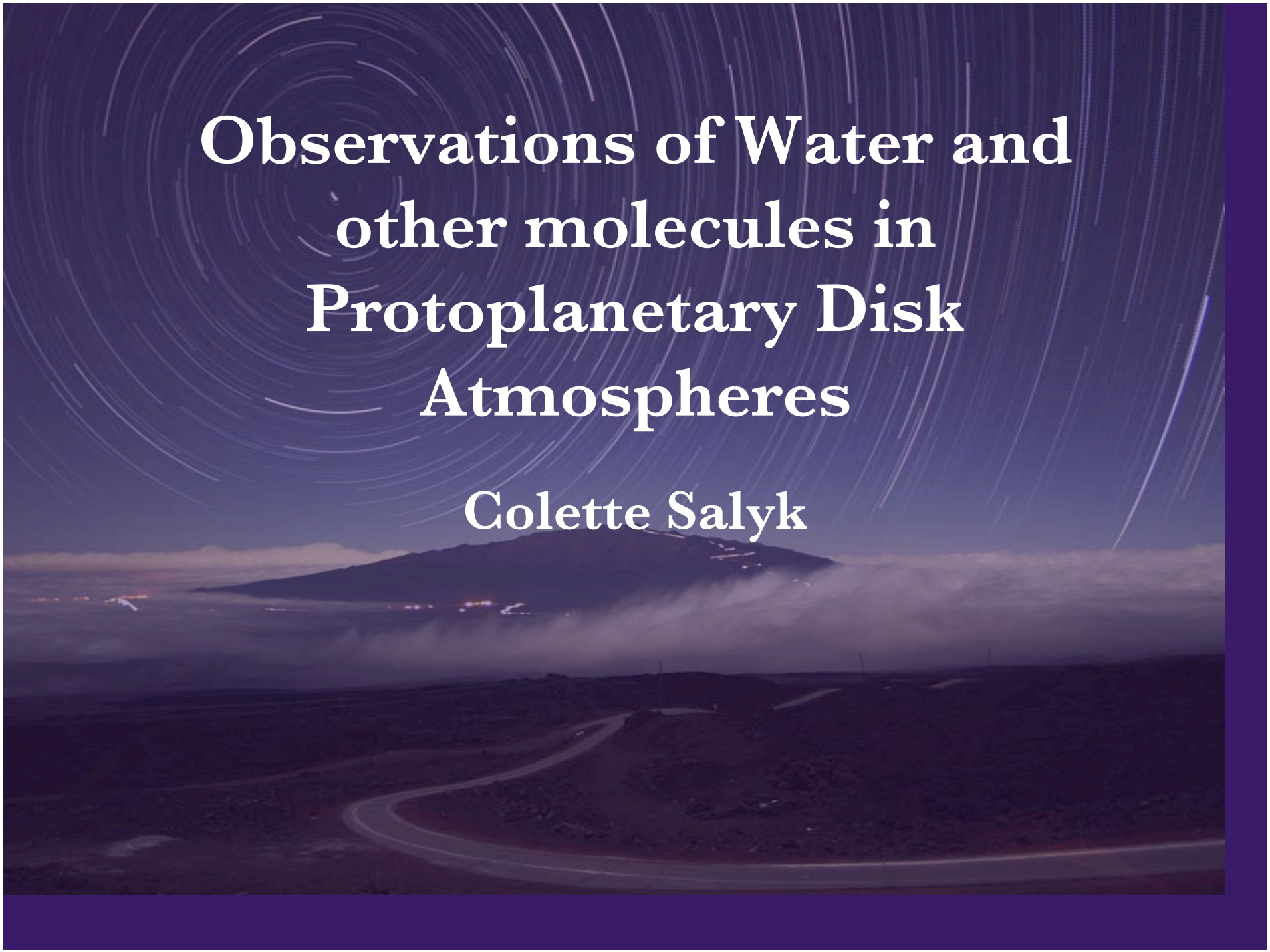
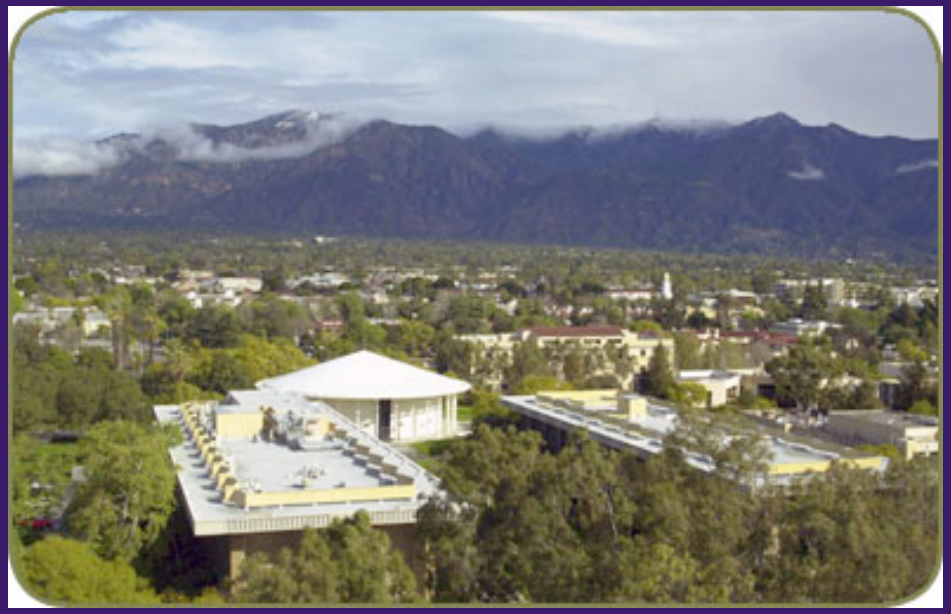


Observations of Water and other molecules in Protoplanetary Disk Atmospheres

Colette Salyk

About me

Recently imported from Caltech



(where I worked with last year's Tinsley visiting professor, Geoff Blake)

About me

I am now a McDonald Observatory Harlan J. Smith Postdoctoral Fellow

You can find me in RLM 15.222 or…

A few of the many unsolved problems in planet formation:

How do small dust grains turn into planetesimals?

