Searching for silicate in the protoplanetary disk of DG Tau

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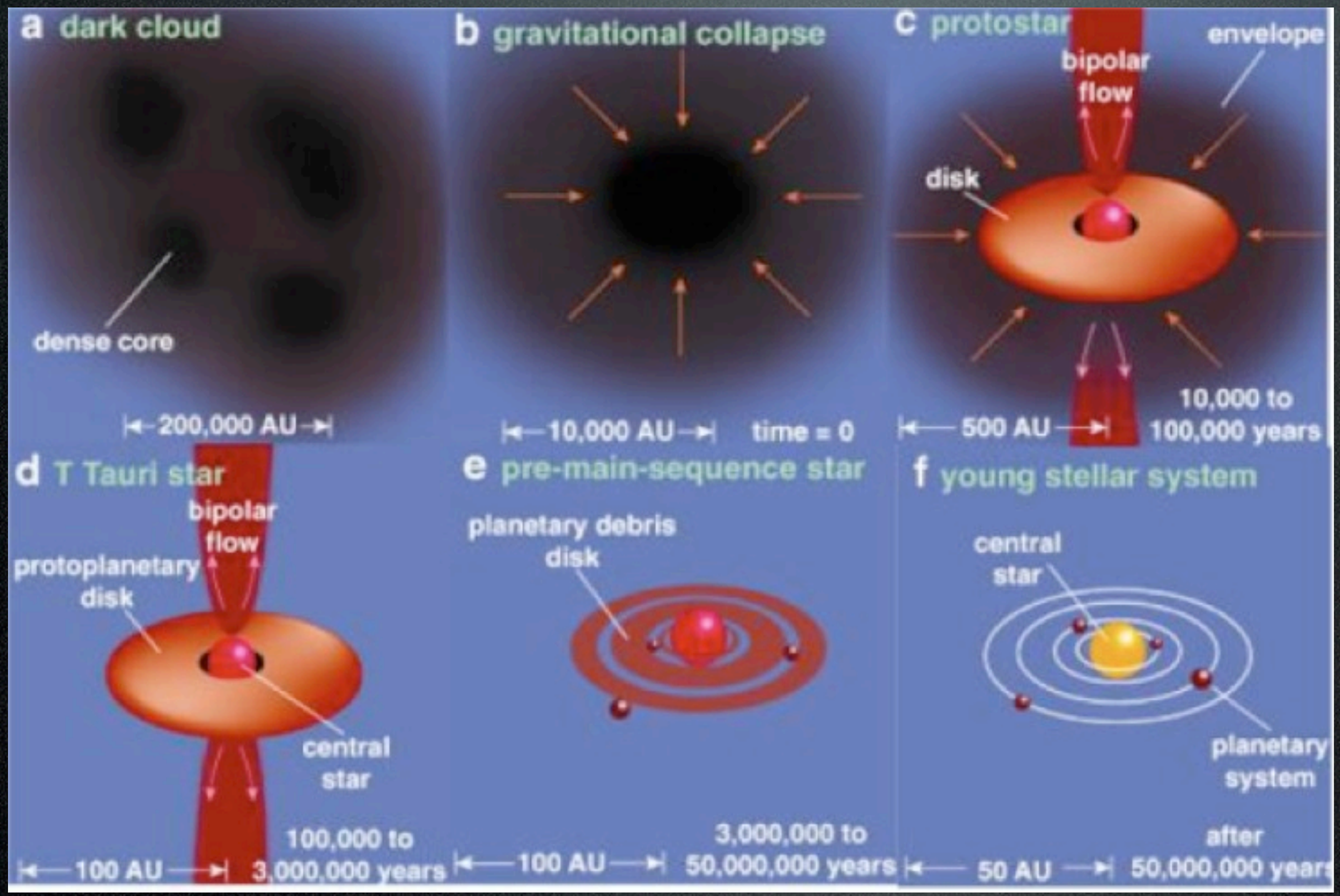
Outline

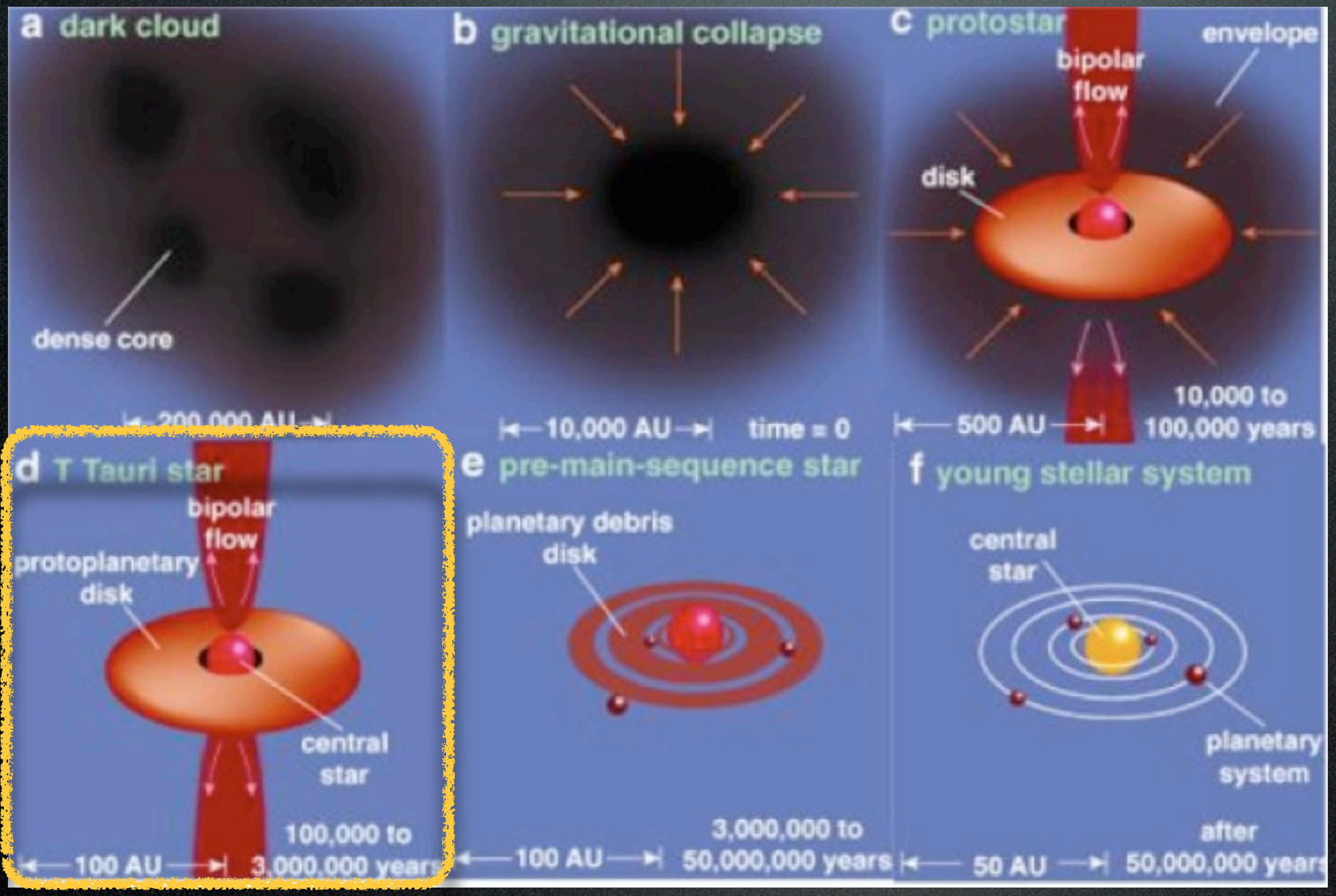
- Protoplanetary disks around YSOs
- VLTI-MIDI
- DG Tau observations
- Preliminary Results
- Summary

