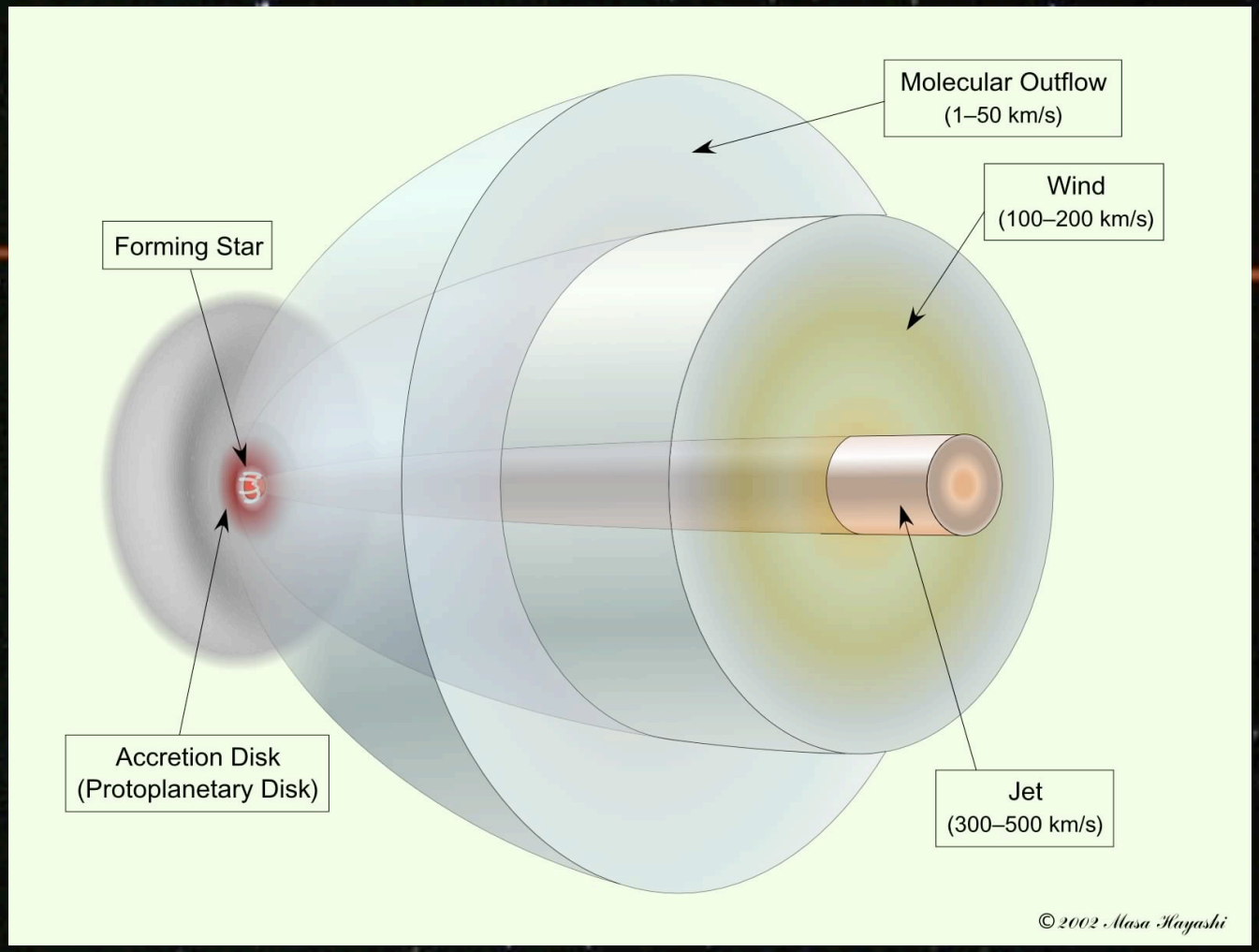


N_e Values in Blueshifted Outflow, derived from [Fe II] Line Ratios





Average n_e values in cross-jet direction - derived from integrated line flux maps - show a clear peak in density along the jet axis!



AO-fed IFU Spectro-scopy is a Powerful Tool for Studying Spatially Resolved Structure in YSO Outflows!!

Pyo et al. 2006

Globally, these data show that DG Tau has a fast, high density on-axis outflow surrounded by a lower density flow, and wide-angle molecular wind in H_2 - “Onion-Skin” structure