Herschel and some questions on star and planet formation

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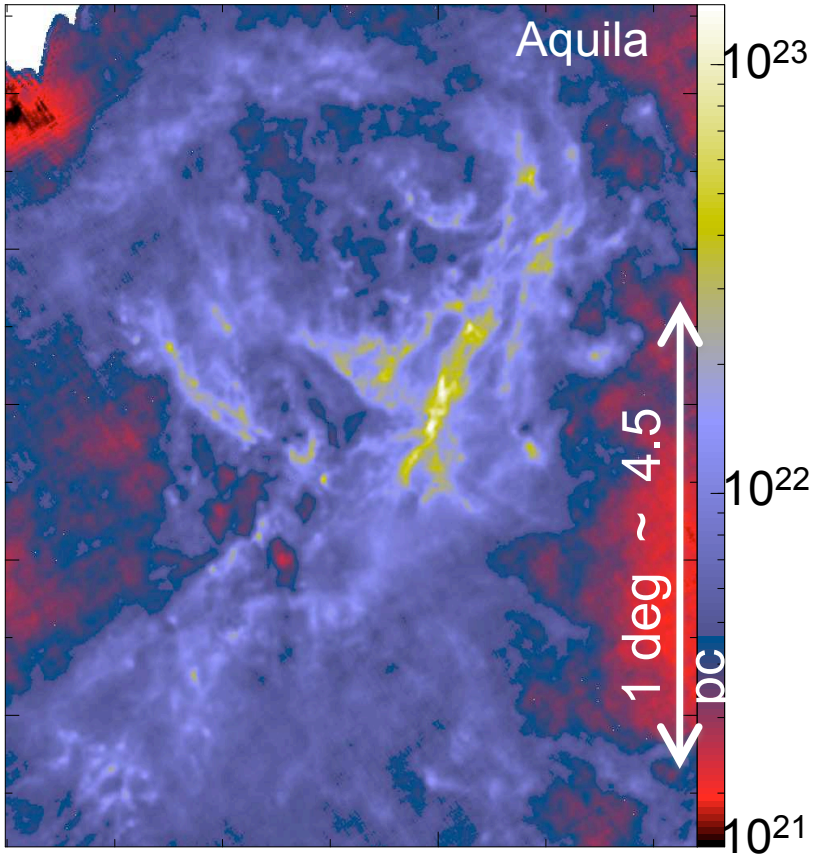
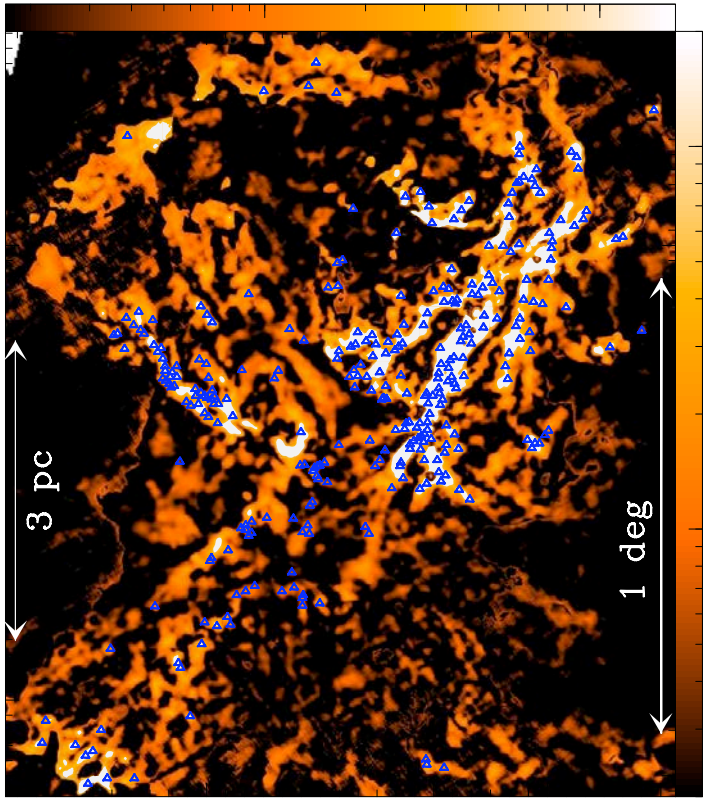
Herschel large surveys: filaments everywhere