Young Stellar Objects



NASA/JPL: Greene, 2001

Young Stellar Objects



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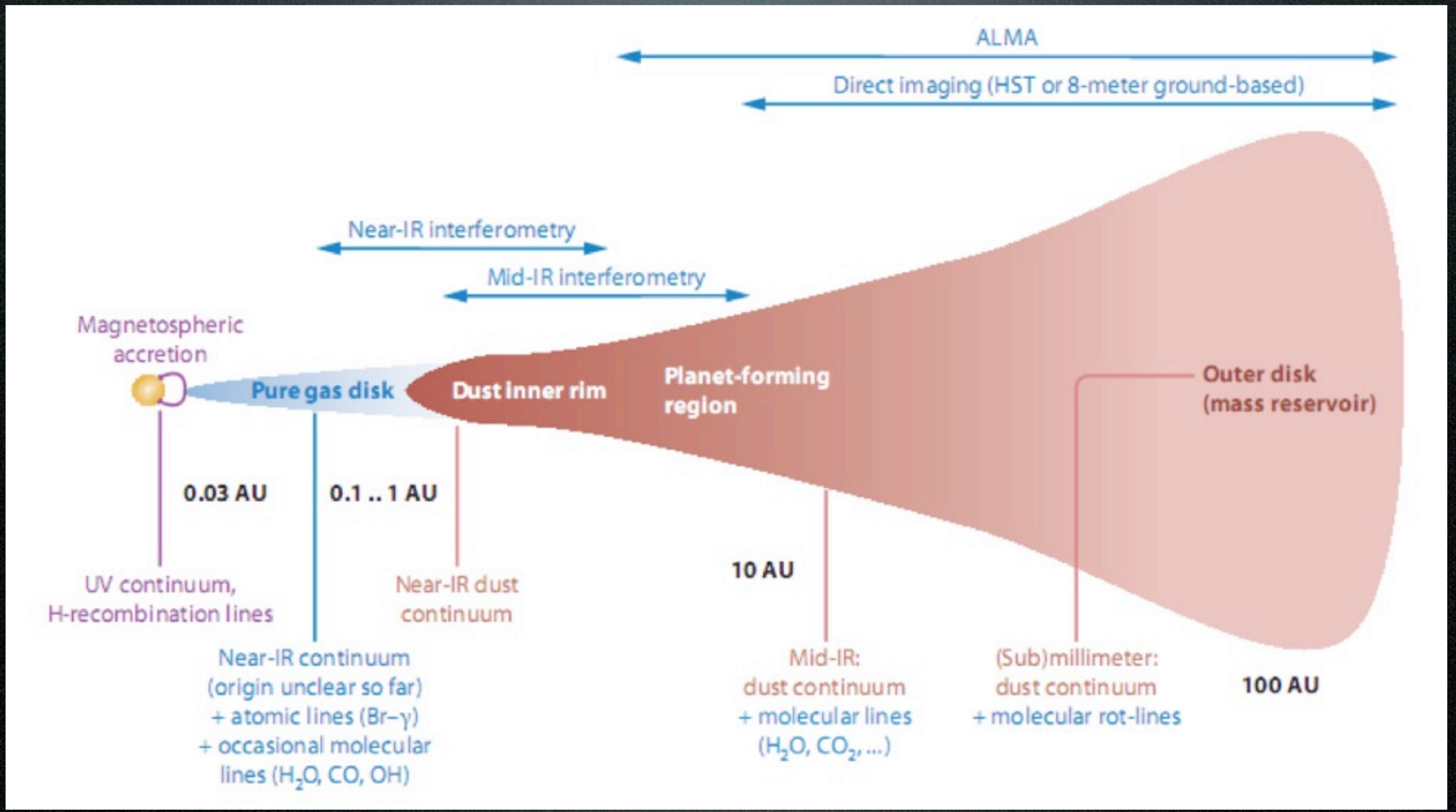
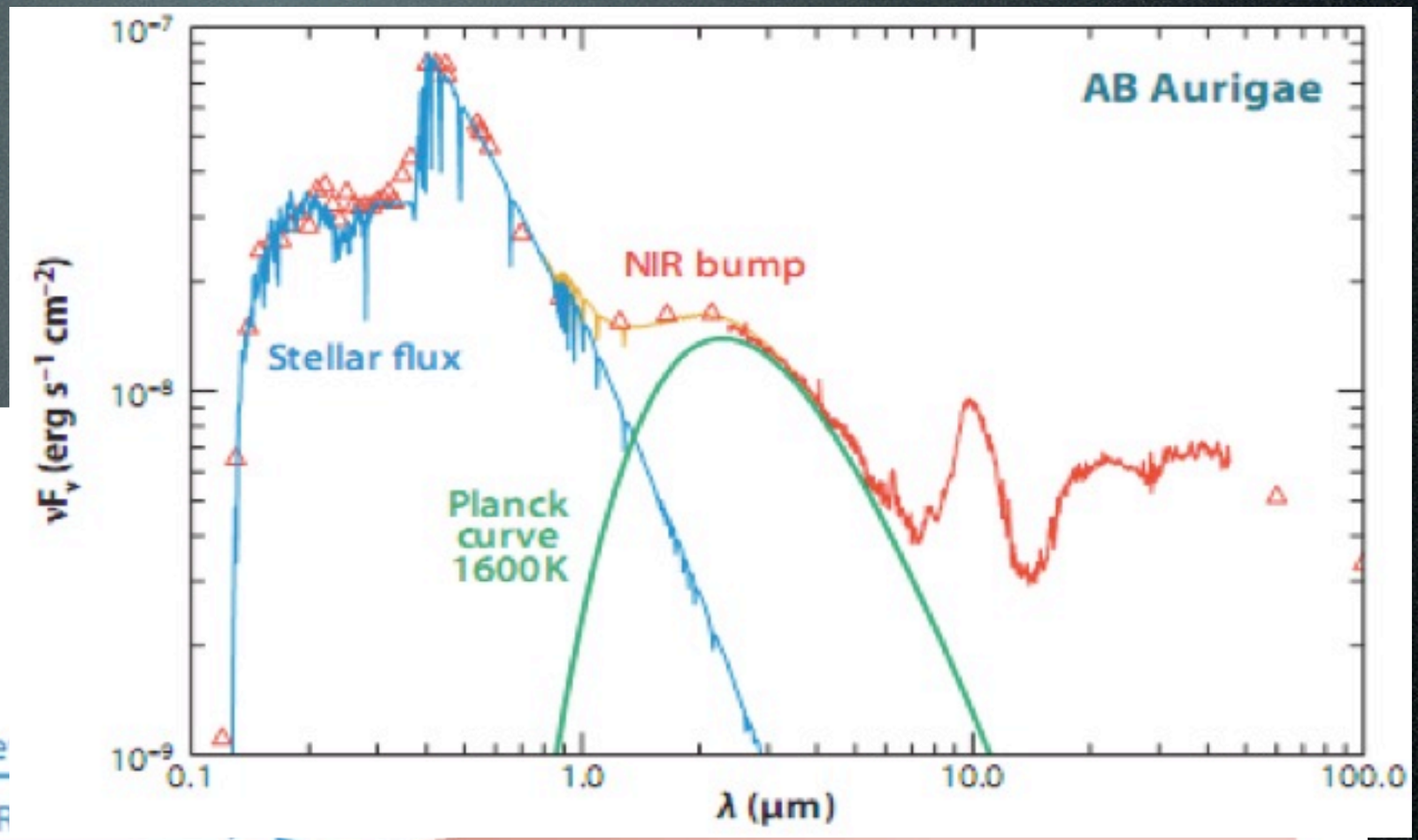
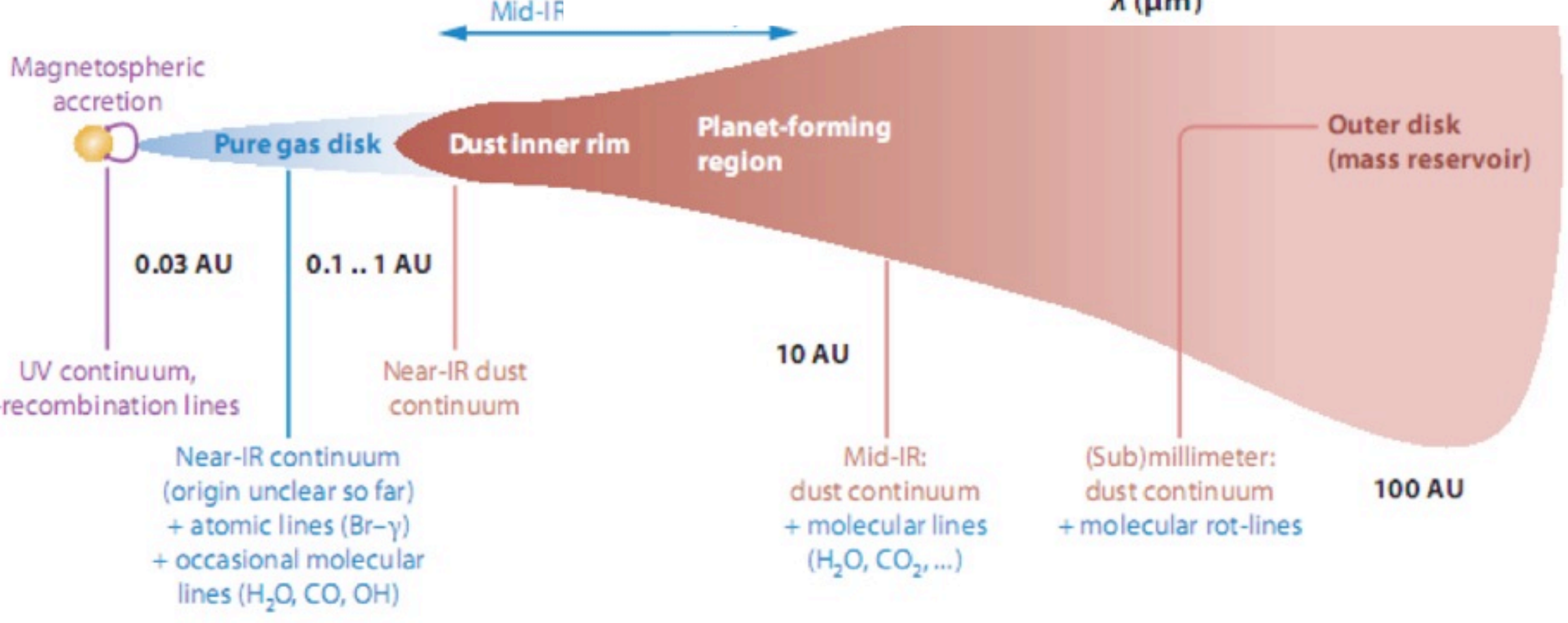


