Different Organic Chemistry in Disks around Sun-like and Cool Stars

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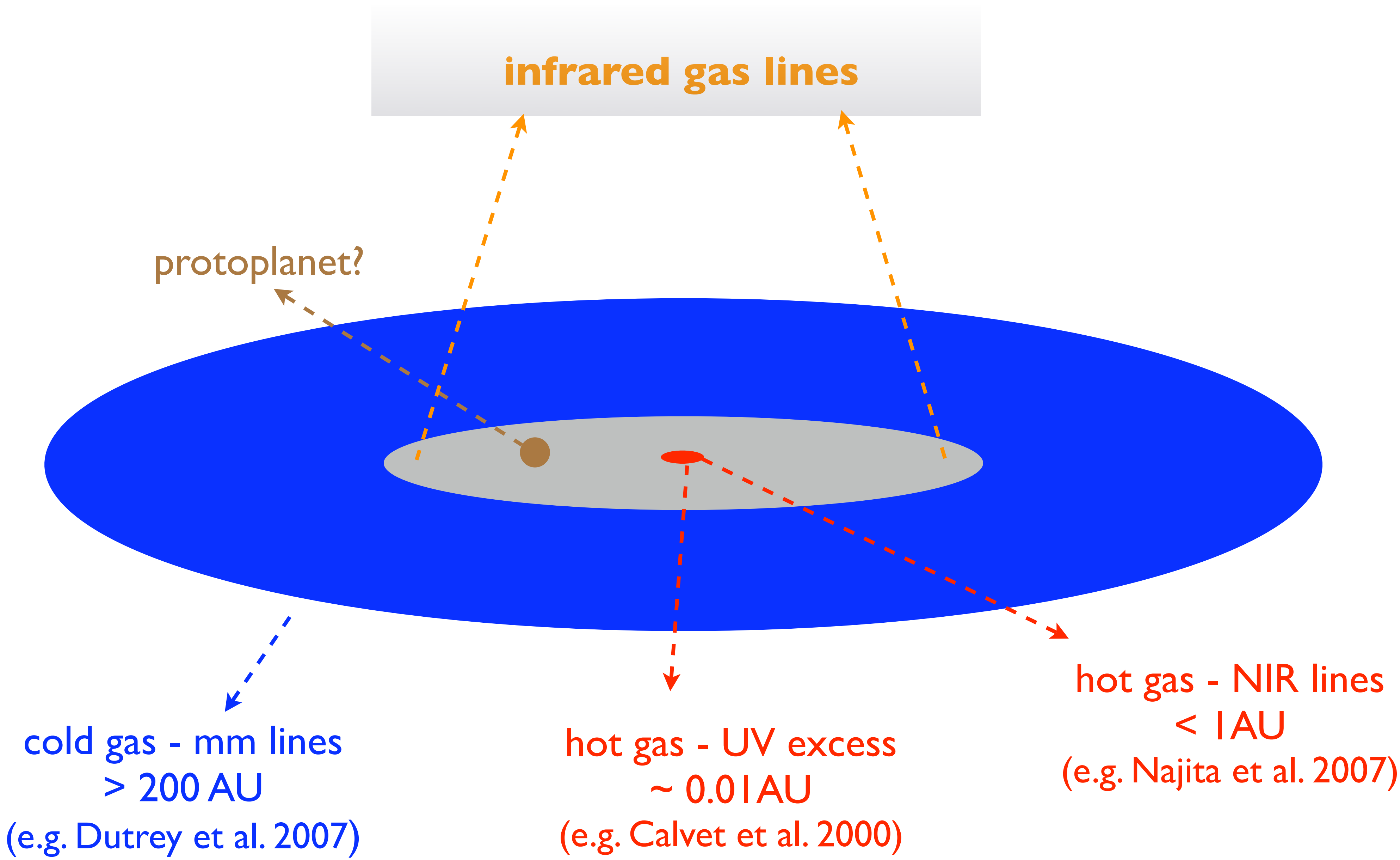
