PRISMAS results and suggestions for ALMA

The impact of Herschel surveys on ALMA Early Science. Garching, 16-19 November 2010

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PRISMAS (*PRobing InterStellar Molecules with Absorption line Studies*) is a comprehensive spectroscopic study of hydrides and carbon clusters in the diffuse interstellar medium.

Goals of the programme:

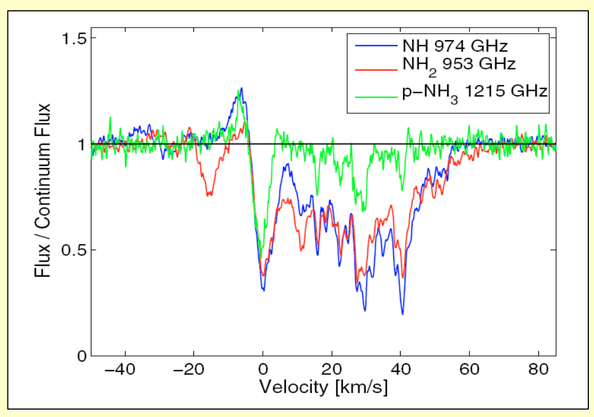
- To address the role of high temperature chemical reactions in the formation of interstellar molecules.
- To understand how such reactions might be driven.
- To investigate the role of grain surface reactions in interstellar chemistry, and the growth of carbon molecules.
- To study both emission and absorption intrinsic to the target sources and the multiple absorption components from foreground clouds.

Observing strategy:

- High-resolution HIFI spectroscopy of 25 molecules and full spectral scans with PACS towards 7 high-mass star formation sources and Sgr A+50 cloud.

A number of papers showing the first results have been published in the A&A Herschel and HIFI special issues.

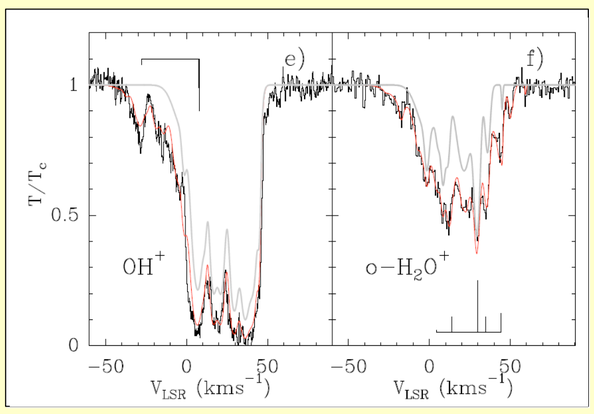
NH, NH_2, NH_3



- Multiple hyperfine components.
- Similar figures in the NH, NH_2 and NH_3 integrated column densities within a factor 2.
- No detection of NH^+.
- No good explanation with state of the art models. Nitrogen chemistry needs to be revised.

Persson, C. et al. 2010, A&A 521, 45

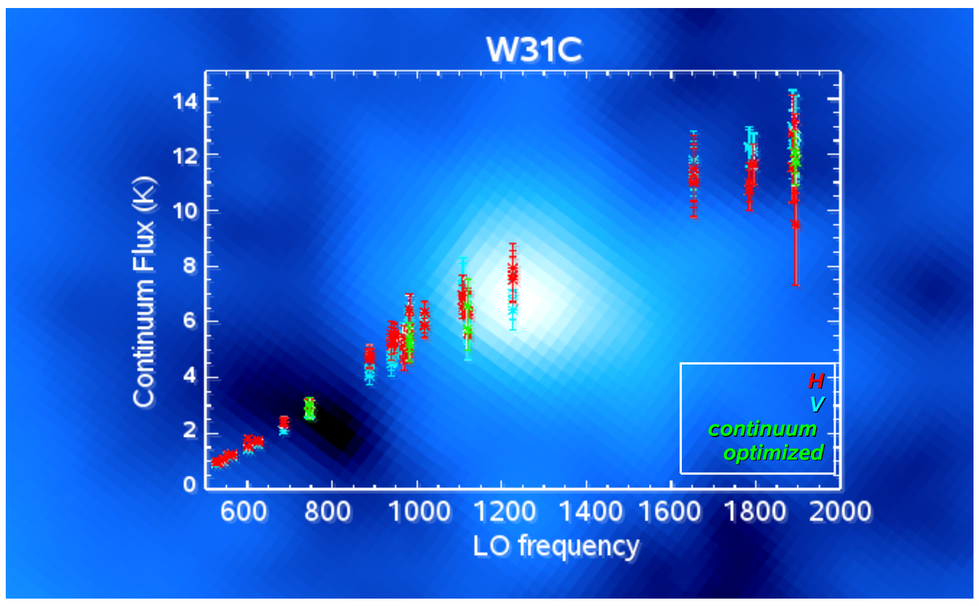
OH^+ and H_2O^+



- OH^+, H2O$^+$ and H_3O^+ trace the gas phase route to H_2O. Strong confirmation of the validity of the chemical network.
- o-H_2O+ at 1.115 THz: strong absorption in diffuse ISM and in massive YSO outflows.
- OH^+ and H_2O^+ not well correlated with CH.
- High OH^+/H_2O^+ (> 4):
  - They trace a phase with a small H_2 fraction.
  - New probe of Cosmic Ray ionization rate.