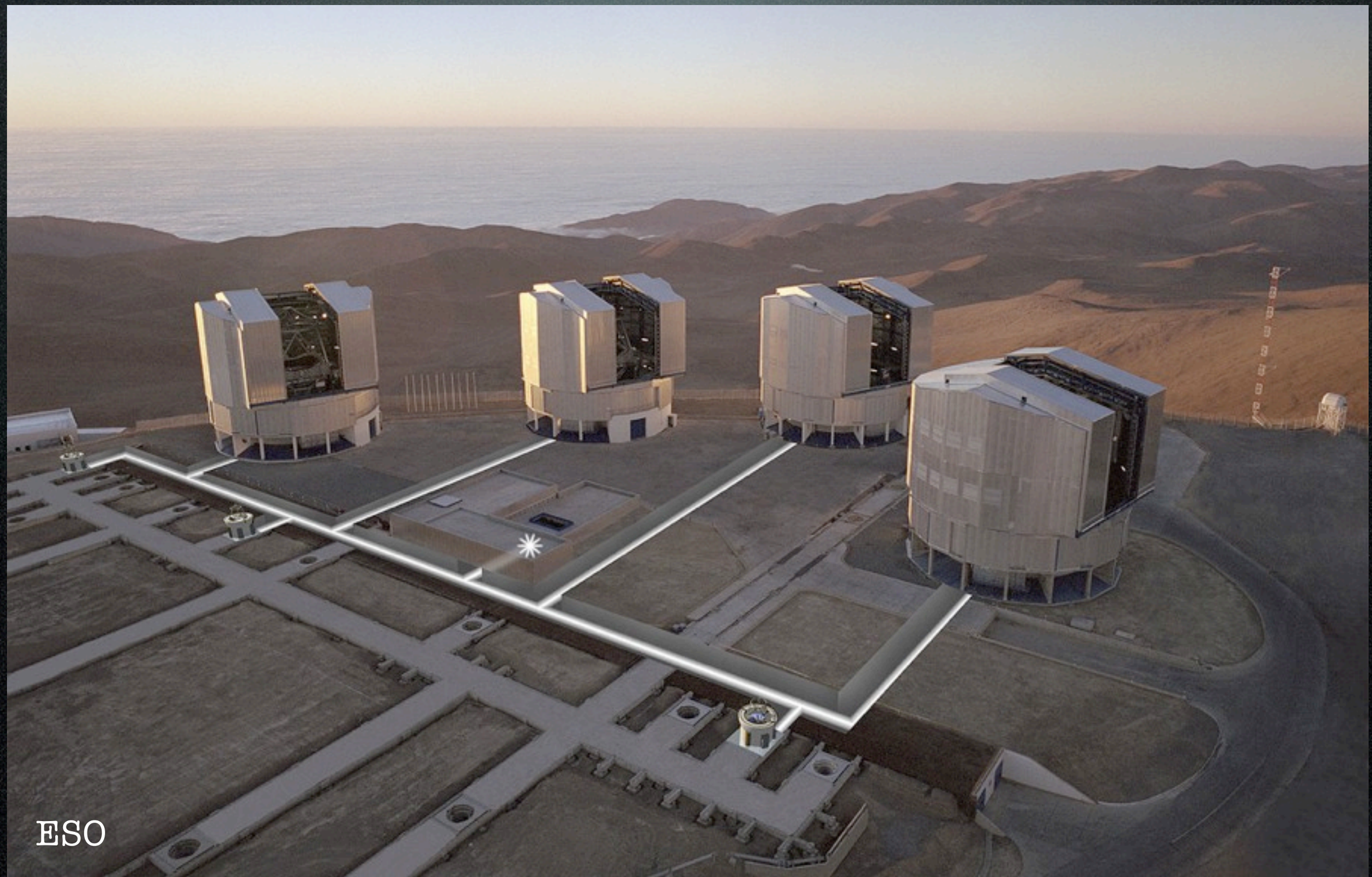
Dullemond & Monnier, 2010



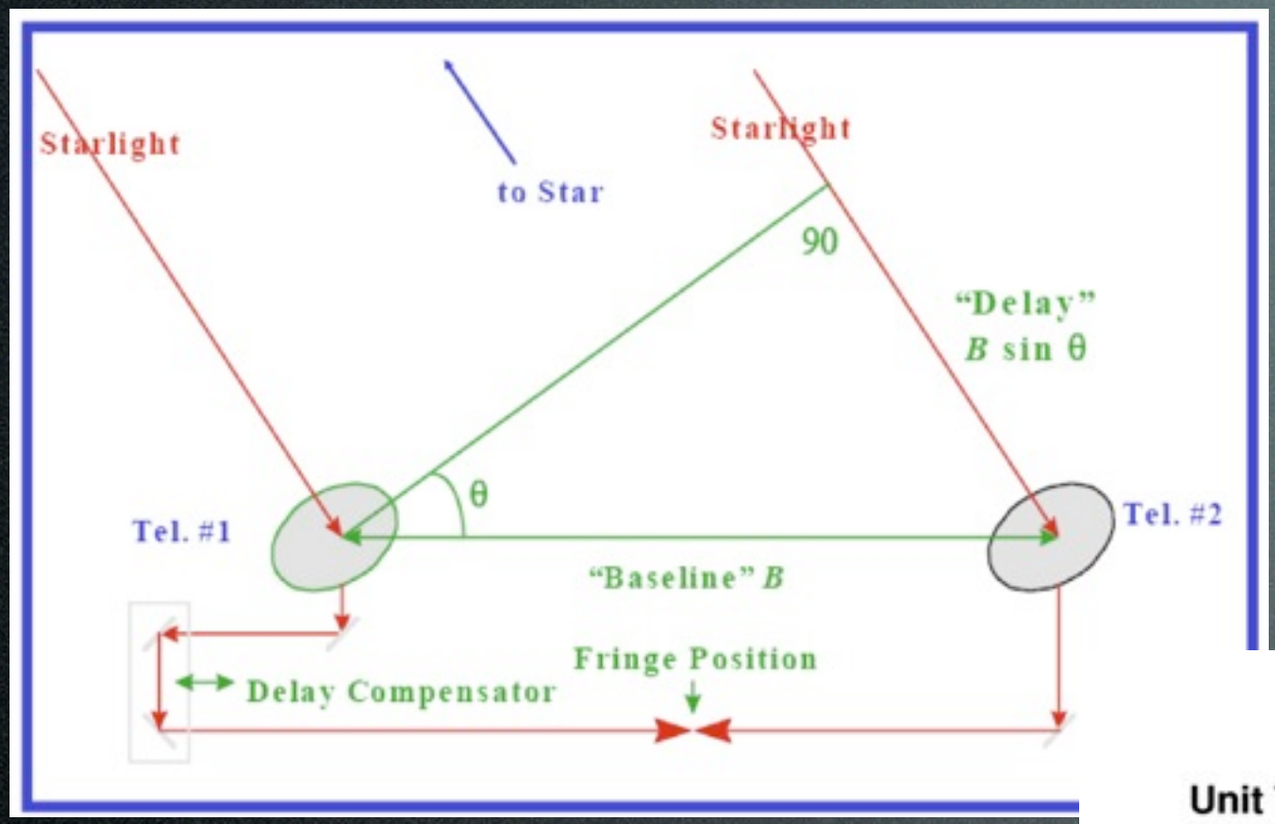


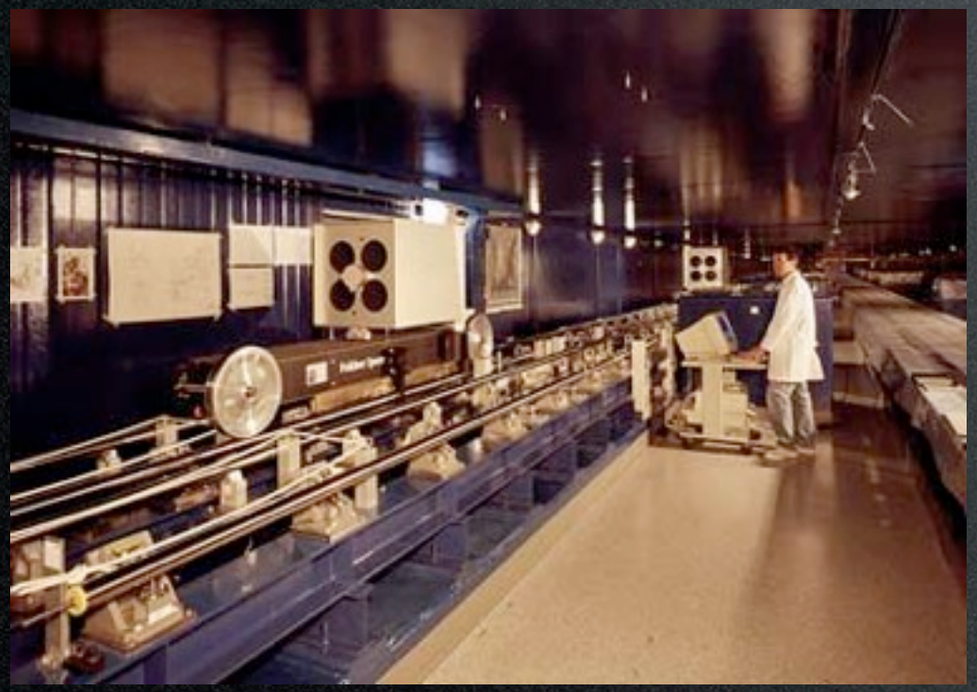
Dullemond & Monnier, 2010

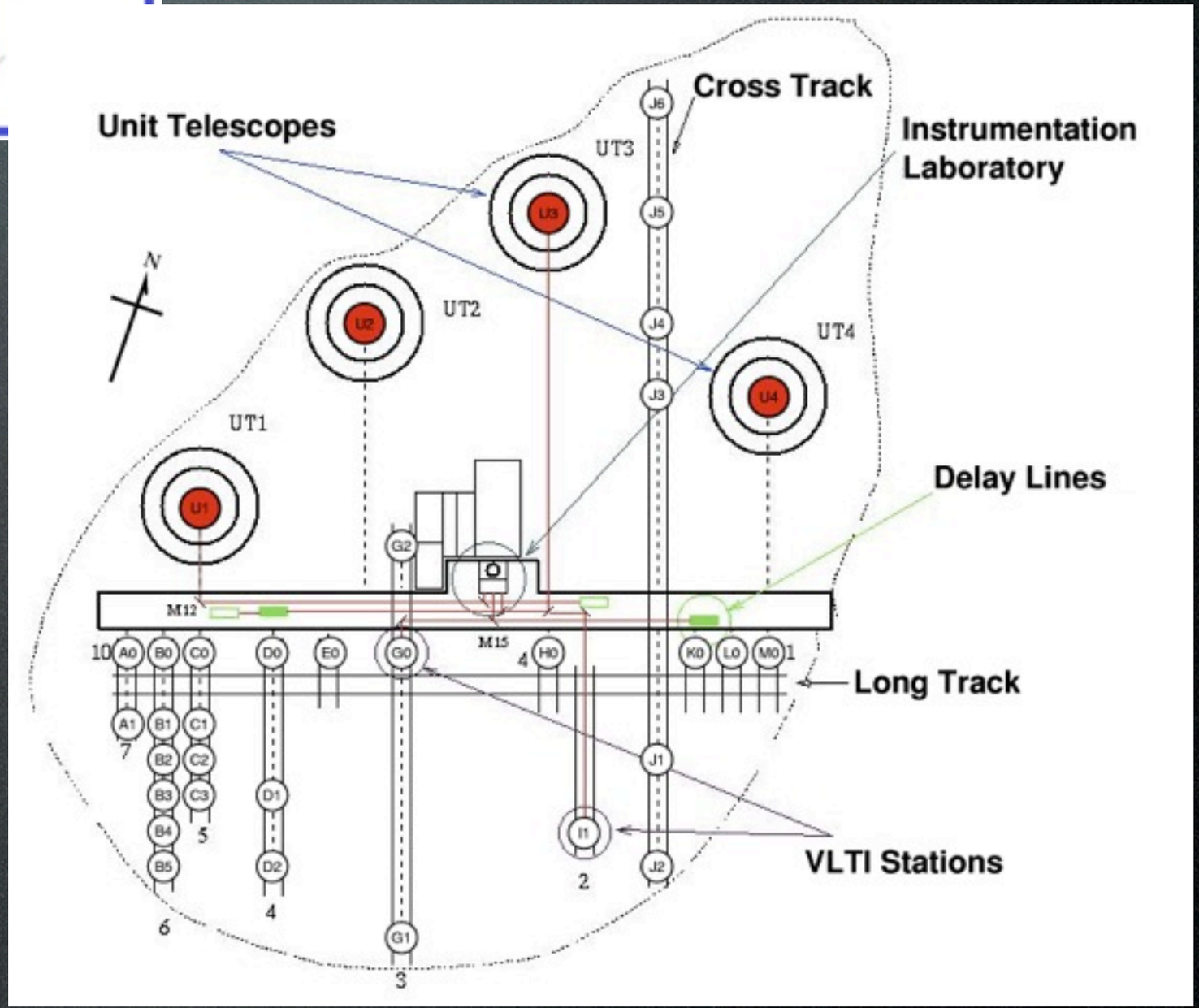
VLTI



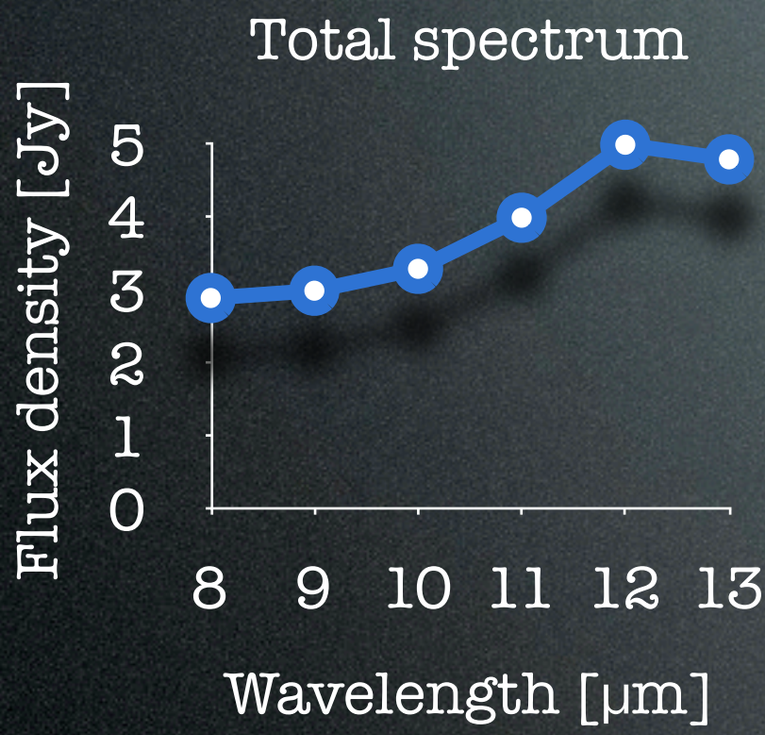
VLTI

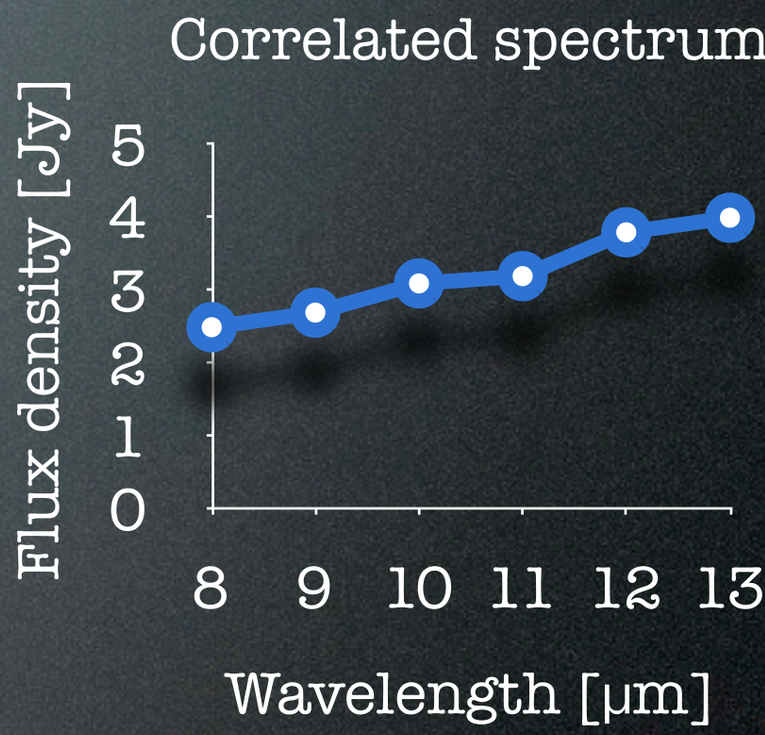

Starlight
to Star
Starlight
90
"Delay"
B sin θ
θ
Tel. #1