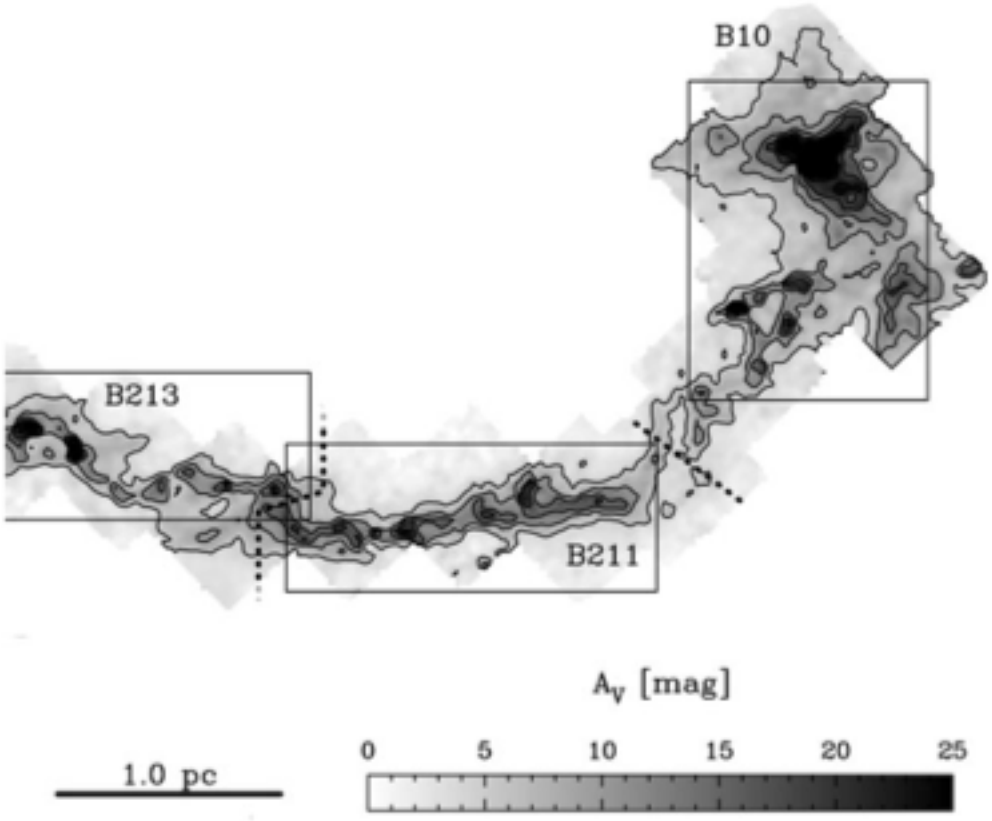




(Könyves et al. 2010; André et al. 2010, A&A vol. 518)

- Filaments - cores - stars
  - In the solar neighborhood the global properties of Star Formation seem to be determined by the cloud structure and fragmentation (rather than feedback?)

Filaments are not so new …



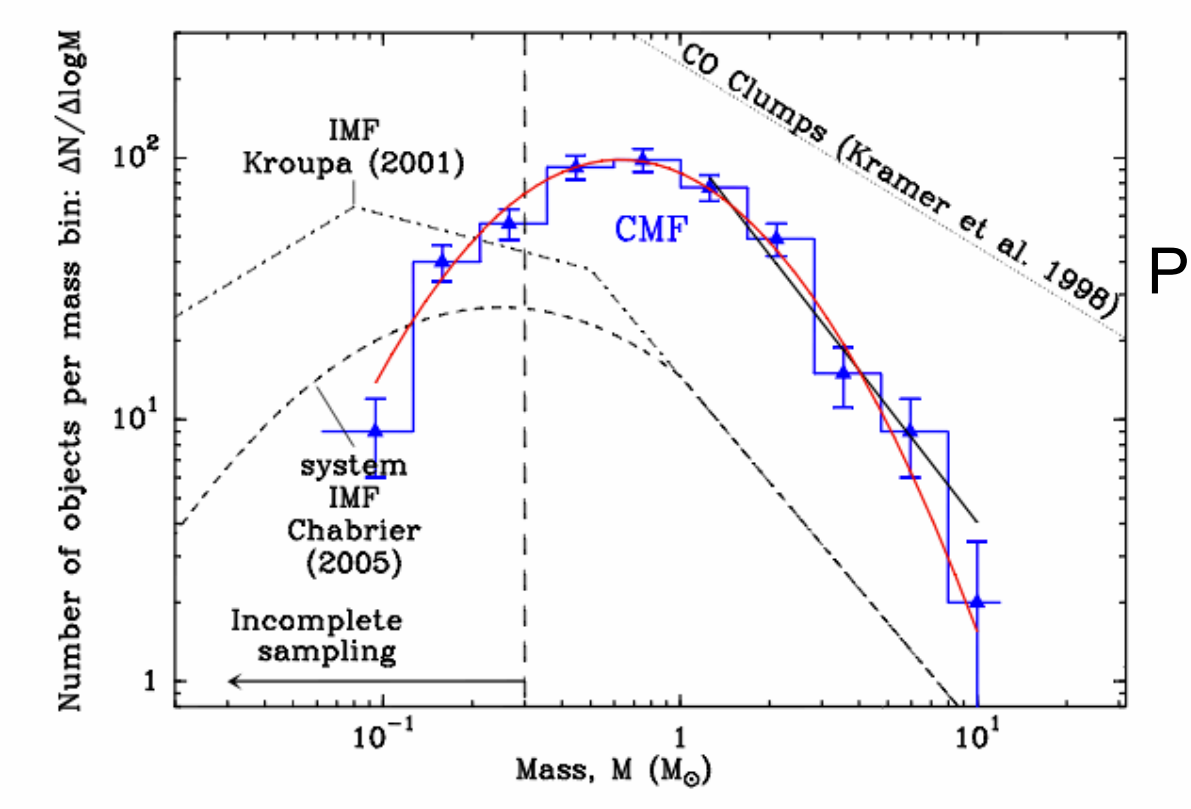
Taurus
extinction map,
Schmalz, Alves et al.