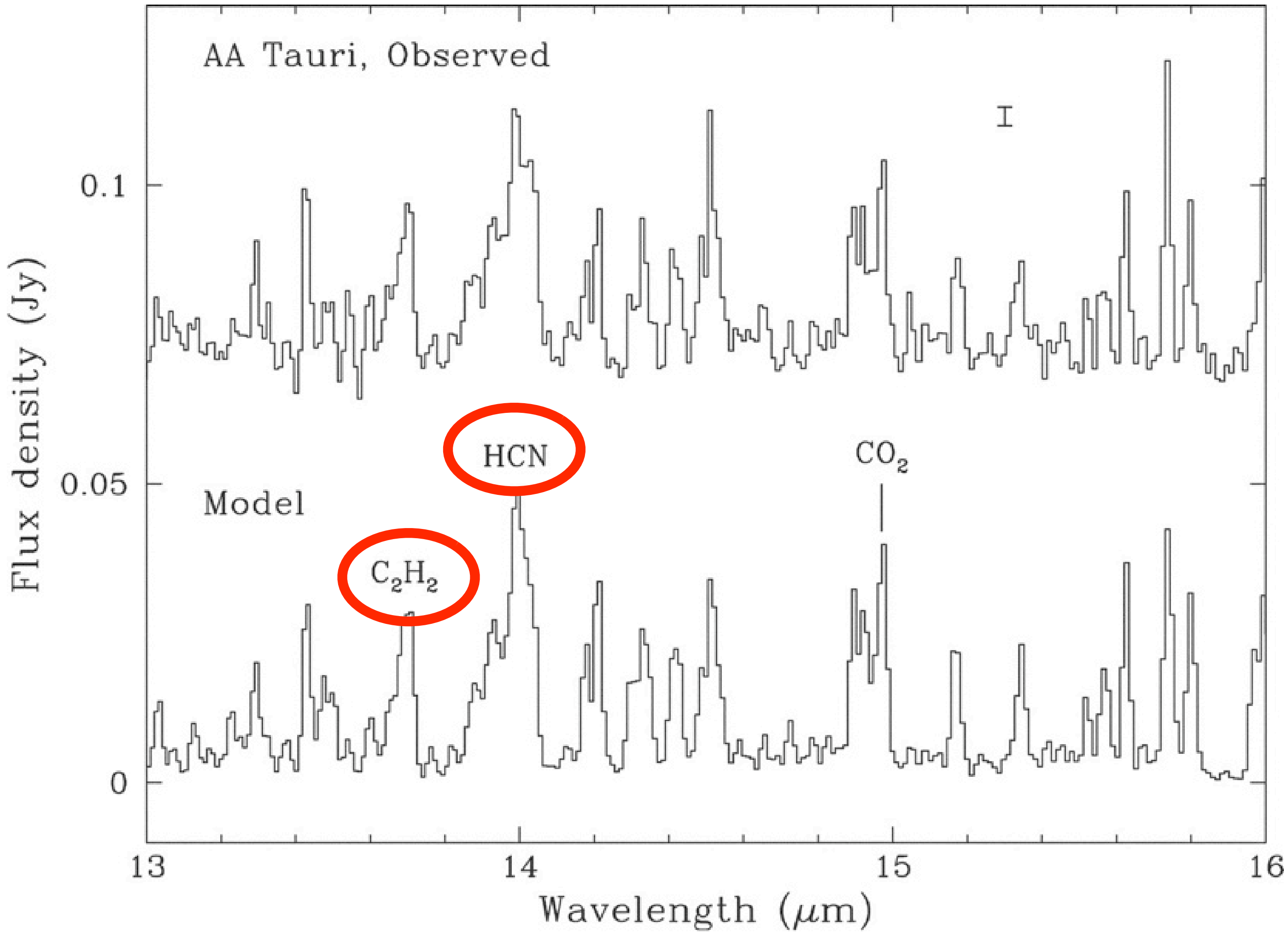
The chemistry of protoplanetary disks determines the material available to form planets, asteroids, comets