Tel. #2
"Baseline" B
Fringe Position
Delay Compensator




Unit Telescopes
Cross Track
Instrumentation Laboratory
UT3
UT2
UT4
UT1
N
Delay Lines
Long Track
VLTI Stations
M12
M15

Typical MIDI output





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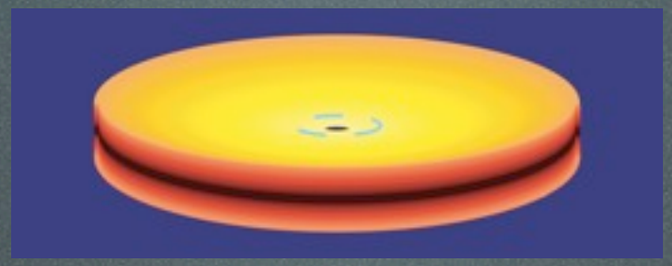
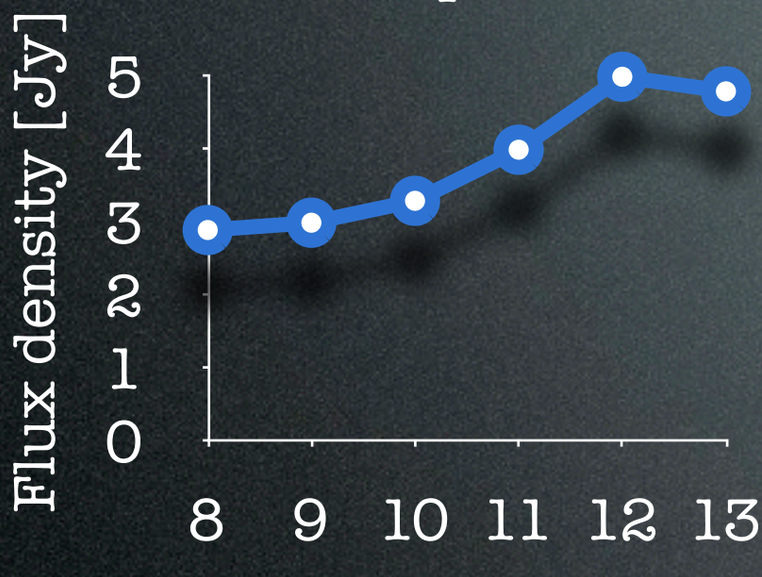
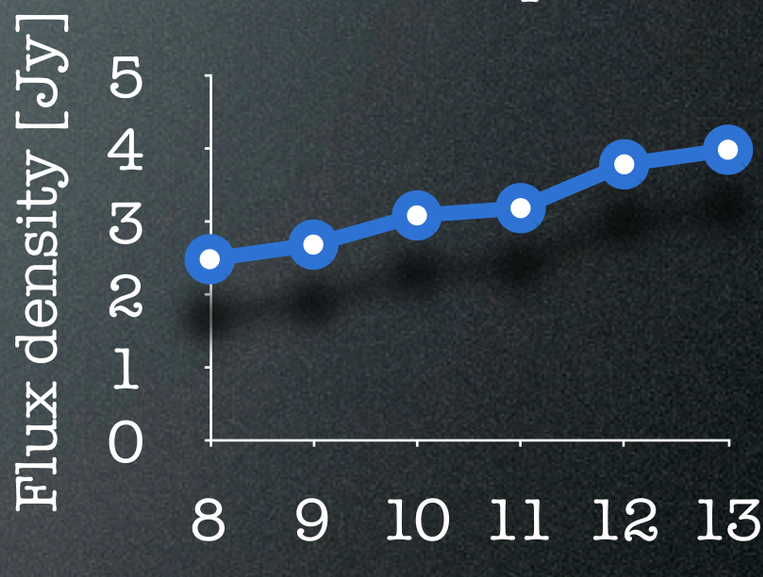