But Herschel does better …

- Filaments with and without dense cores
  - Pipe Nebula (Peretto et al.)
- Clusters where filaments join?
  - Rosette Molecular Cloud (Schneider et al.)

✓Density and temperature filament structure
✓Kinematics
✓Core properties and filamentary structure

CMF consistent with IMF



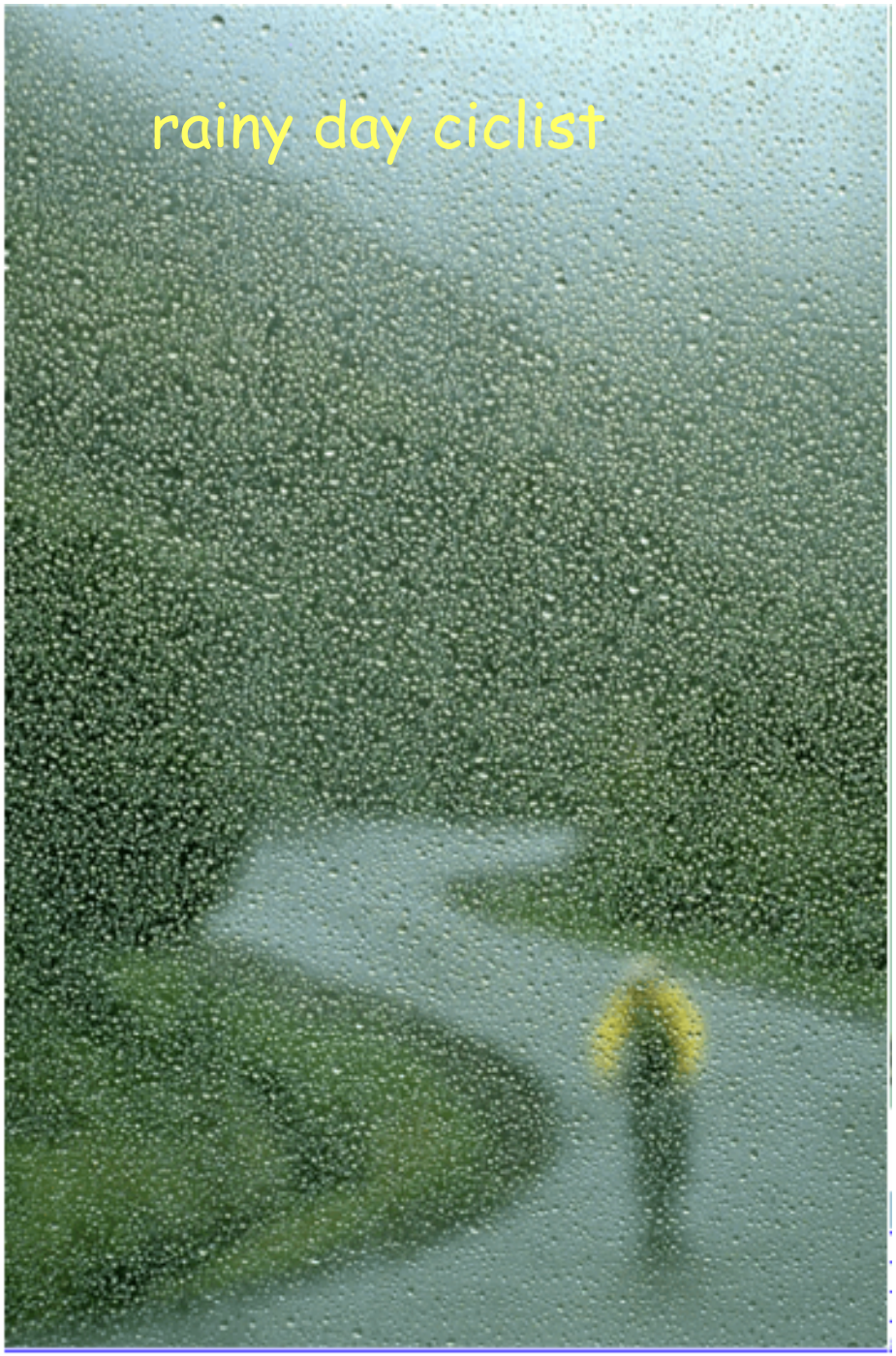
Prestellar CMF in Aquila

(Könyves et al. 2010
André et al. 2010
A&A vol. 518)

- An universal efficiency factor of ~30-40% ?