Complex organic molecules detected in the ISM

Which complex molecules survive in accretion disks?
Which molecules are available when planets assemble?


infrared gas lines
protoplanet?
cold gas - mm lines
> 200 AU
(e.g. Dutrey et al. 2007)
hot gas - UV excess
~ 0.01AU
(e.g. Calvet et al. 2000)
hot gas - NIR lines
< 1AU
(e.g. Najita et al. 2007)

Organic Molecules in a T Tauri Disk



Spitzer high–resolution spectrum and model

$T(HCN) = T(C_2H_2)$

$N(HCN) > N(C_2H_2)$

probe disk surface

(Carr & Najita 2008)

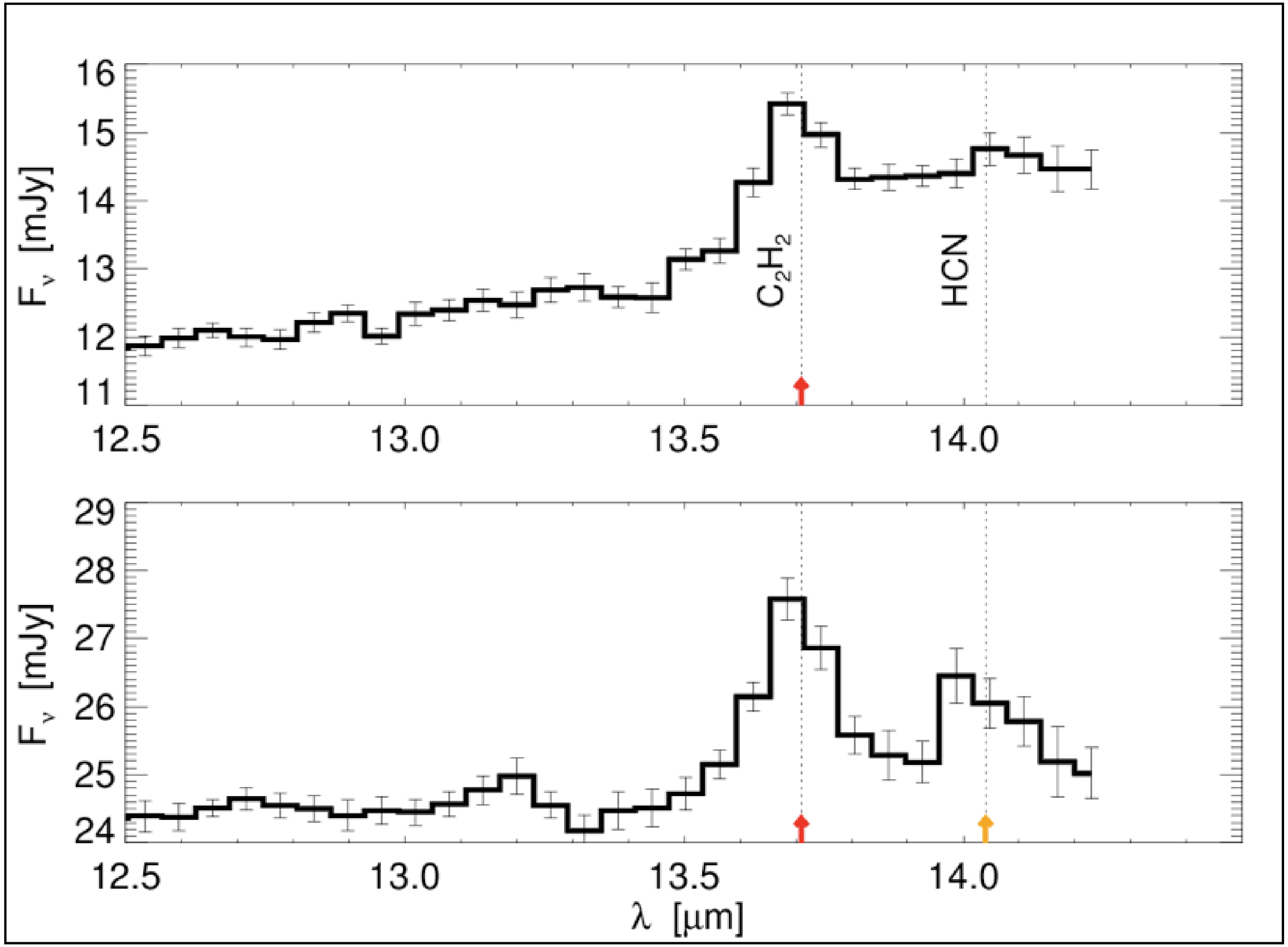
First Comparative Study

Sample	stars	#	<T> [K]	<M> [M_{sun}]
Sun-like stars	T Tauri	44	3,900	0.8
Cool stars	very low-mass stars and BDs	14	3,000	0.1