What are transport processes like in protoplanetary disks?

How does a thick 'classical' circumstellar disk turn into a debris disk?

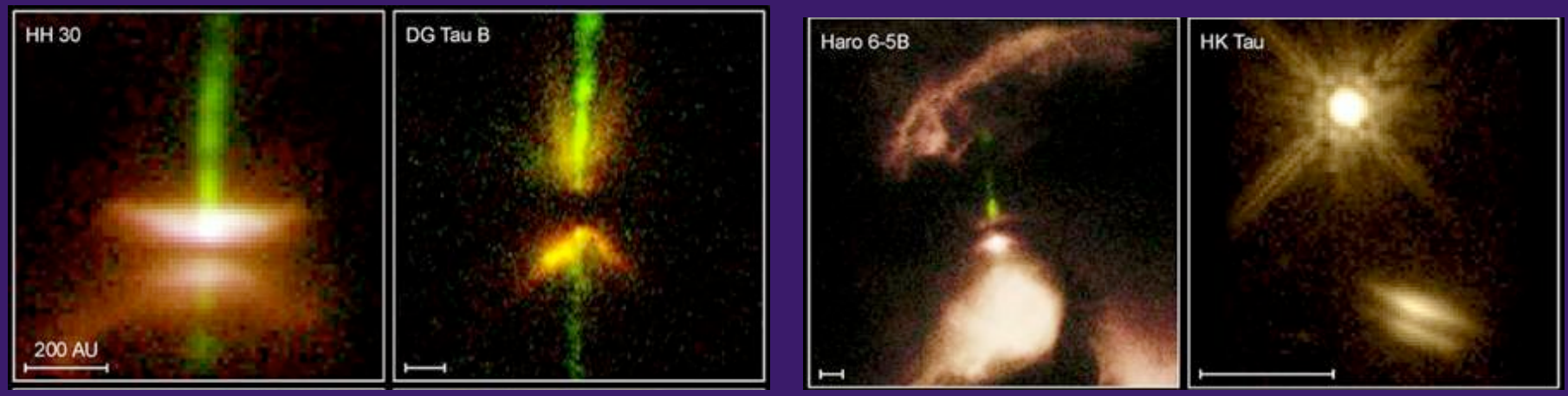
How diverse are planet formation processes and outcomes?

A few of the observational challenges for studying protoplanetary disks:

High opacity impedes view of the inner disk.

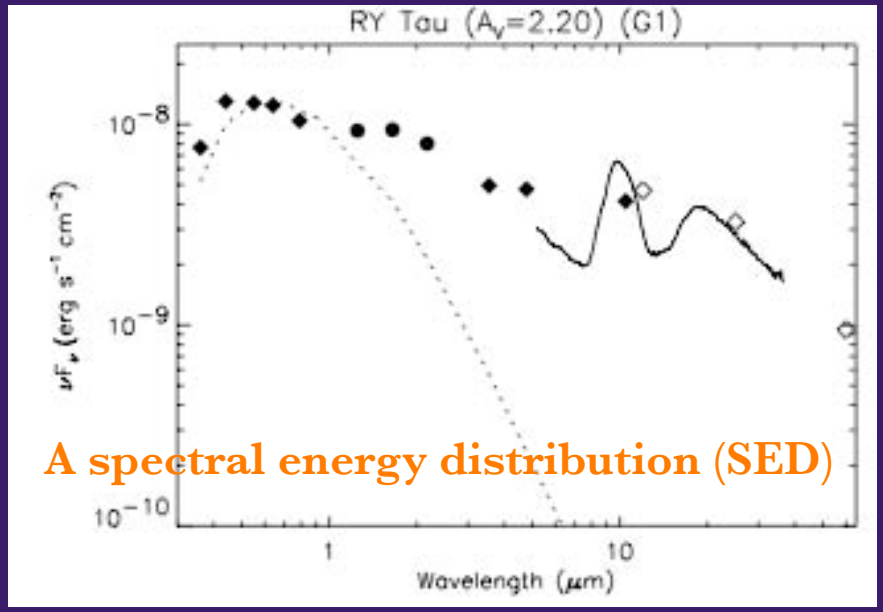
Small scales at large distances make resolution of planet-forming regions difficult.

The bulk of the disk mass is H_2, which is difficult to detect.



How spectroscopy helps:

Disk temperature gradients mean each radius emits at a different wavelength.