Water

- Herschel: water is underabundant
  - (ices and freeze-out on grains)
- Detected mostly in shocked regions (outflows)



Outflows/shocks

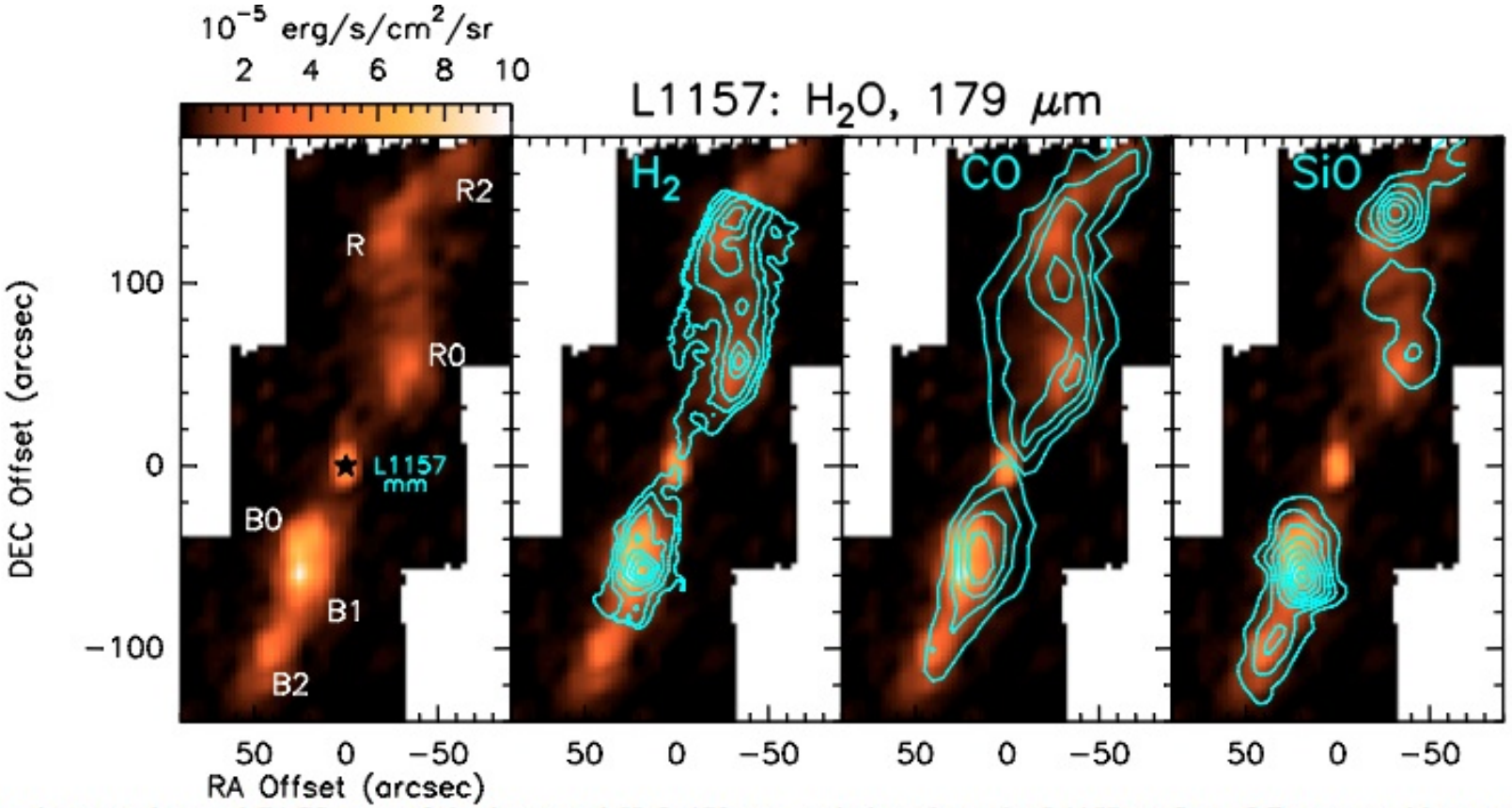


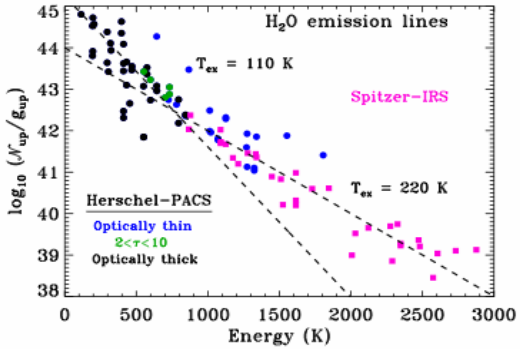
Fig. 1. Continuum subtracted PACS map of the integrated H_2O 179 μm emission along the L1157 outflow. Offsets are with respect to the L1157-mm source, at coordinates $\alpha(2000) = 20{:}39{:}06.2$, $\delta(2000) = +68{:}02{:}16$. The different emission peaks are labelled following the nomenclature adopted by Bachiller et al. (2001) for individual CO peaks. The same map is shown in the other panels with overlays of other tracers, namely H_2 0–0 S(1) at 17 μm (Neufeld et al. 2009), CO 2–1, and SiO 3–2 (Bachiller et al. 2001). The spatial resolution of these images are ~11″, for H_2 and CO, and 18″ for SiO. Note that the H_2 observed region does not cover the B2 and R2 shocked peaks.