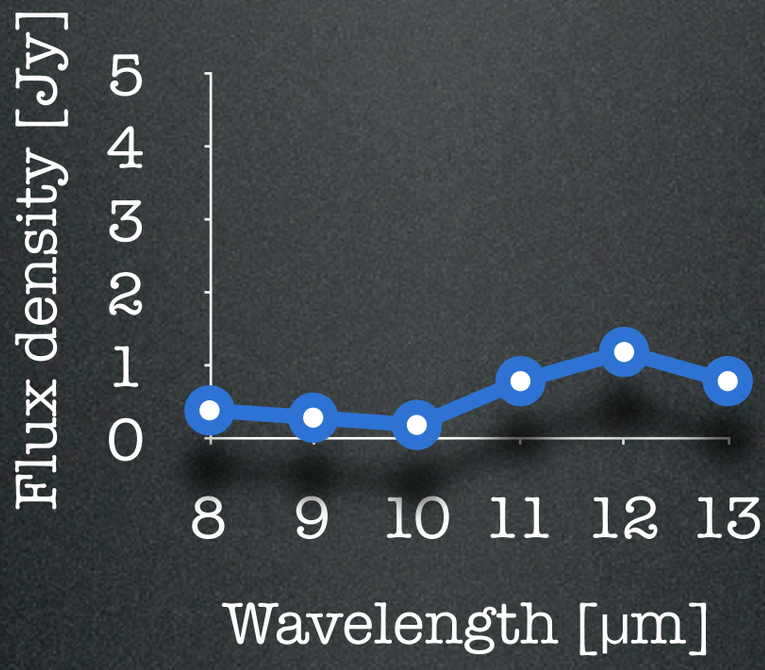
Total spectrum

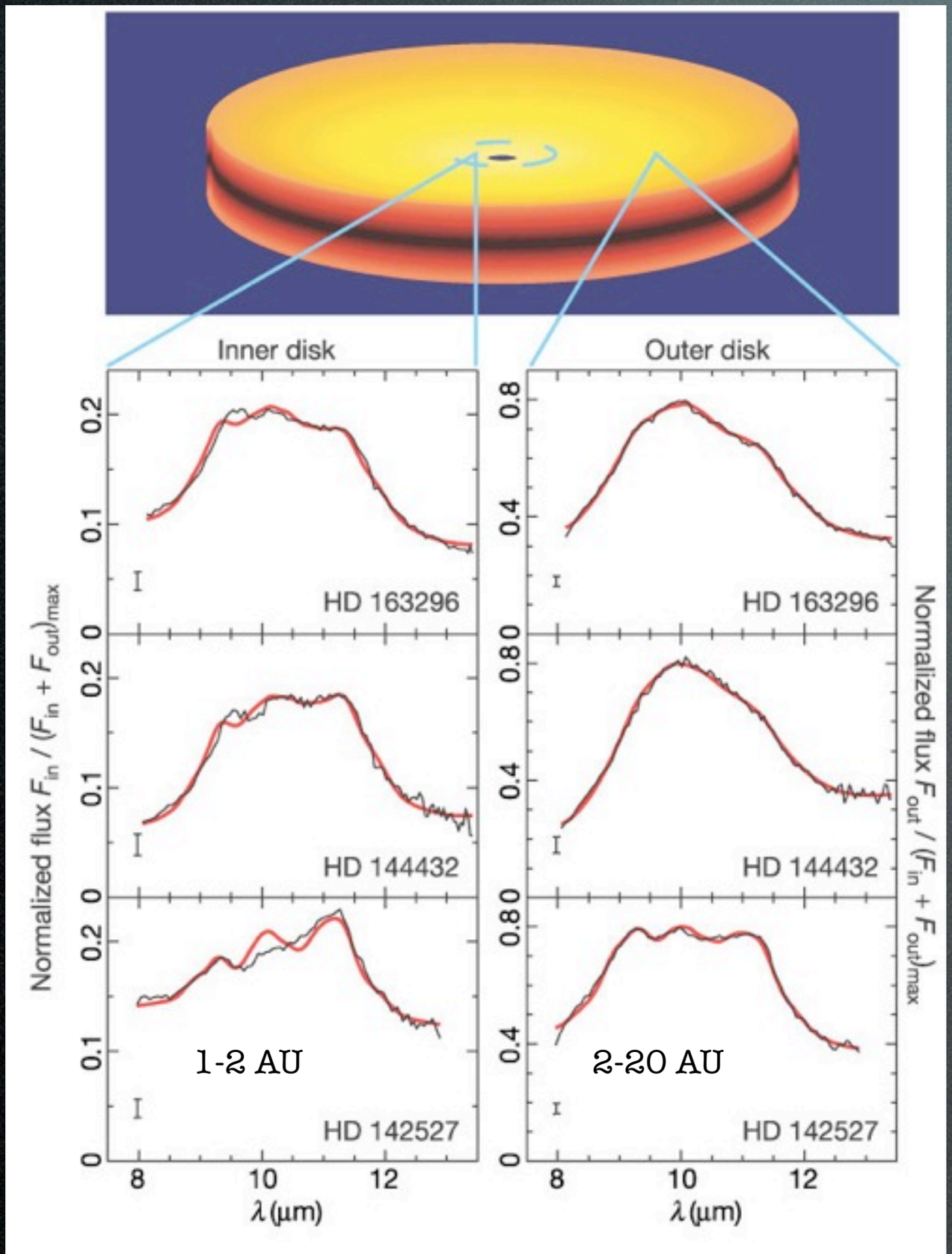


Correlated spectrum



Uncorrelated spectrum

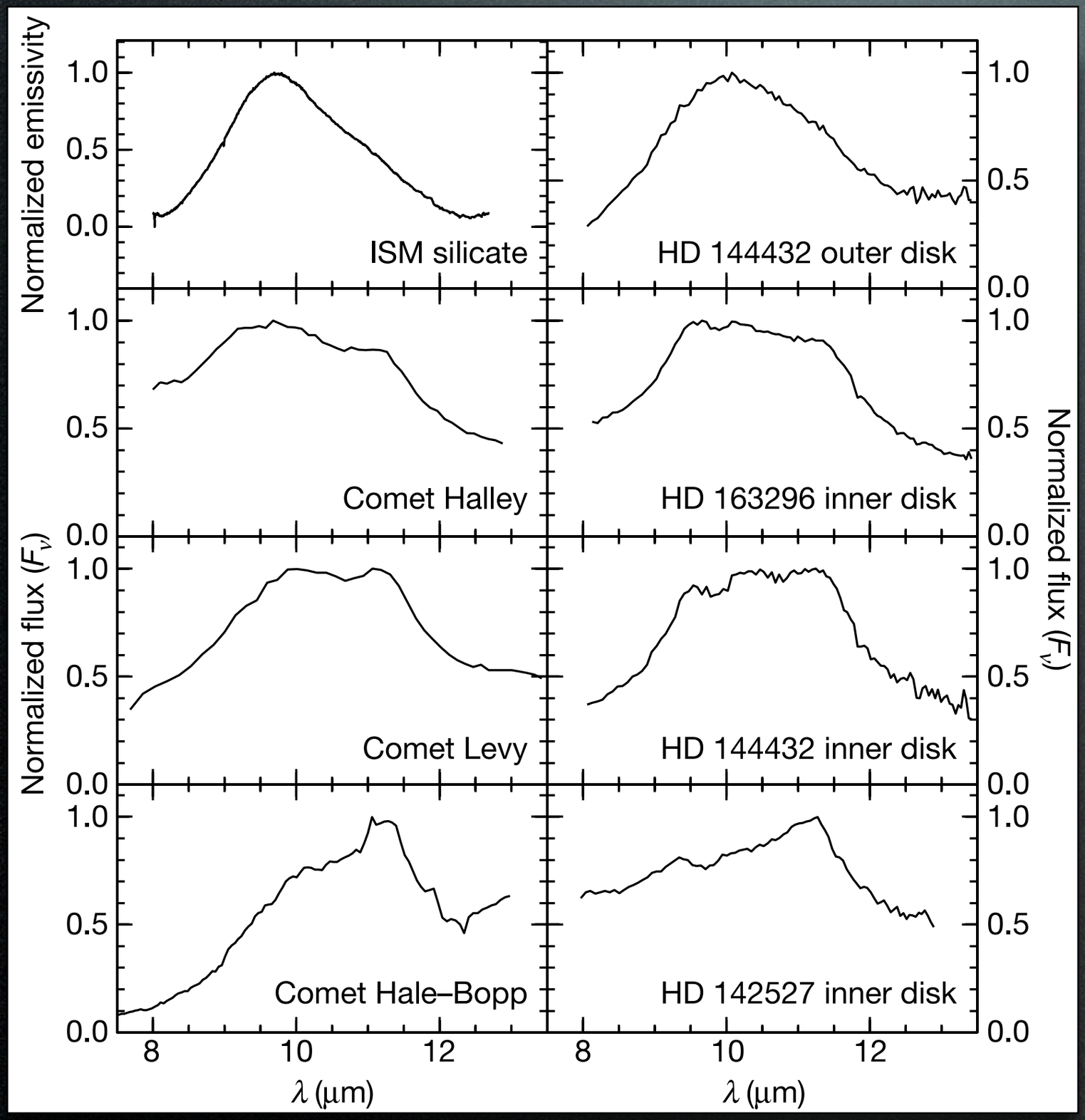




van Boekel et al., Nature, 2004

VLTI-MIDI observation of 3 Herbig Ae stars (van Boekel et al., 2004):

- Different shapes of the spectra ⇒ difference in dust composition
- Dust in the inner disk is highly crystallized (even before any planet formation).

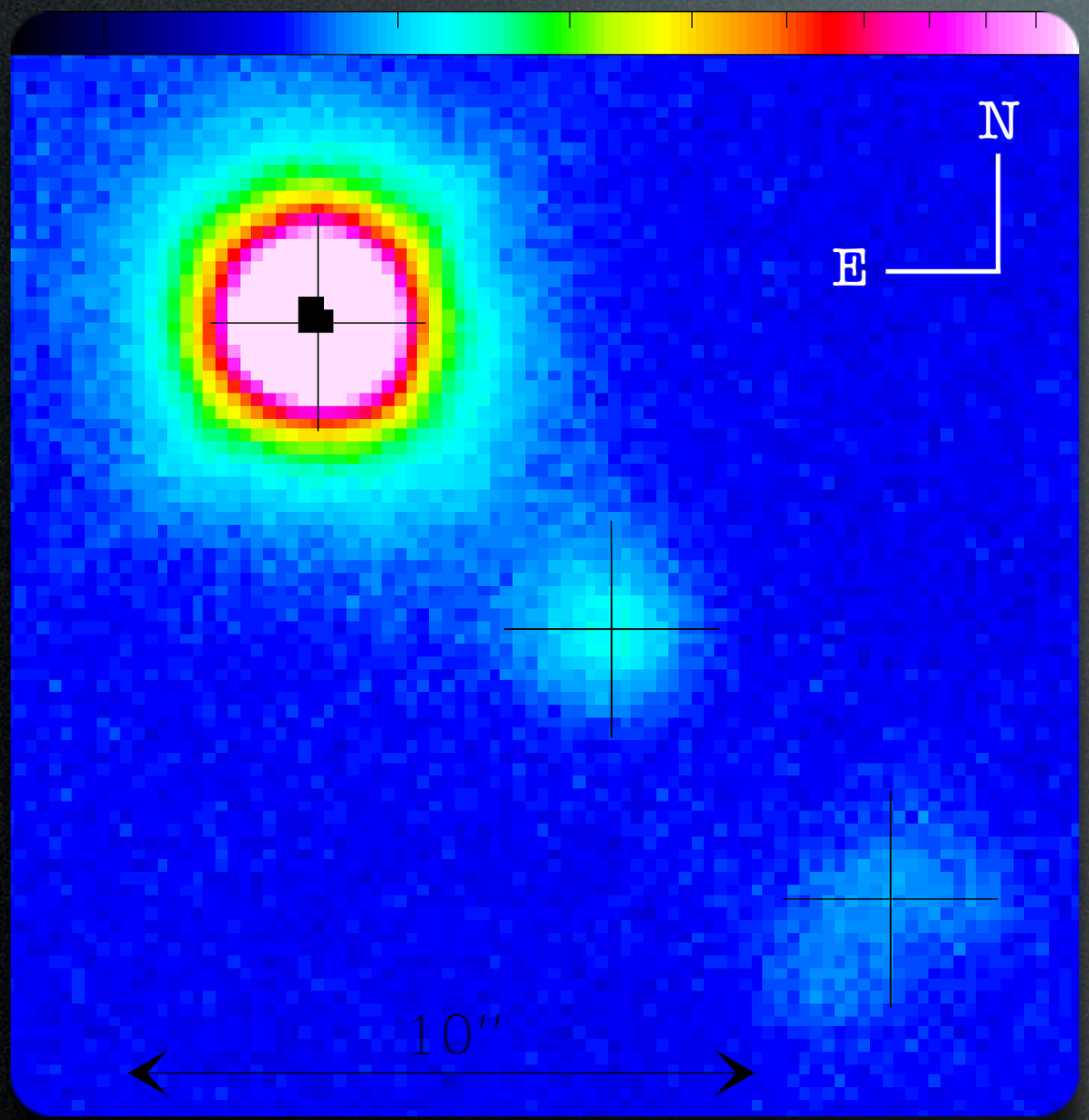


van Boekel et al., Nature, 2004

VLTI-MIDI observation of 3 Herbig Ae stars (van Boekel et al., 2004):

- Inner disk: Broadening indicates dust grain growth and similarity to comets of the Solar System.
- Different crystalline "species" in the outer and inner disk
- More crystallized silicates in the inner disks (mostly olivine)