A spectral energy distribution (SED)

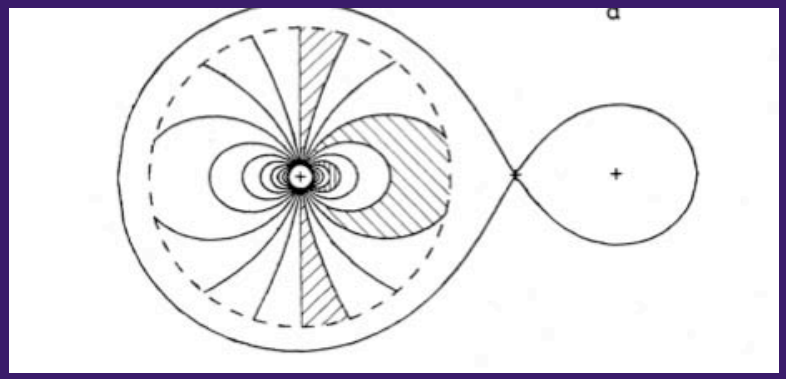
Furlan et al. 2006

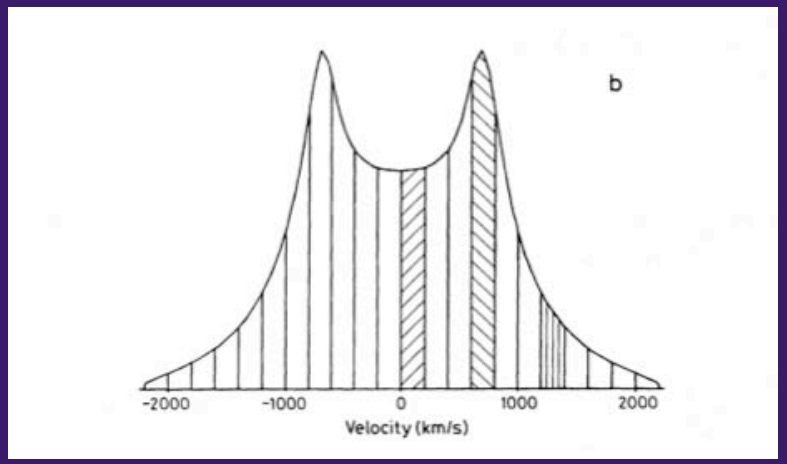
RY Tau from Gemini (APOD)

How spectroscopy helps:

If you look at molecules (atoms) instead:
Every transition probes a particular molecule (atom), and a particular temperature and density regime.

If the lines are spectrally resolved, then they also contain kinematic information. Line broadening typically comes from Keplerian rotation and turbulence.



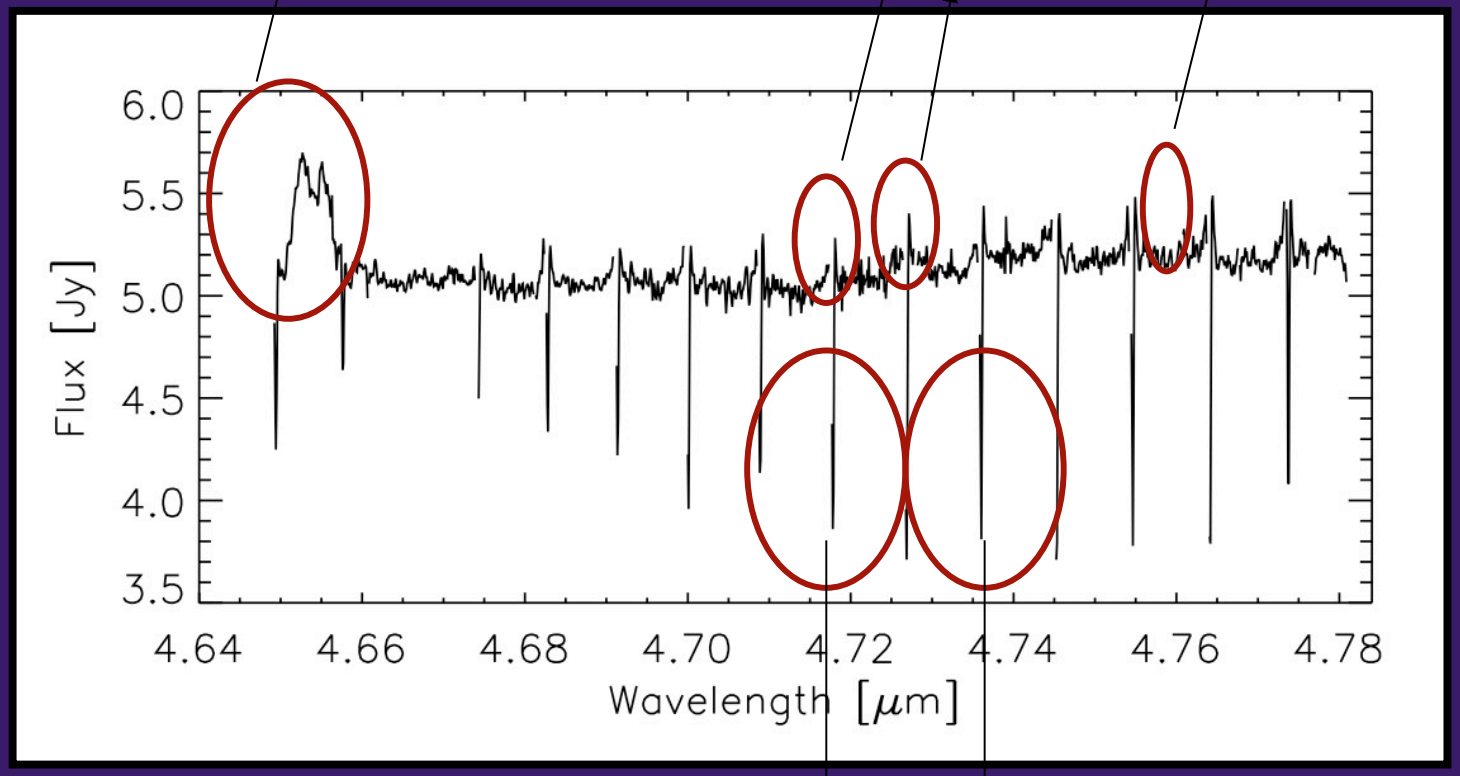


Horne & Marsh 1986

very hot gas
(star-disk boundary)

warm disk gas
(inside 1 AU)

warm disk solids
(inside 1 AU)