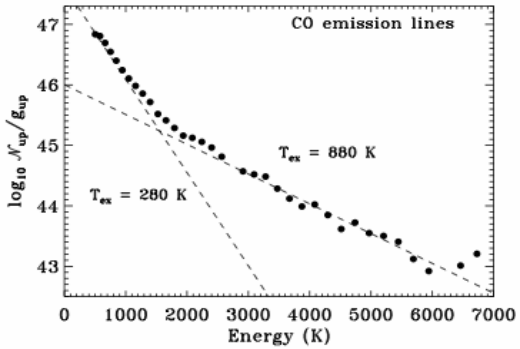
Nisini et al. 2010

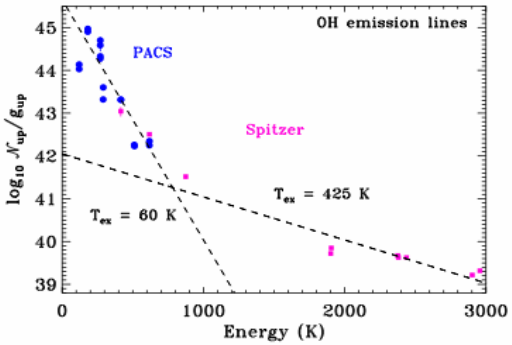
Not just water

- Excitation diagrams

NGC 1333 IRAS 4B



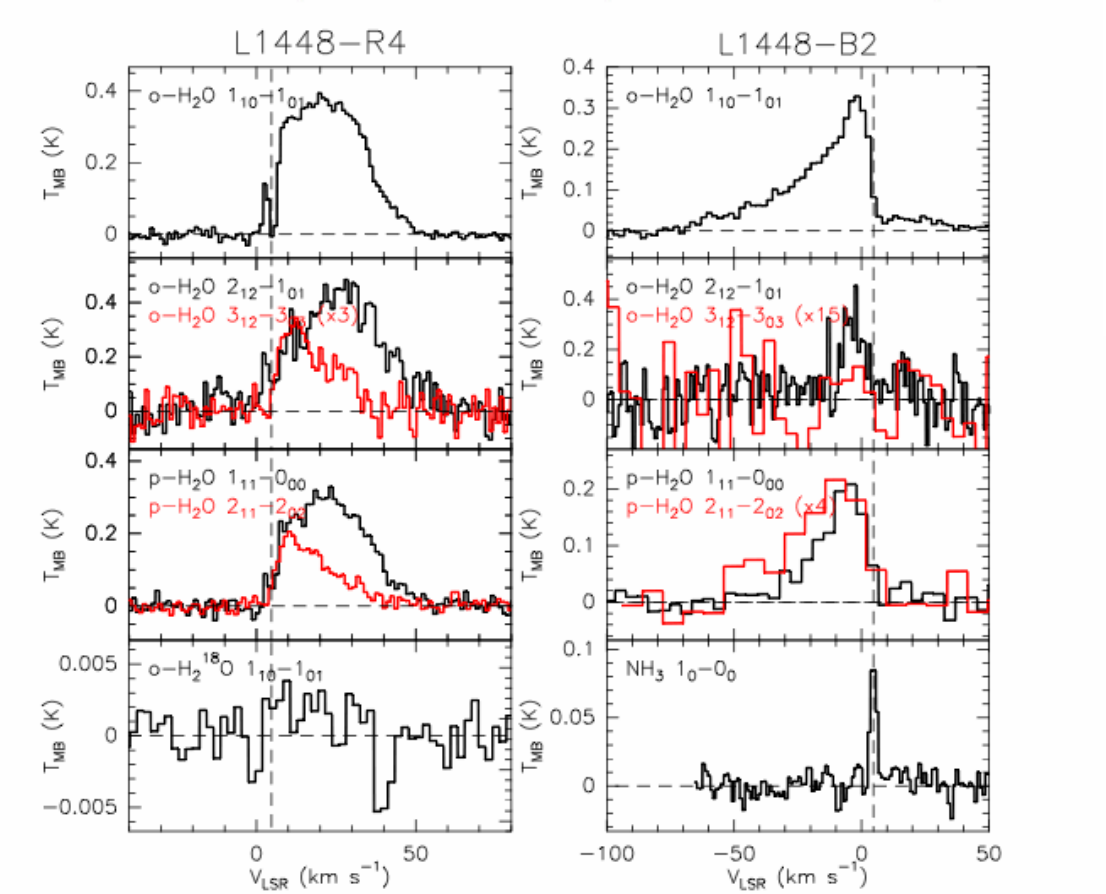




Herczeg et al. 2012

All the known heating mechanisms
… and possibly some more

HIFI high-res line profiles



Santangelo et al. 2012

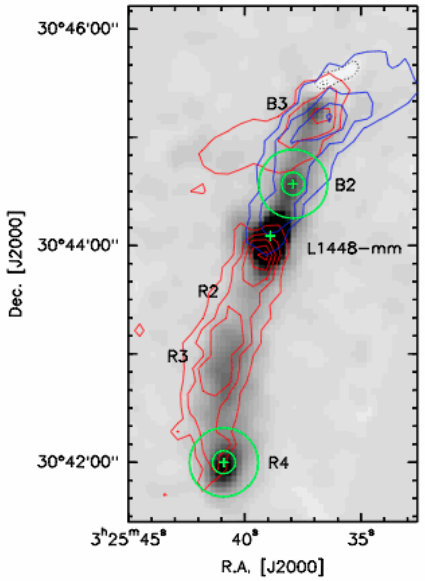