low-resolution spectra from the Spitzer Space Telescope covering the wavelength region between ~7–14 μm

Pascucci, Apai, Luhman, Henning, Meyer, Bouwman submitted

Organic molecules in BD disks



first detections of organic molecules in BD disks

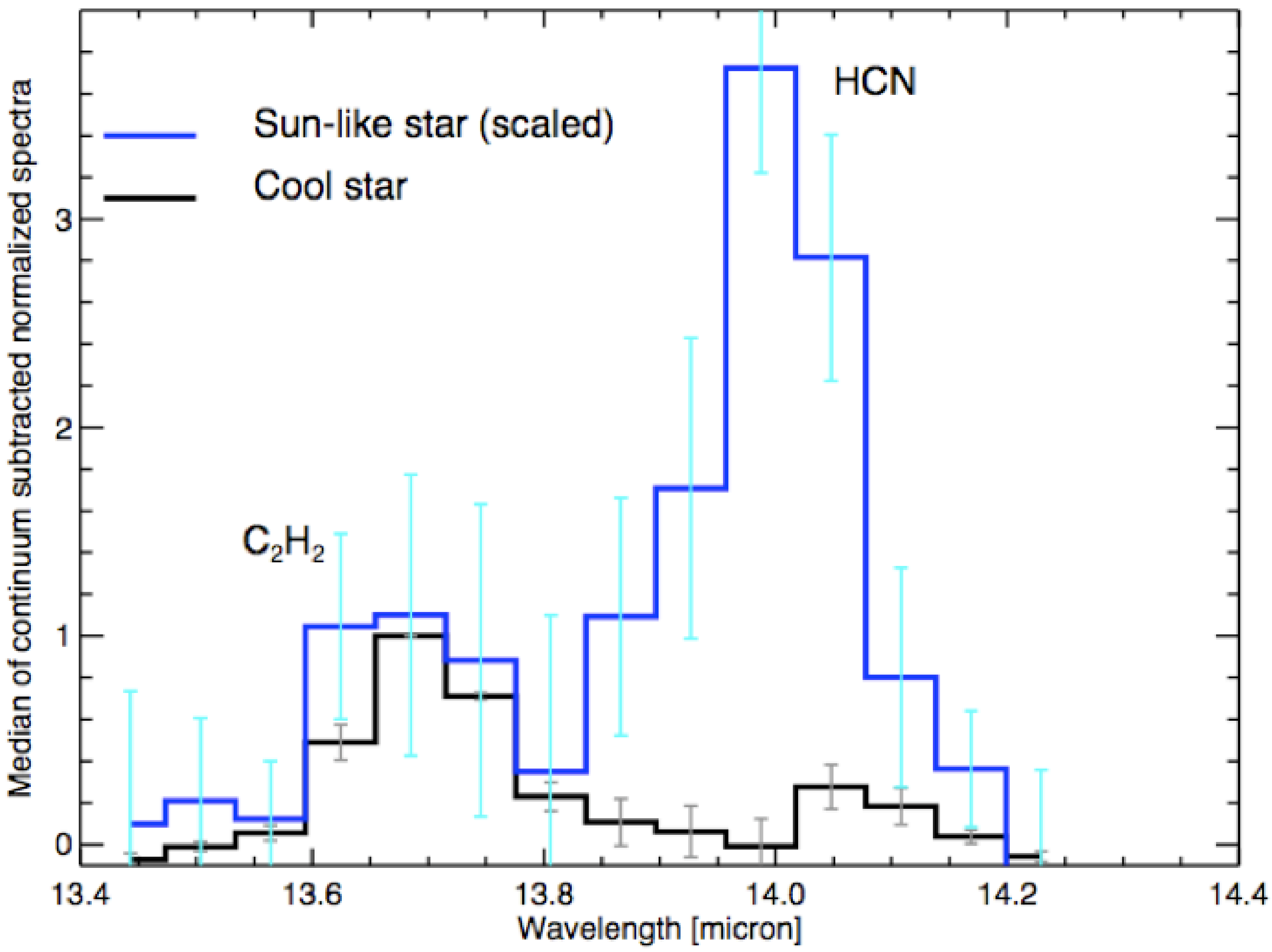