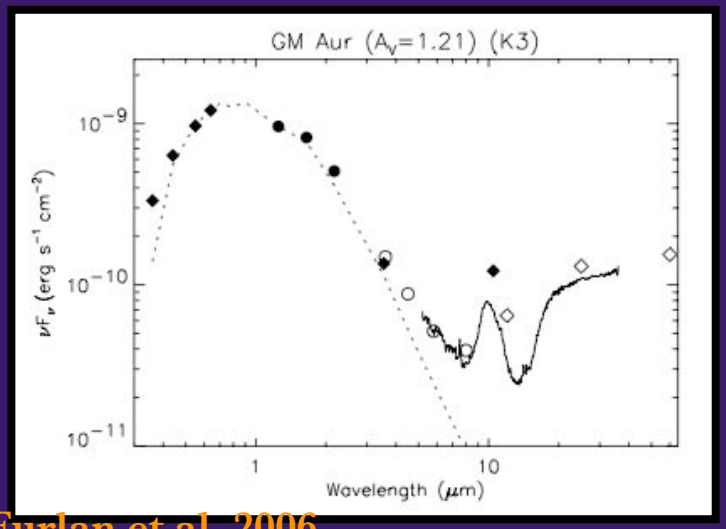


cold cloud gas
(10's - 100's of AUs)

With spectroscopy, the devil is in the interpretation…

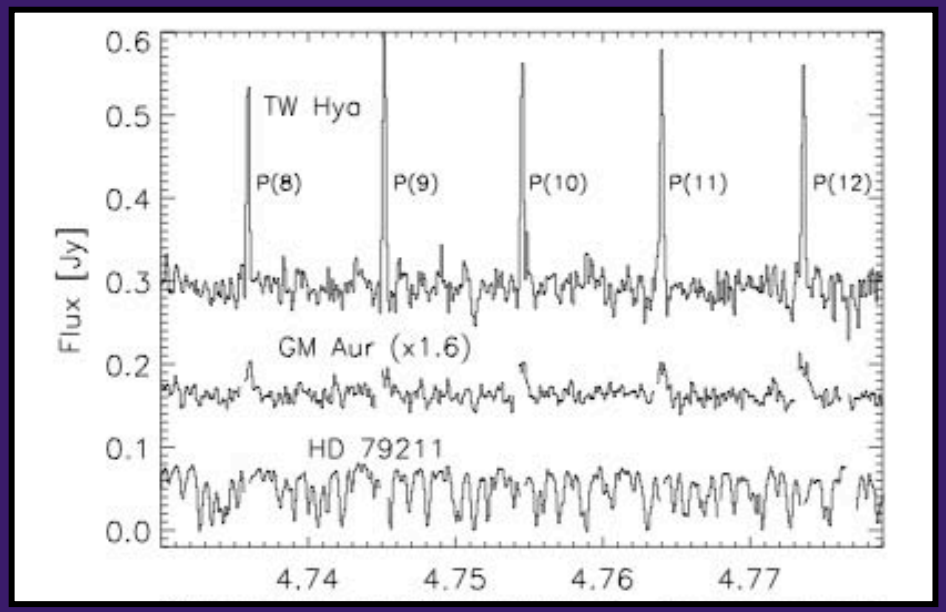
And now for a few interesting results:

Transitional Disks: Disks with planets in formation?