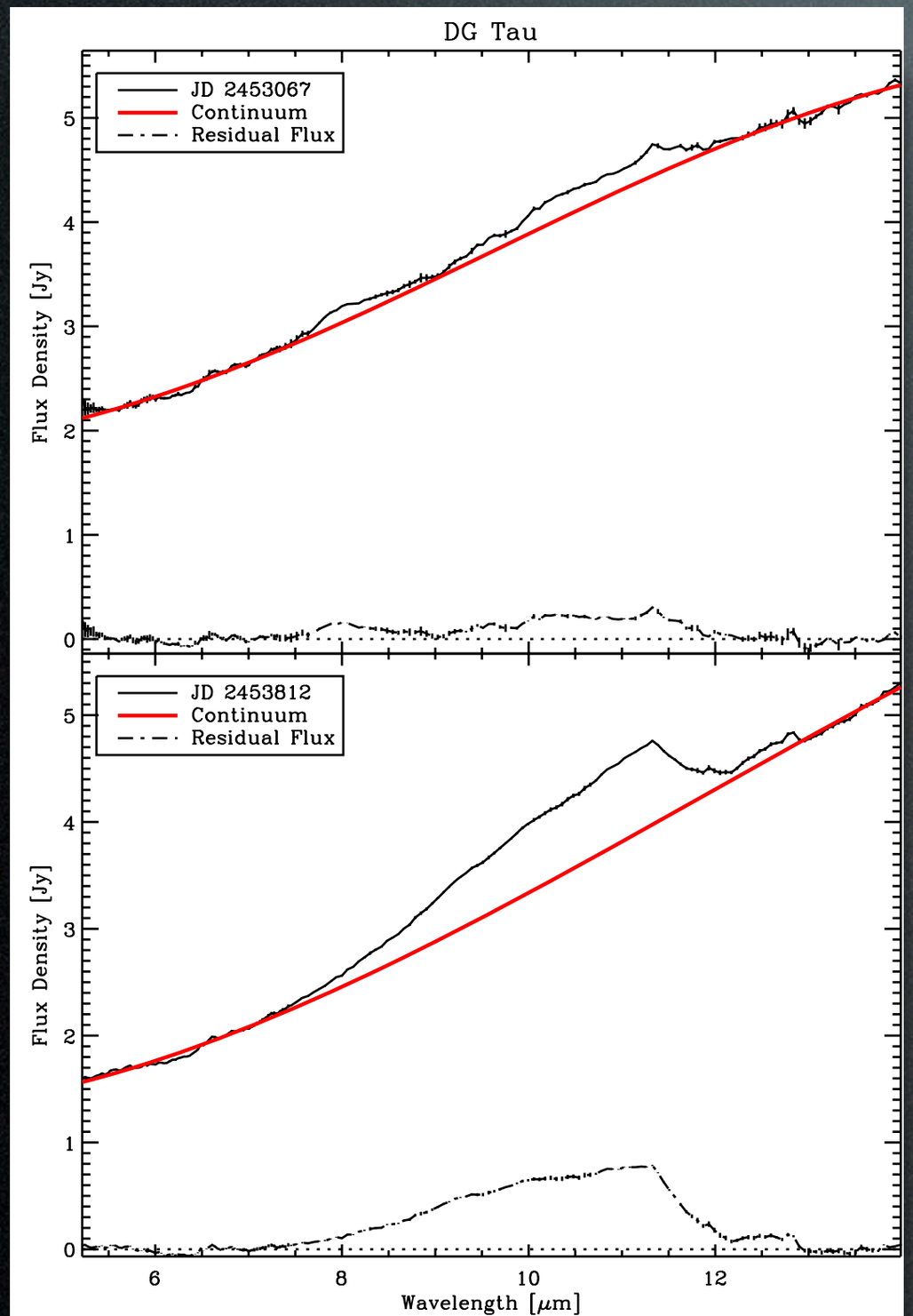
DG Tau

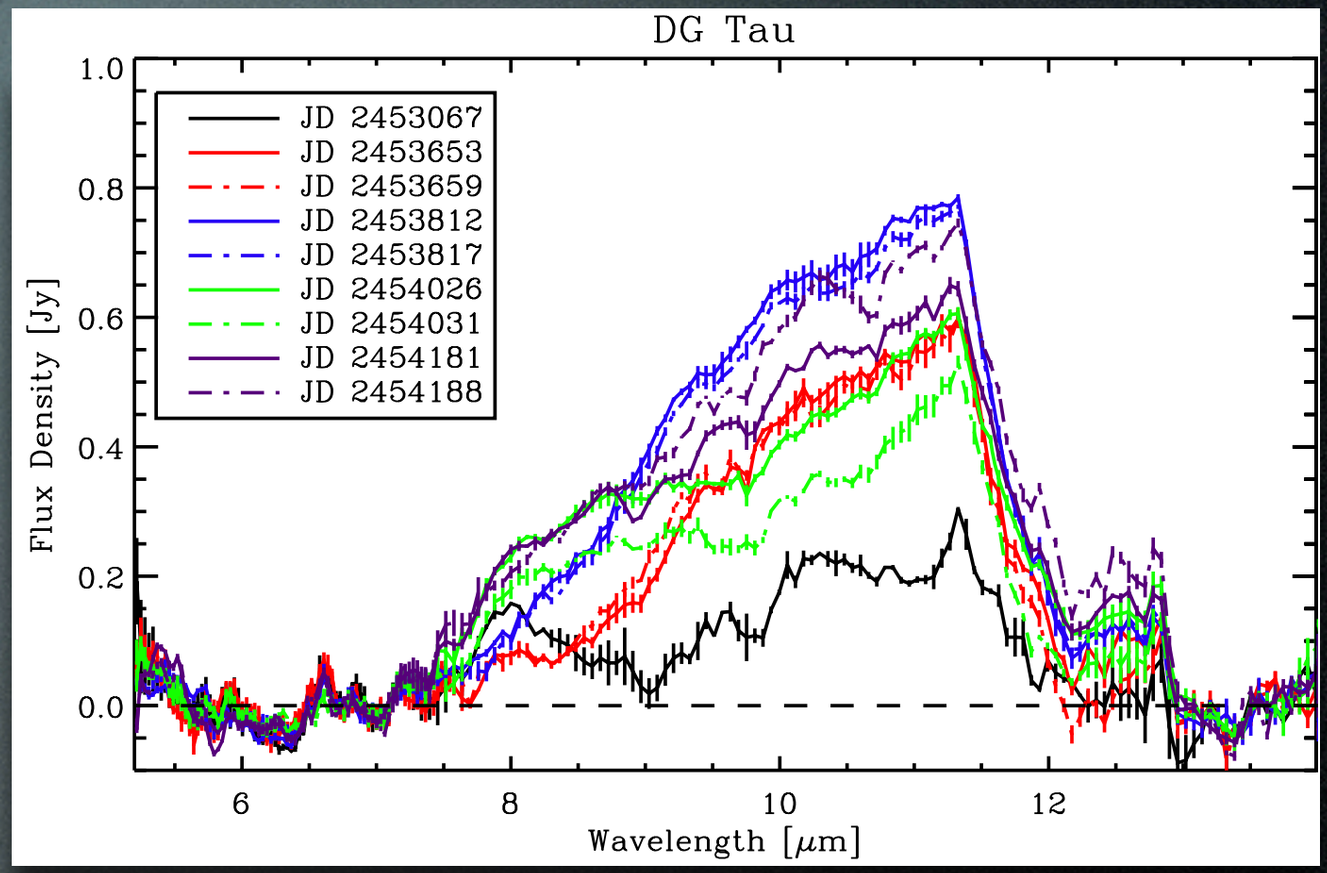


Rodríguez et al., 2011

- T Tauri type young star (~10^6 yrs)
- distance: ~140 pc
- ~1.3 L_{Sun}
- ~0.7 m_{Sun}
- Spectral type: K5V

DG Tau





Bary et al., 2009

- Spitzer observations(5.2-14.5μm) show variable silicate emission
- Scenarios: short timescale -> exclude variability in the dusty envelope
  - inner disk's rim cast a shadow
  - cooler dust gets above the disk via turbulent mixing or via disk winds

DG Tau - VLTI/MIDI observations

- 2011.10.10
  - UT1 - UT2: 33.4m, PA=30°
  - UT1 - UT3: 75.4m, PA=45°
- 2011.12.13
  - UT1 - UT2: 36.5m, PA=34°
  - UT1 - UT3: 55.7m, PA=35°
- 2012.02.04/05
  - UT1 - UT2: 45m, PA=40°
  - UT1 - UT3: 83.9m, PA=46°

- The obtained data products:
  - Total spectrum: 8-13 μm
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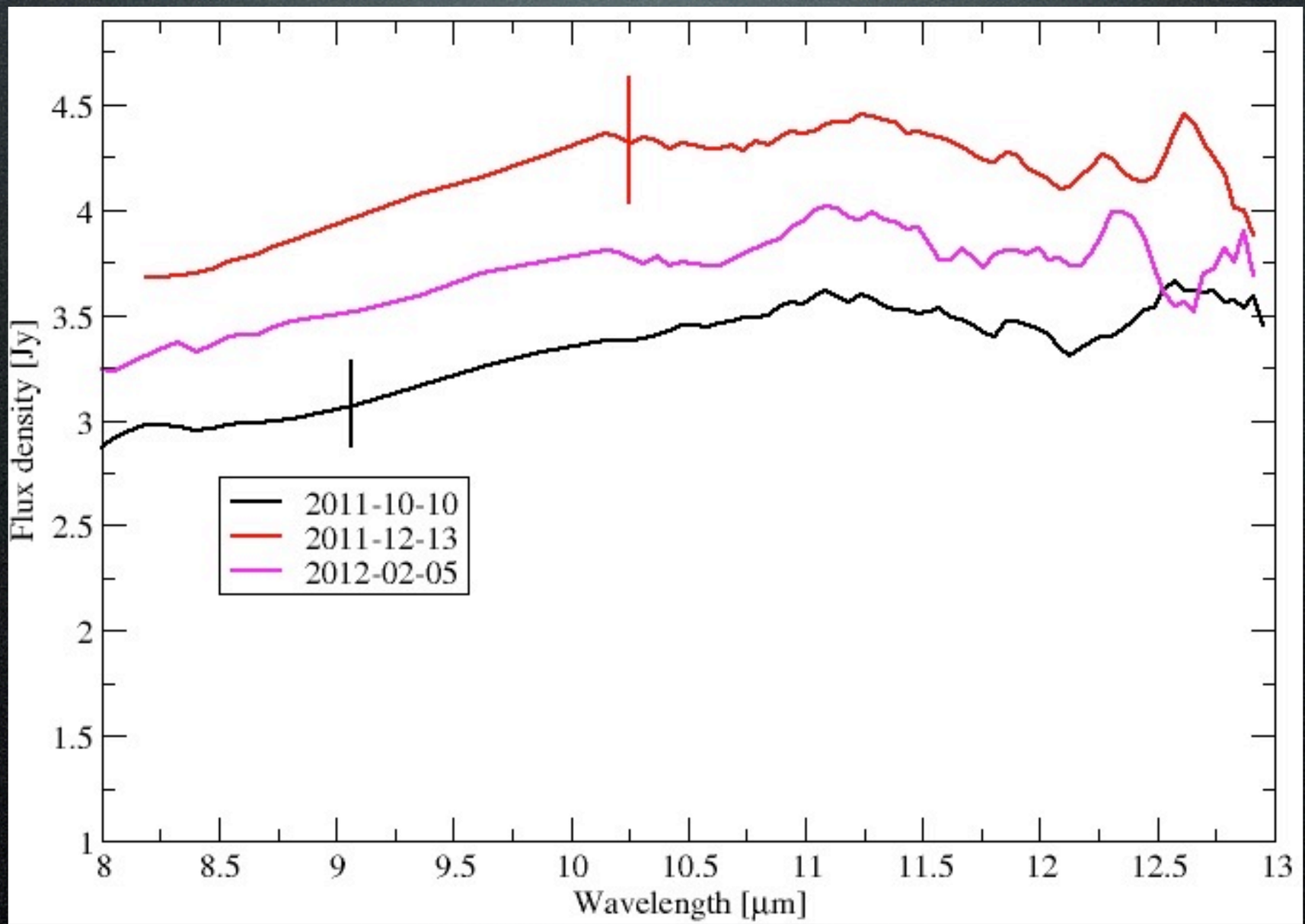
DG Tau - MIDI prelim. results: total spectra