Detection Rate Statistic

Sample	HCN	C_2H_2
Sun-like stars	13/44	7/44
Cool stars	4 expected [redacted]	2 expected

Detection Rate Statistic

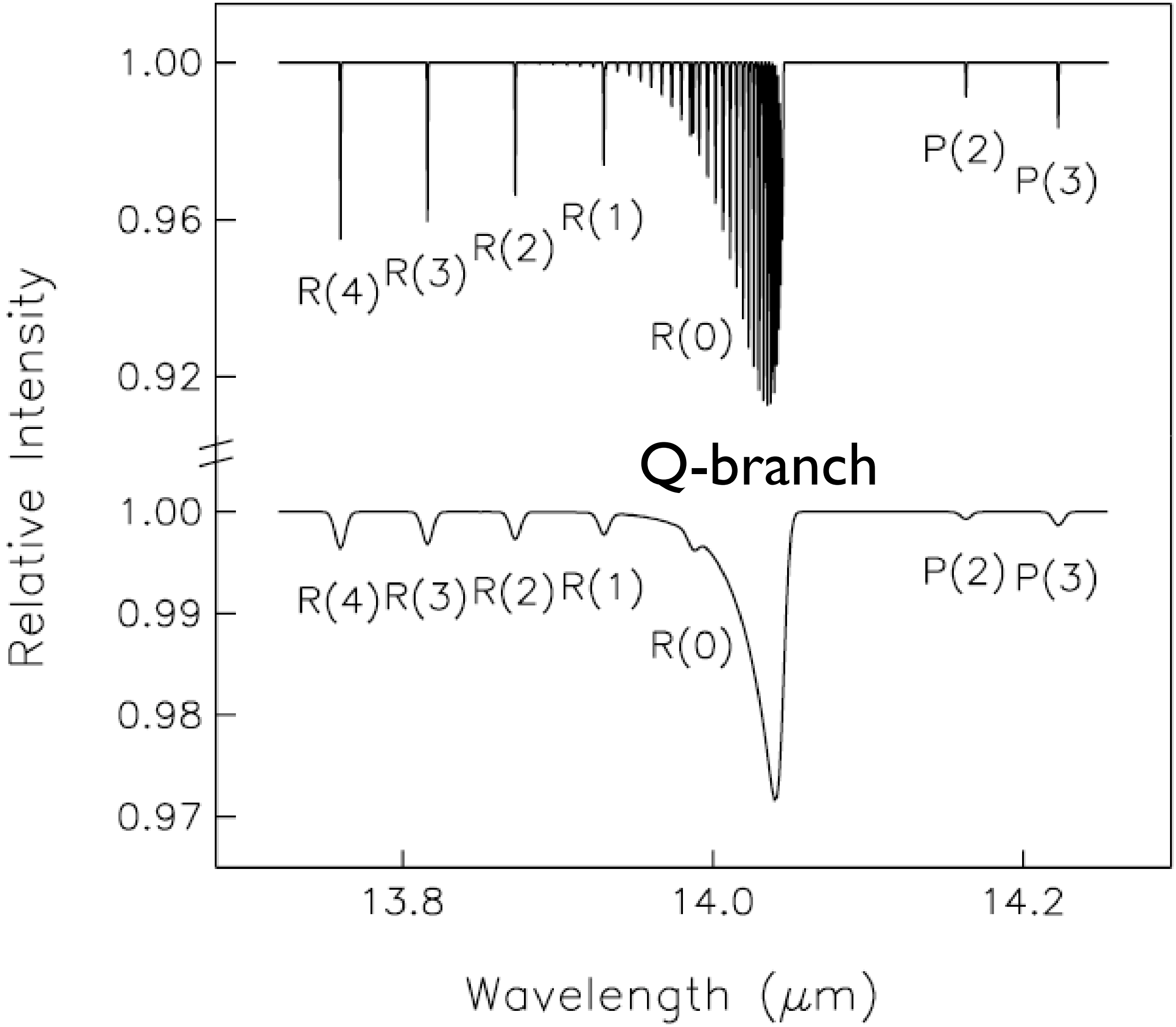
Sample	HCN	C_2H_2
Sun-like stars	13/44	7/44
Cool stars	4 expected 0/14	2 expected 5/14