Fig. 1: PACS image of L1448 at 1670 GHz in false colors, with the negative contours in dotted line, and the JCMT CO(3-2)

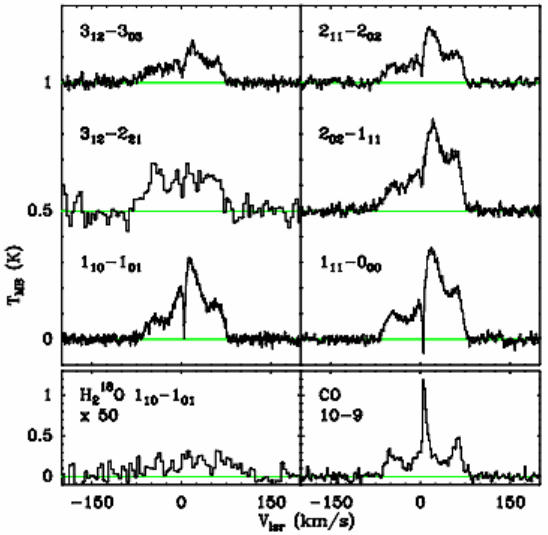


Fig. 1. Continuum-subtracted HIFI H_2O, $H_2^{18}O$ and CO spectra obtained at the central position of L1448-MM (v_{source} = 5.2 km s^{-1}).

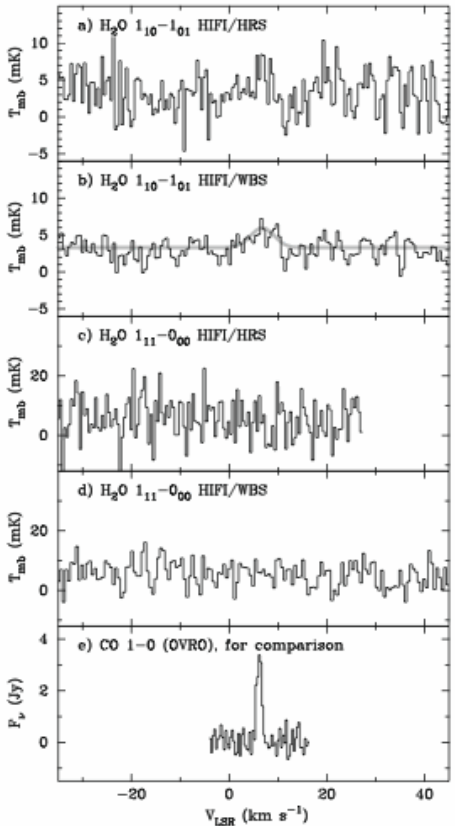
Kristensen et al. 2011

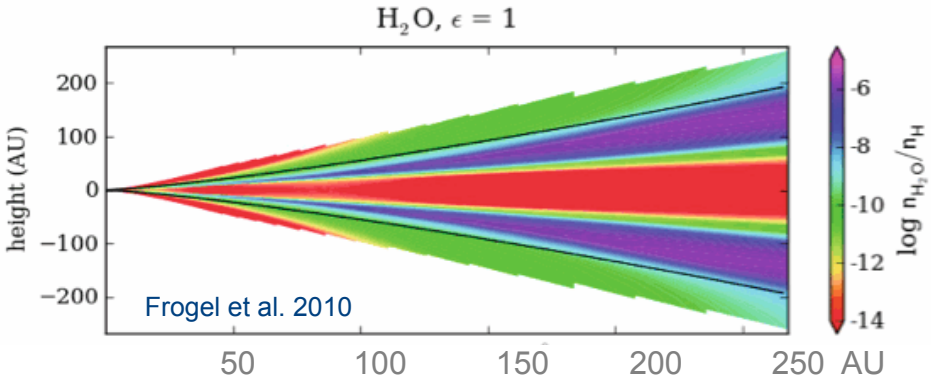
An explosion of data!