Furlan et al. 2006

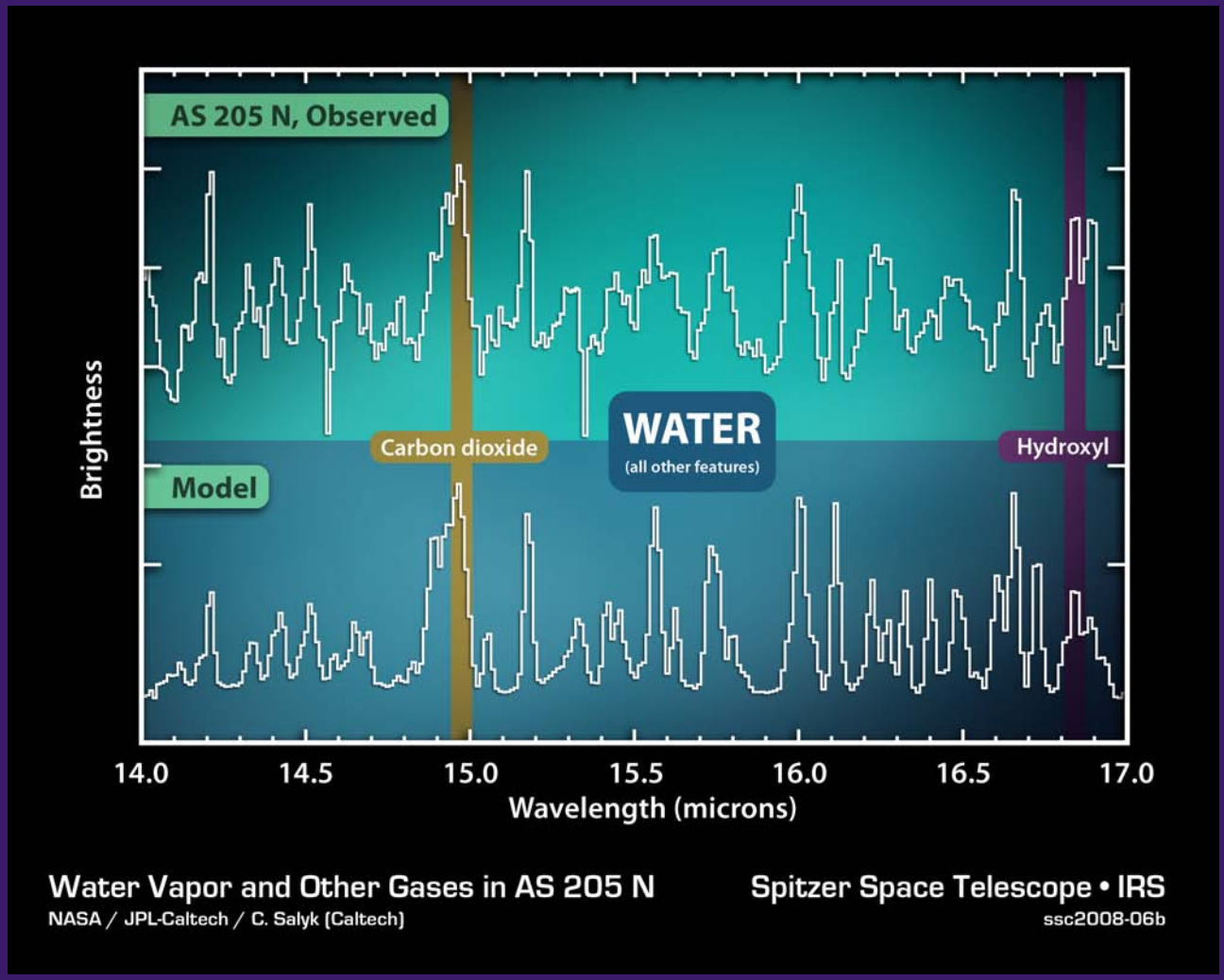
Vertical slice through half of a disk.
Not to scale!



Inner disks have significant amounts of gas (enough to circularize terrestrial planet orbits).

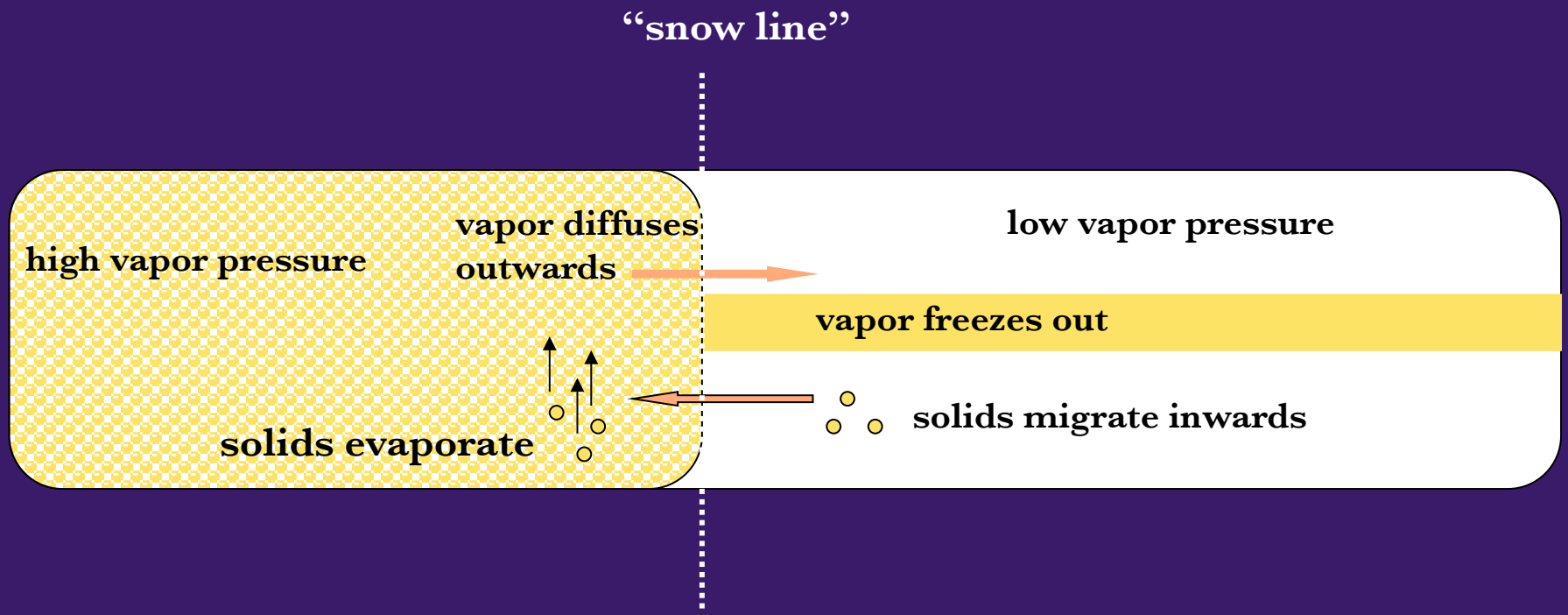
Salyk et al. 2007, 2009

~50-60% of disks around low-mass stars contain water vapor and organics in the ~few AU region