Different Line Strengths



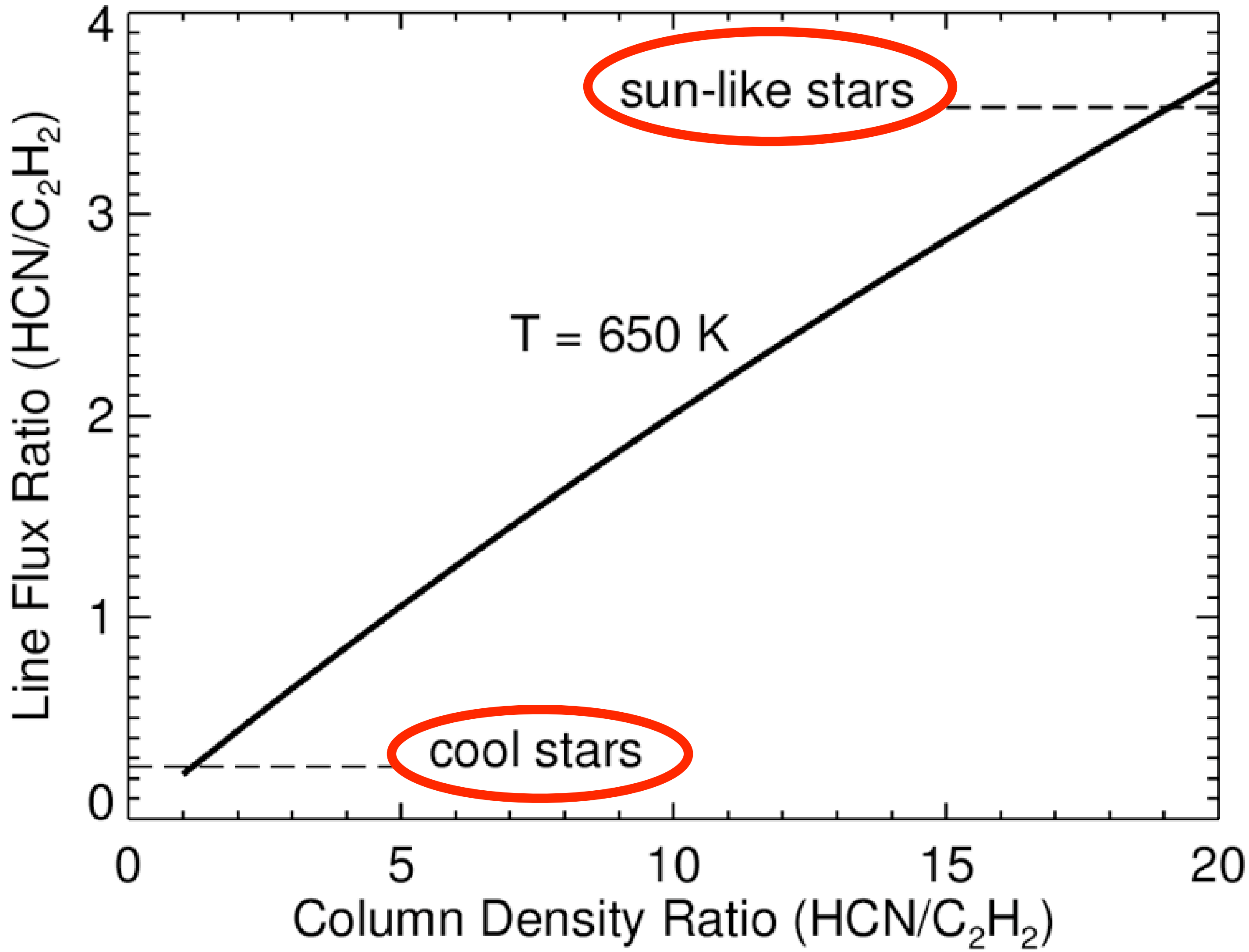
Line flux HCN/C_2H_2 in sun-like stars ~ 18 times that in cool stars