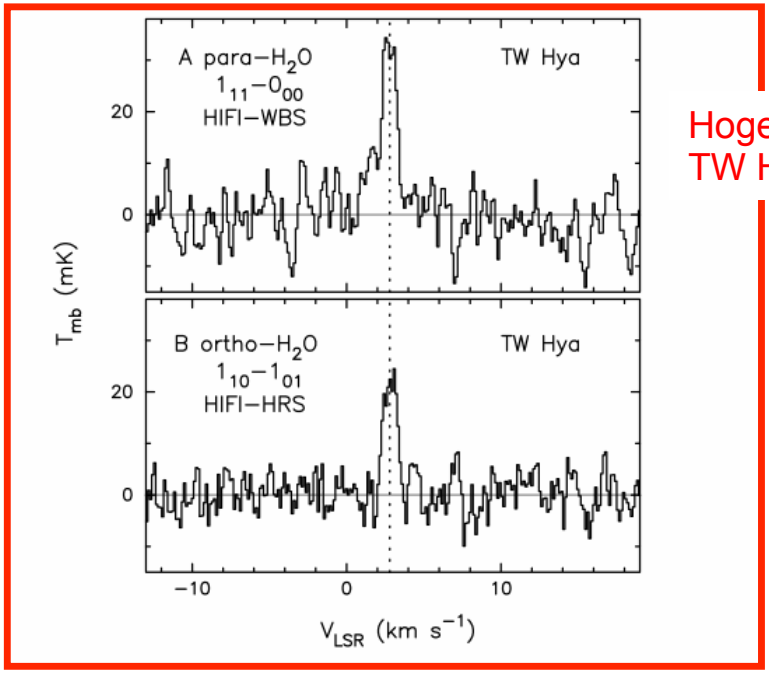
- Can we measure the ouflow efficiency in preventing matter from collapsing?
  - The factor 3 between core mass function/ stellar mass IMF
- As function of core mass, core environment, etc?

Protoplanetary disks: much less fun with chemistry!

Bergin et al. 2010 DM Tau







Hogererheijde et al. 2011
TW Hya

The only strong line: [OI] 63.3 mic

[CII], OH,
some (weak) H2O, etc

Riviere-Marichalar et al 2012:
68 Classical and Weak-line TTS in Taurus
33 have [OI] 63.2 mic emission,
8 tentative H2O at 63.3mic