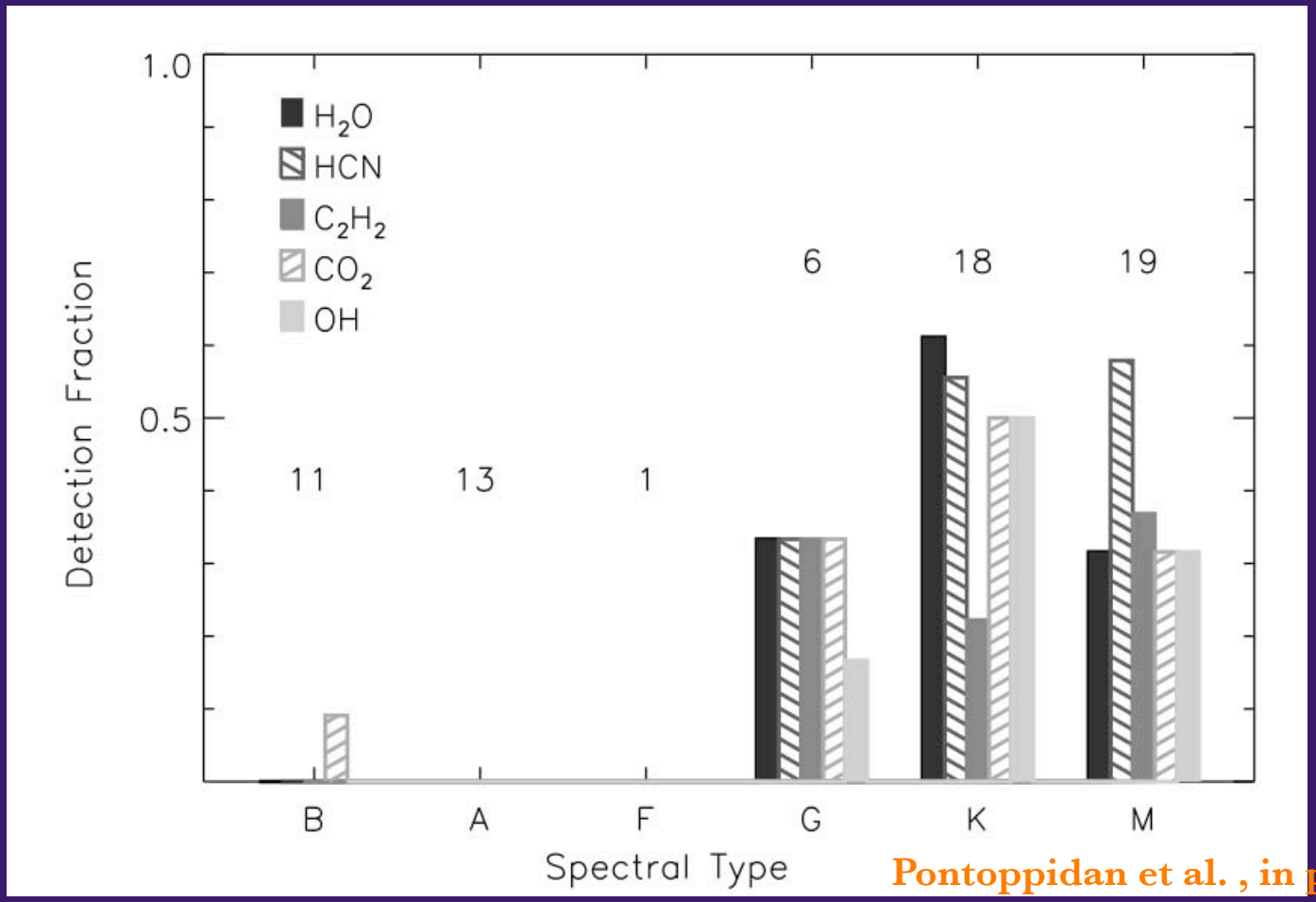
Salyk et al. 2008; Carr & Najita 2008

Observations may require migration of icy planetesimals



e.g. Ciesla & Cuzzi 2006

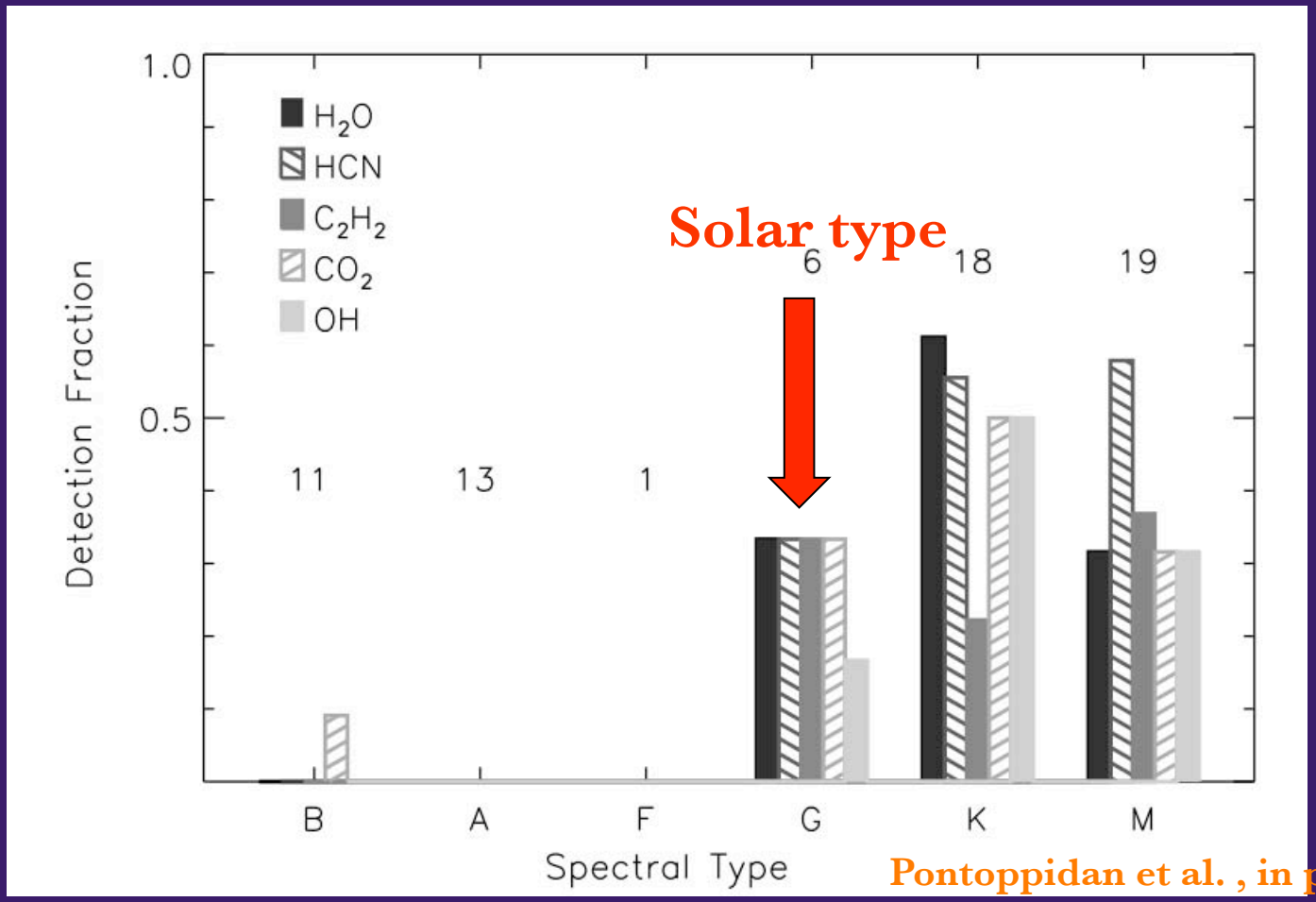
The chemical environment may depend strongly on stellar mas.



Pontoppidan et al. , in prep

Decreasing mass 

The chemical environment may depend strongly on stellar mas.

