Herschel and some questions on star and planet formation

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Herschel large surveys: filaments everywhere

- 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?)

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

- An universal efficiency factor of \( \sim 30\%-40\% \)?
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$_2$O 179 $\mu$m 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 $\mu$m (Neufeld et al. 2009), CO 2–1, and SiO 3–2 (Bachiller et al. 2001). The spatial resolution of these images are $\sim$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

Kristensen et al. 2011

Fig. 1. PACS image of L1448 at 1670 GHz in false colors, with the spectral ranges in dashed line, and the KMA (KMS7).

Fig. 1. Continuum-subtracted HIFI H$_2$O, H$_3^+$ and CO spectra obtained at the central position of L1448-MM ($v_{\text{lsr}} = 5.2$ km \( s^{-1} \)).
An explosion of data!

• Can we measure the outflow 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

Frogel et al. 2010

Hogerheijde 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

- 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)
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

Fomalhaut

Acke et al., in press
Debris Disks

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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 crystalline silicates in HAe stars

Fig. 3. The full SWS spectrum of HD 100546. Wavelengths on the abscissa are in \( \mu m \), fluxes on the ordinate are in $Jy$.

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)

• Where is the iron?
Let’s start!