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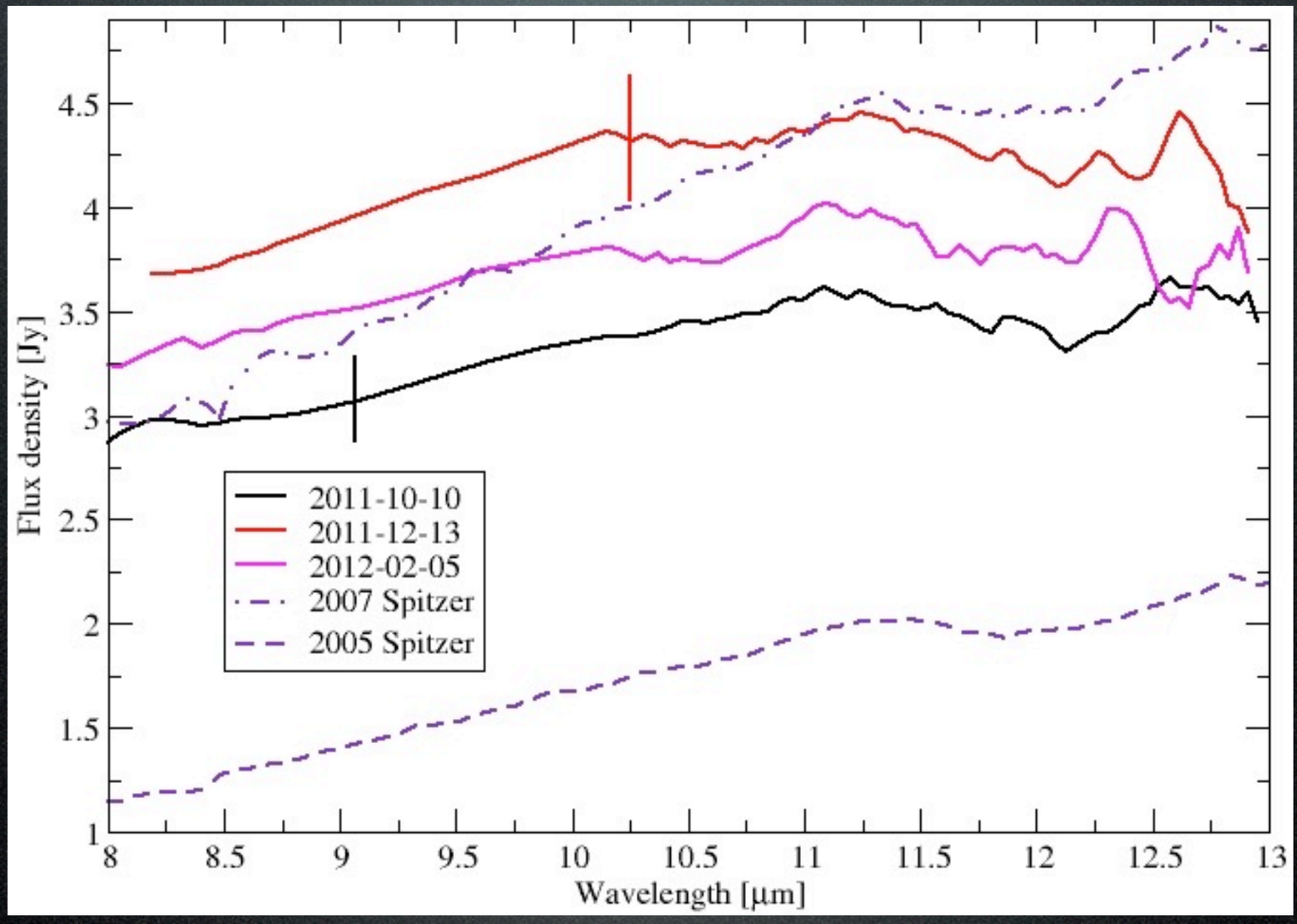
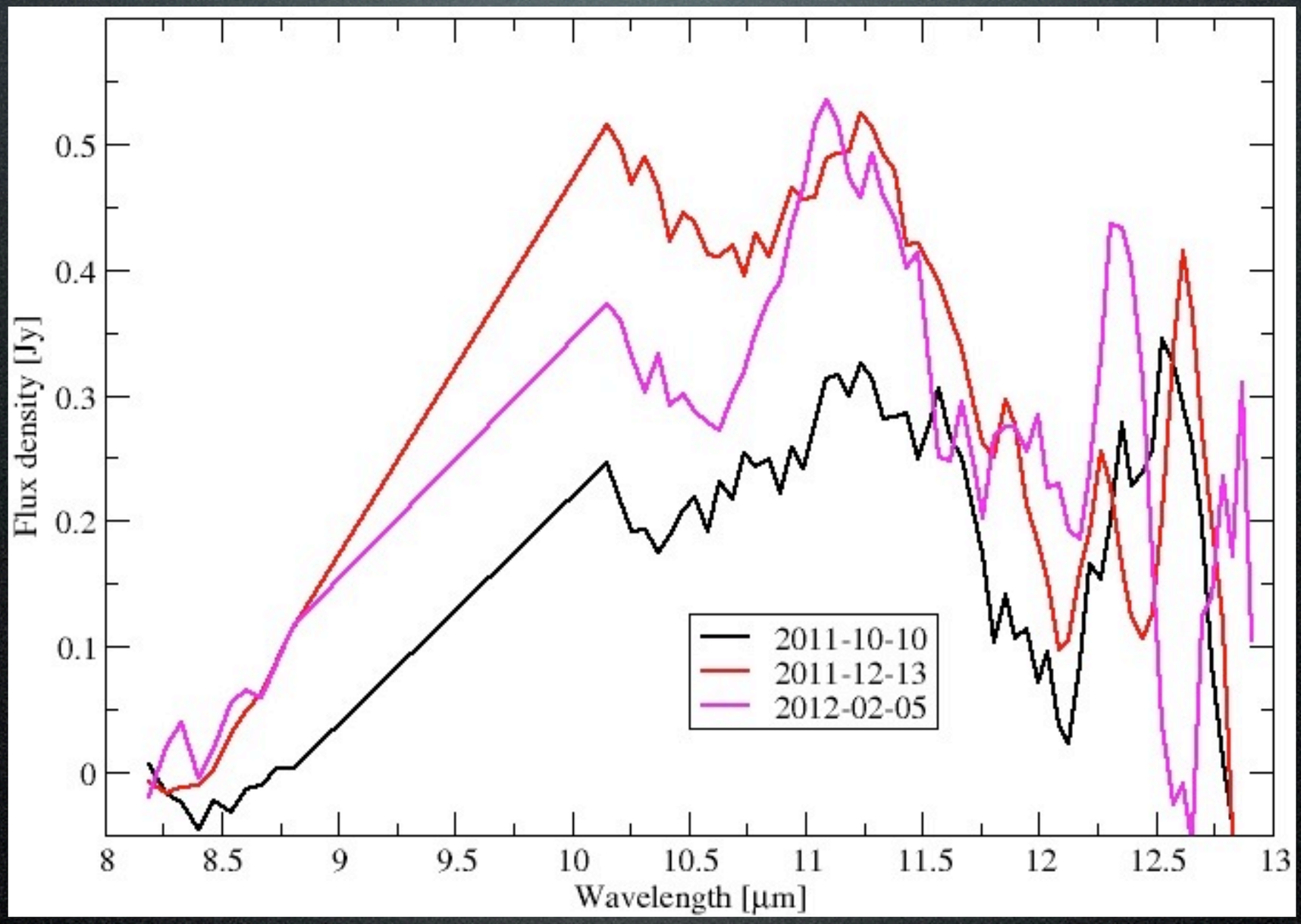