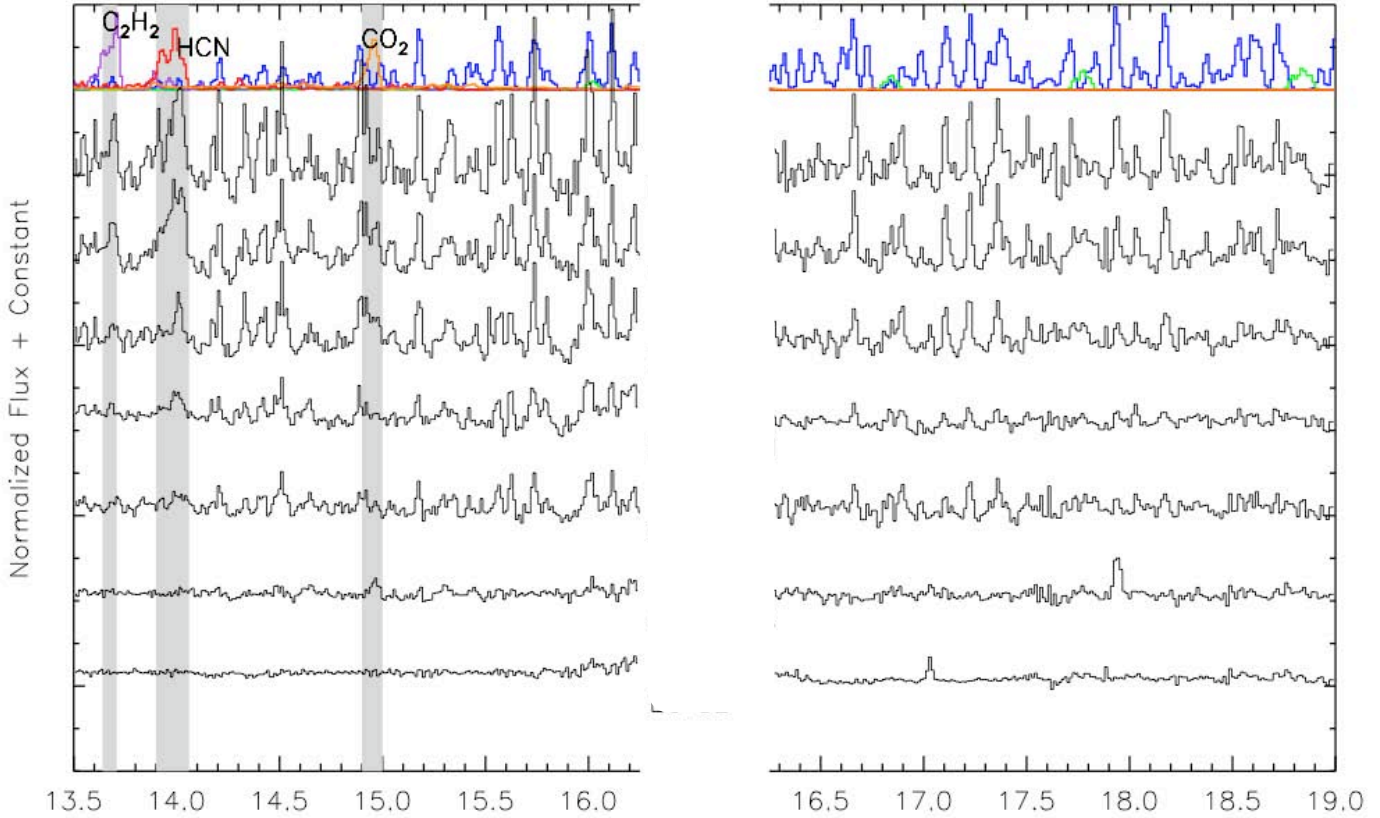


Pontoppidan et al. , in prep

Decreasing mass →

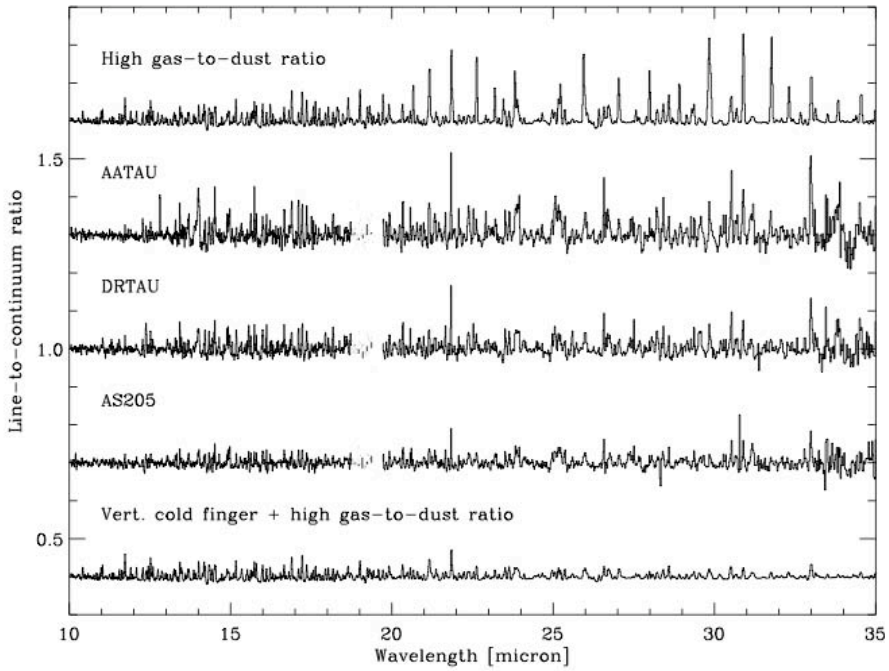
The strength of water emission lines requires a depletion of small grains in the upper atmosphere (grains have grown or settled).

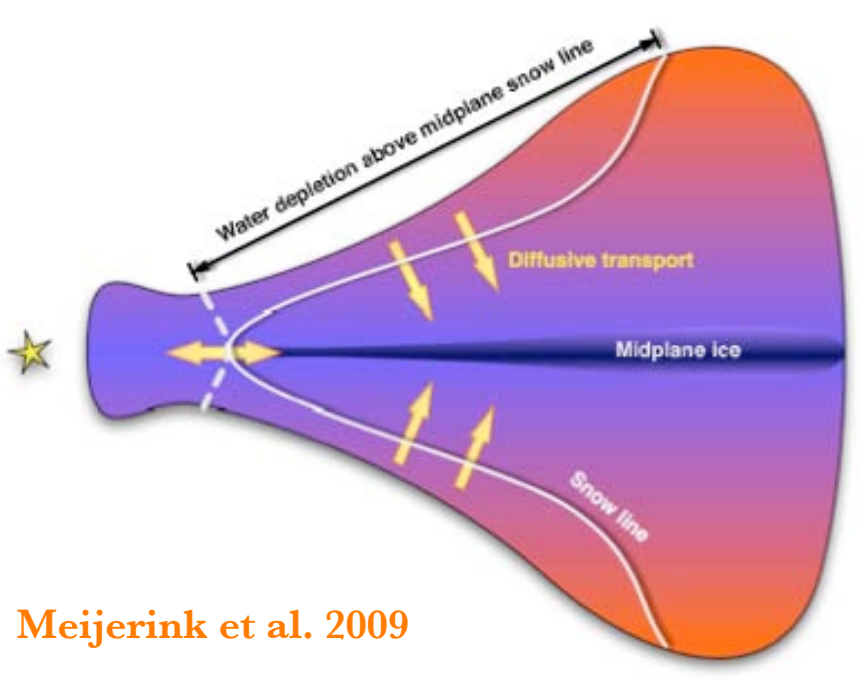
Meijerink et al. 2009



Salyk 2009, PhD thesis

Relative strengths of water emission lines may require depletion of water well-within the canonical ‘snow-line’.





Meijerink et al. 2009

Come talk to me about my current research:

Planet formation
Protoplanetary disk evolution
Infrared spectroscopy

Or topics from past lives:

Dynamics of planetary atmospheres
Earth GCMs
Stellar occultations by planets

Or my hobbies:

Rock climbing
Running
Viola playing