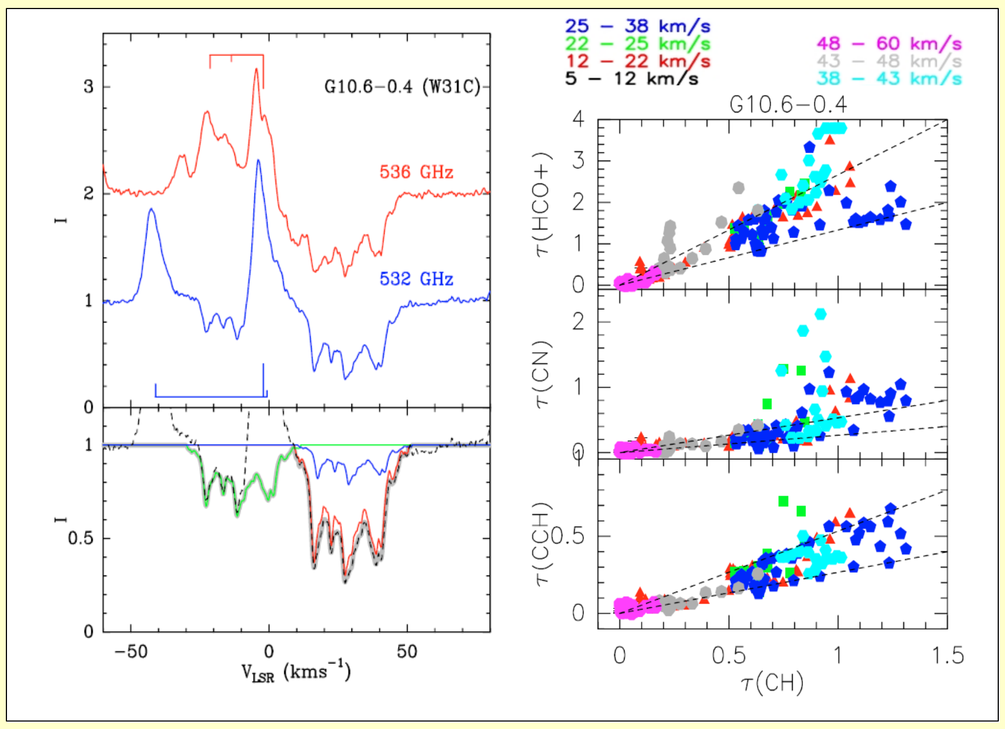
Gerin, M. et al. 2010, A&A 518, 110

Neufeld, D. et al. 2010, A&A 521, 10



Herschel-HIFI continuum emission measurements of the Galactic star forming region W31C (G10.6-0.4). Background: SHARC 850 GHz map.

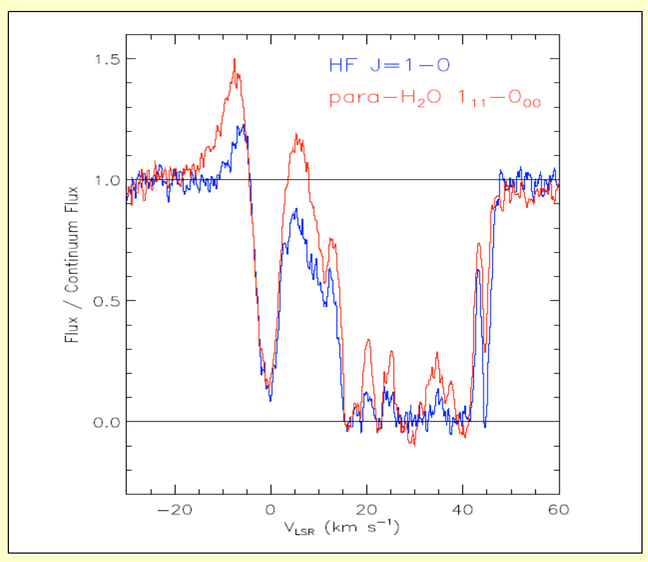
CH



- Complex line profiles: combined emission and absorption.
- Linear scaling with other molecules (HCO^+, H_2O, HF) implies constant abundant ratios.
- Deviations from linearity found in narrow velocity intervals.

Gerin, M. et al. 2010, A&A 521, 16

HF and H_2O



- Exothermic reaction of Fluorine with H_2, making HF.
- HF uses most of the gas phase F
- HF reveals H_2.
- HF is present even in clouds with no detectable CO or H_2O.
- $\tau_{HF} > \tau_{H2O}$.
  - $HF/H_2 \sim 1\text{-}3 \cdot 10^{-8}$; $F/H \sim 1.8 \cdot 10^{-8}$

Neufeld, D. et al. 2010, A&A 518, 108

Sonnentrucker, P. et al. 2010 A&A 521, 12

Other PRISMAS results

- Strong CH+ absorption reaching saturation, in agreement with Turbulent Dissipation Region (TDR) models (talk by E. Falgarone) *(Godard, B. et al. 2009 A&A 495, 847)*
- o-/p-$H_2O \sim 3$ for most velocities *(Lis, D. et al. 2010 A&A 521, 26)*;
  - ~ 2 - 2.5 in narrow velocity intervals *(Goldsmith, P. et al.in prep.)*
- C_3 detected in the envelope of massive star forming regions, both emission and absorption *(Mookerjea, B. et al. 2010 A&A 521, 13)*

ALMA

Local Universe: small scale structures of diffuse ISM in absorption (e.g.: $^{13}CH^+$, OH^+).

ISM in external galaxies:

- HF and CH as probes of H_2 column density: $\tau_{HF} \sim N_{H2} \cdot 10^{-20}$, $\tau_{CH} \sim N_{H2} \cdot 10^{-21}$ (for dv=1km/s).
- Expected strong OH^+ and H_2O^+ features in the spectra of distant galaxies, where elevated fluxes of ionizing radiation are produced by active nuclei and intense star-formation activity.
- Different molecules will be observable from the ground at different redshifts depending on ALMA bands frequency ranges (e.g.: HF at z>0.3, CH at z>0.06, OH^+ at z>0.02, H_2O^+ at z>0.17).

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