Synthetic Spectra



HCN synthetic absorption spectrum from Lahuis & van Dishoeck 2000

Different HCN/C_2H_2 densities



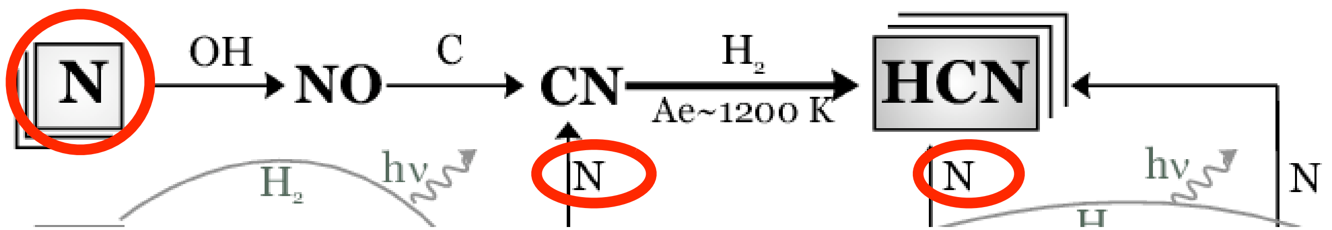
assumption:
$T(HCN) = T(C_2H_2)$

Pascucci et al. submitted

Interpretation

HCN abundance limited by the stellar UV flux

– formation of HCN in the gas phase requires N
– N_2 is likely the most abundant N-bearing molecule
– cool stars have less UV–photons λ < 110 nm to dissociate N_2
– if accretion dominates UV flux ➔ $\Phi_{uv}(TTs)/\Phi_{uv}(BDs) \sim 1{,}000$

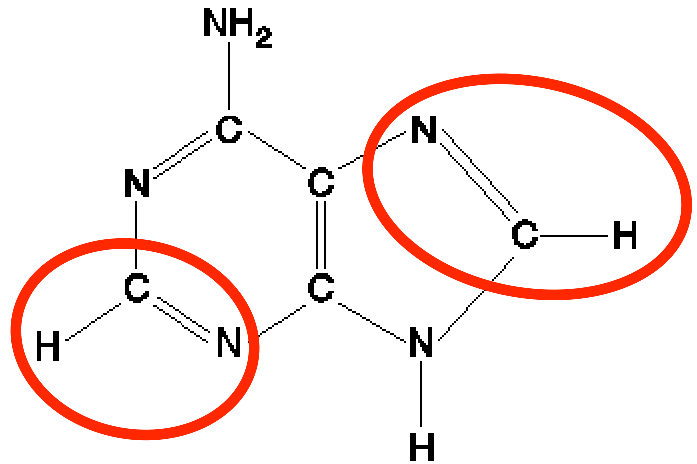


(e.g. Agundez et al. 2008)

Why is HCN interesting?

HCN is the building block of purine nucleobases

Adenine



HCN polymerization under terrestrial conditions

OR

adenine delivery through cometary or meteoritic impacts?

Summary

- First detections of organic molecules in BD disks
- Different detection rate statistics and line flux ratios of HCN and C_2H_2 in disks around sun-like and cool stars
- Lower abundance of HCN in disks of cool stars than in disks of sun-like stars
- Possible explanation:
HCN abundance limited by the stellar UV flux