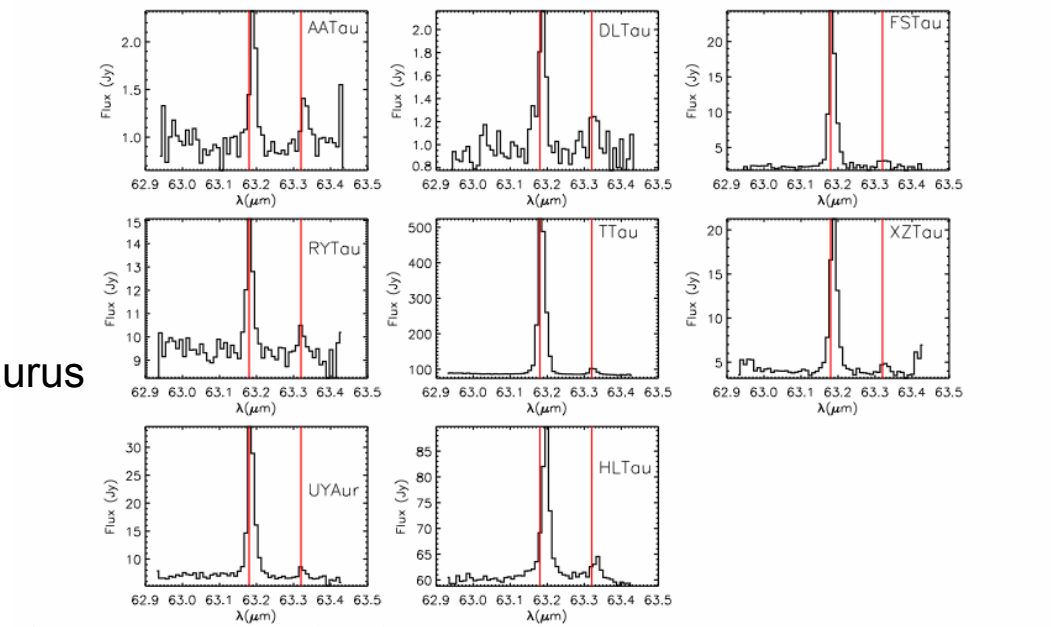


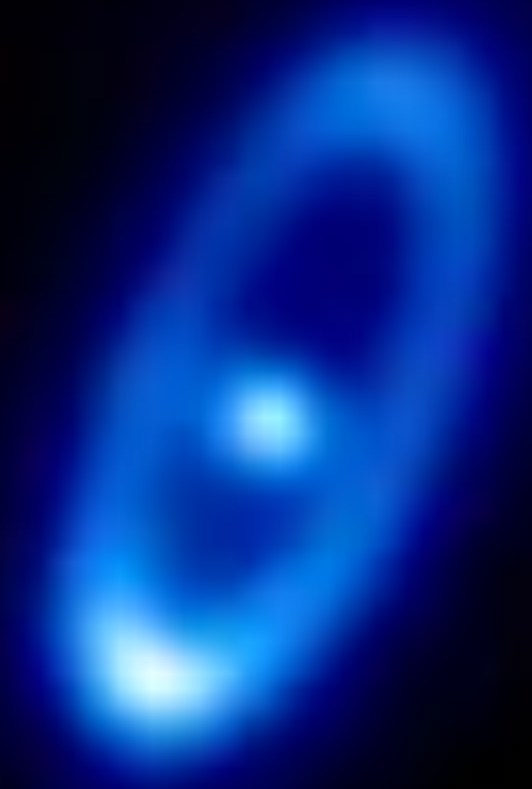
Fig. 1. Spectra for the objects with a 63.32μm feature detection (> 3σ). The red lines indicate the rest wavelength of the [O I] and o-H_2O emission.

- Will we get robust measurements of the disk gas mass?

Debris Disks

- Photometric surveys
  - Statistics, discovery of cold disks
  - Imaging of some disks, disk structure
- Gas Spectroscopy (OI, CII)
  - From vaporization of colliding grains
  - Beta Pic: O/C cosmic (Brandeker et al. 2011)

Fomalhaut



Acke et al., in press

Remarks:

- Central component too bright
- Region inside the ring is not empty
- Star is off-center
- Ring is very smooth
- Outer region is extended
- S side brighter

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- Dust properties

Dust composition and evolution

- Diffuse ISM
- Molecular clouds/cores
- Proto-planetary disks of various age
- Debris disks of various age

ISO discovery of cristalline silicates in HAe stars

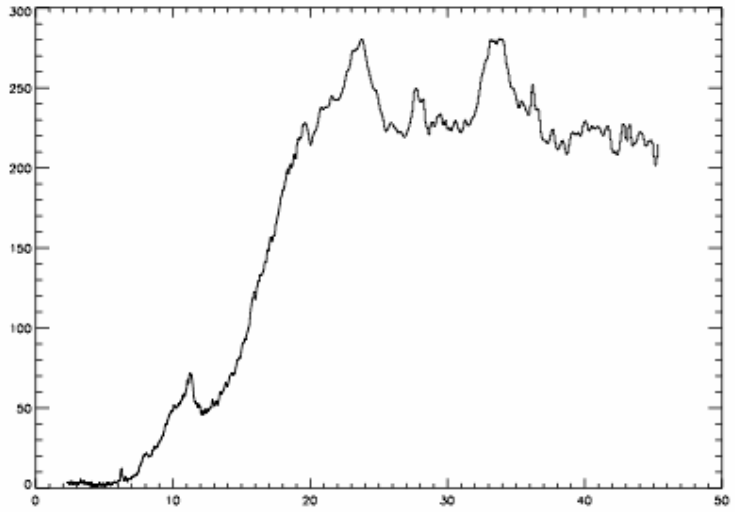


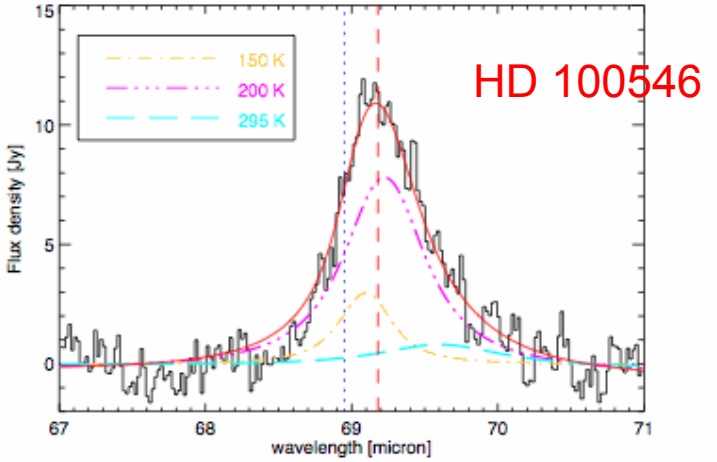
Fig. 3. The full SWS spectrum of HD 100546. Wavelengths on the abscissa are in μm, fluxes on the ordinate are in Jy.

ISO, Waelkens, Water, et al. 1996, HD100546

Herschel: dust features in the far-IR

- HD100546: the forsterite crystals contain at most a few percent iron by mass - Sturm et al. 2010

- Beta Pic: crystalline olivine grains contain 2-3% iron in mass (69 mic band)- De Vries et al. (2011, Toledo)



Sturm et al. 2010

- Where is the iron?

Let’s start!