DG Tau - MIDI prelim. results: continuum subtracted total spectra



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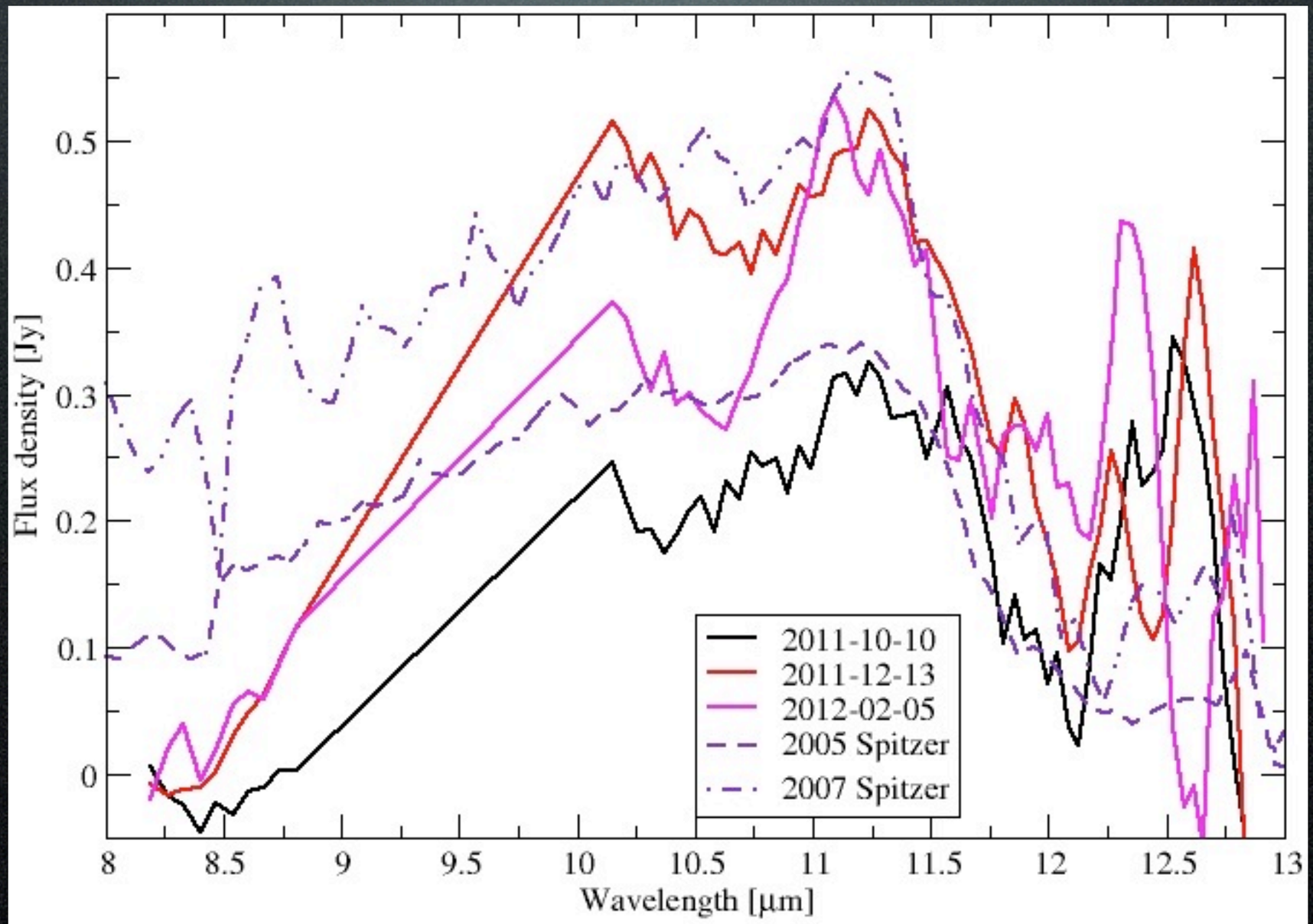
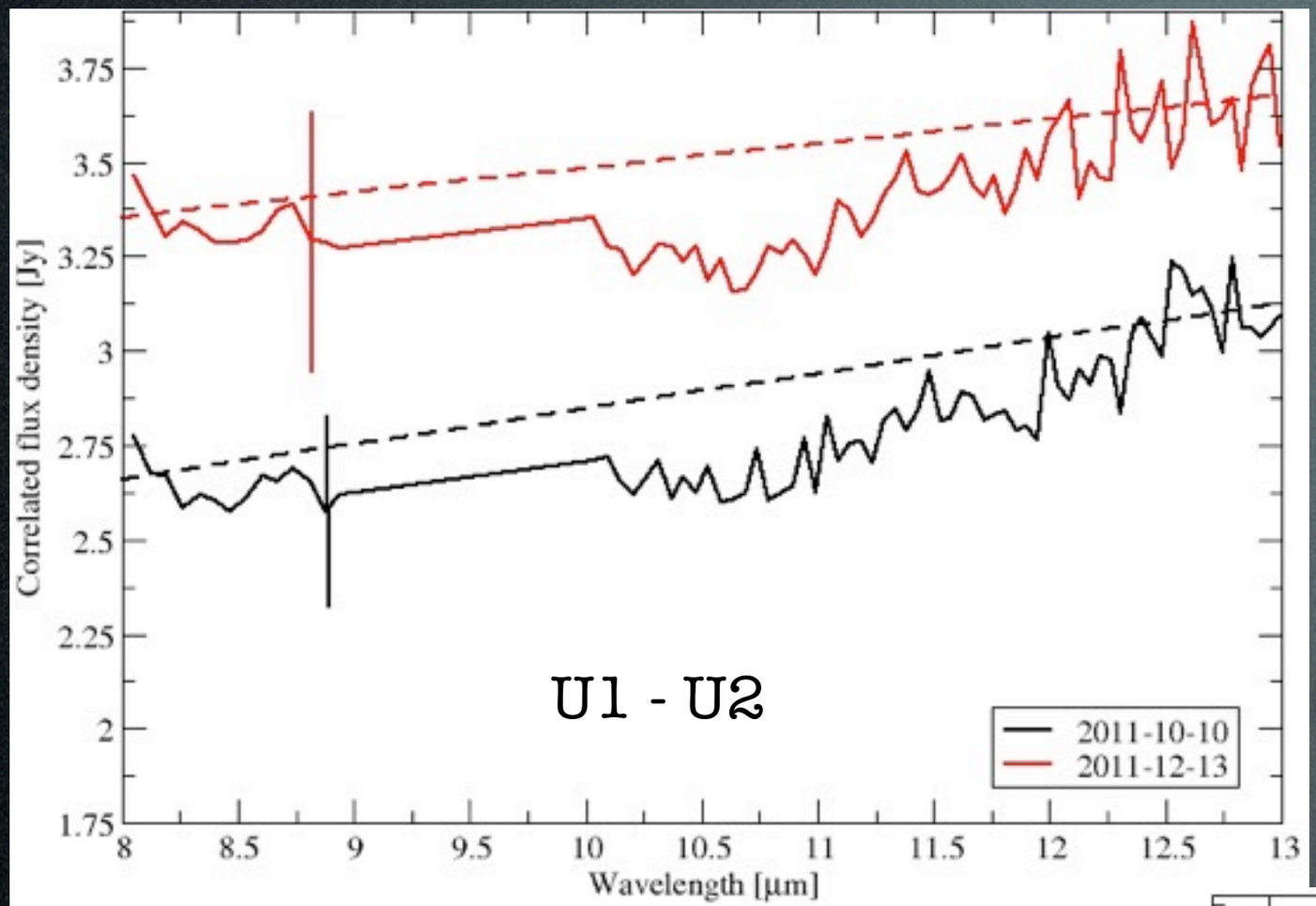
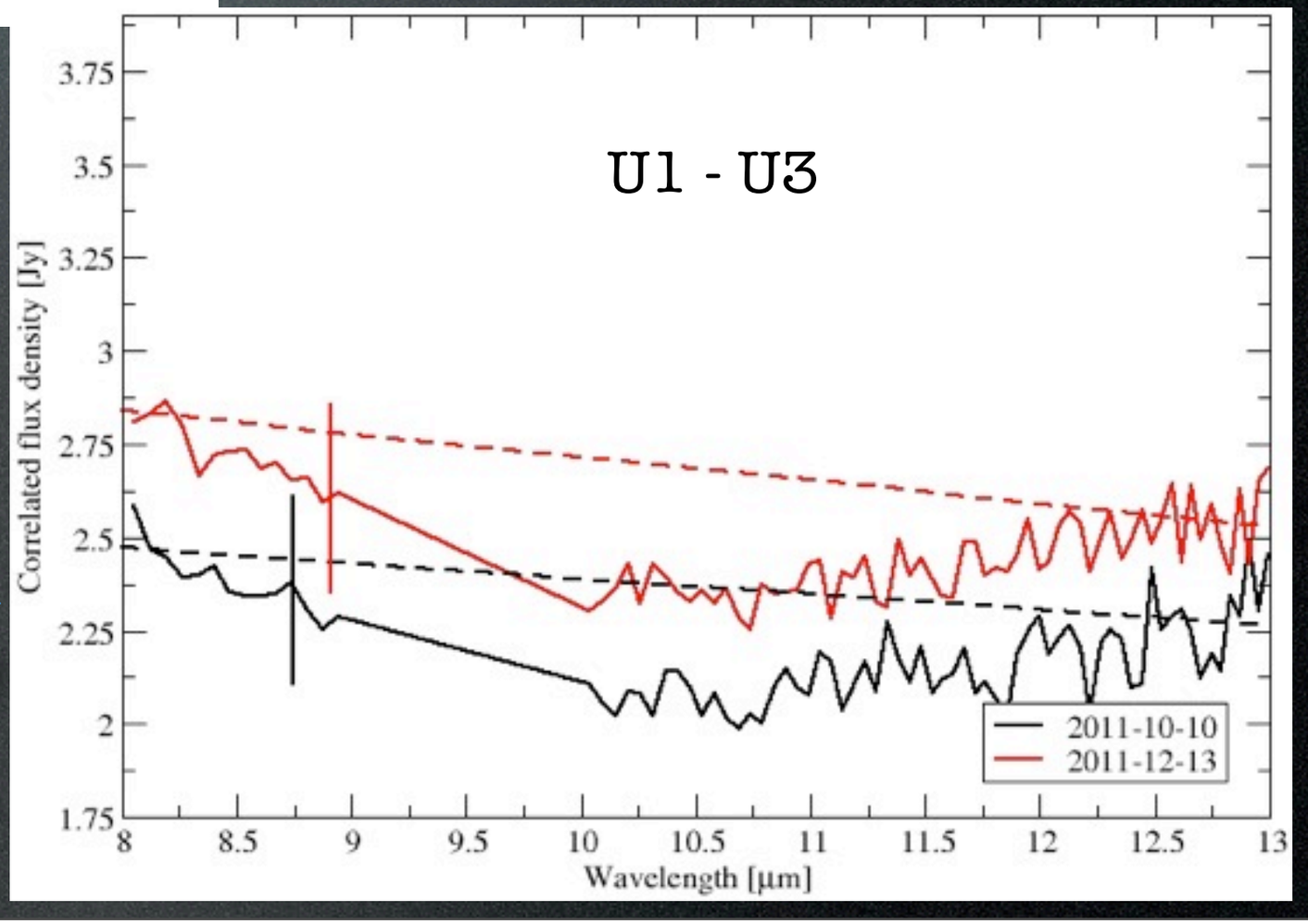




shorter baseline
lower resolution
less compact component

longer baseline
better resolution
more compact component



Summary

- Long wavelength (>10μm) comes from ~3 AU sized disk
- Temporal variations on timescale of months observed with VLTI/MIDI in the total spectra (whole structure)
  - change in the continuum and
  - change in the silicate feature
- Silicate emission in total spectra, but absorption in correlated spectra -> absorption in the inner disk
- ?? Dredged-up material above the disk
- ?? Rim of the disk gets puffed up (and cast a shadow) - can be related to changes in the accretion rate

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