Science & Technology
Facilities Council
UCL
Galactic and Extragalactic
Chemistry with SPICA
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&
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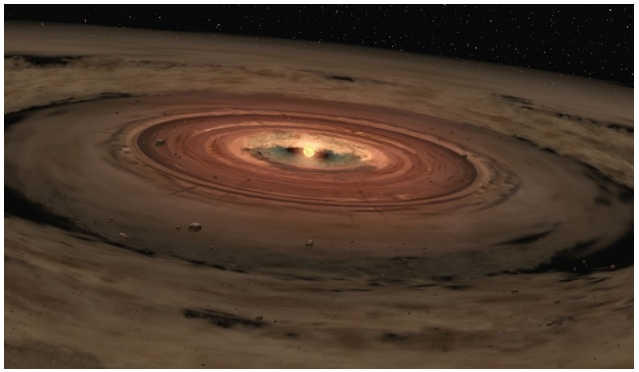
Unique Science with SPICA:

- Dust life cycle:
  - Organic chemistry: PAHs (not revisited since ISO!)
  - ISM Physics: Dust (Ward-Thompson's talk)
  - Ice composition (Helen Fraser's talk)

- Spectroscopy: hydrides!!!
  - HD, H2O, H2, OH, NH, NH2

- C(+), N and O probe:
  - gas physical conditions (density, temperature, UV field)
  - turbulence (kinematics of the PDR layer)

HD (@112μm): best gas mass tracer



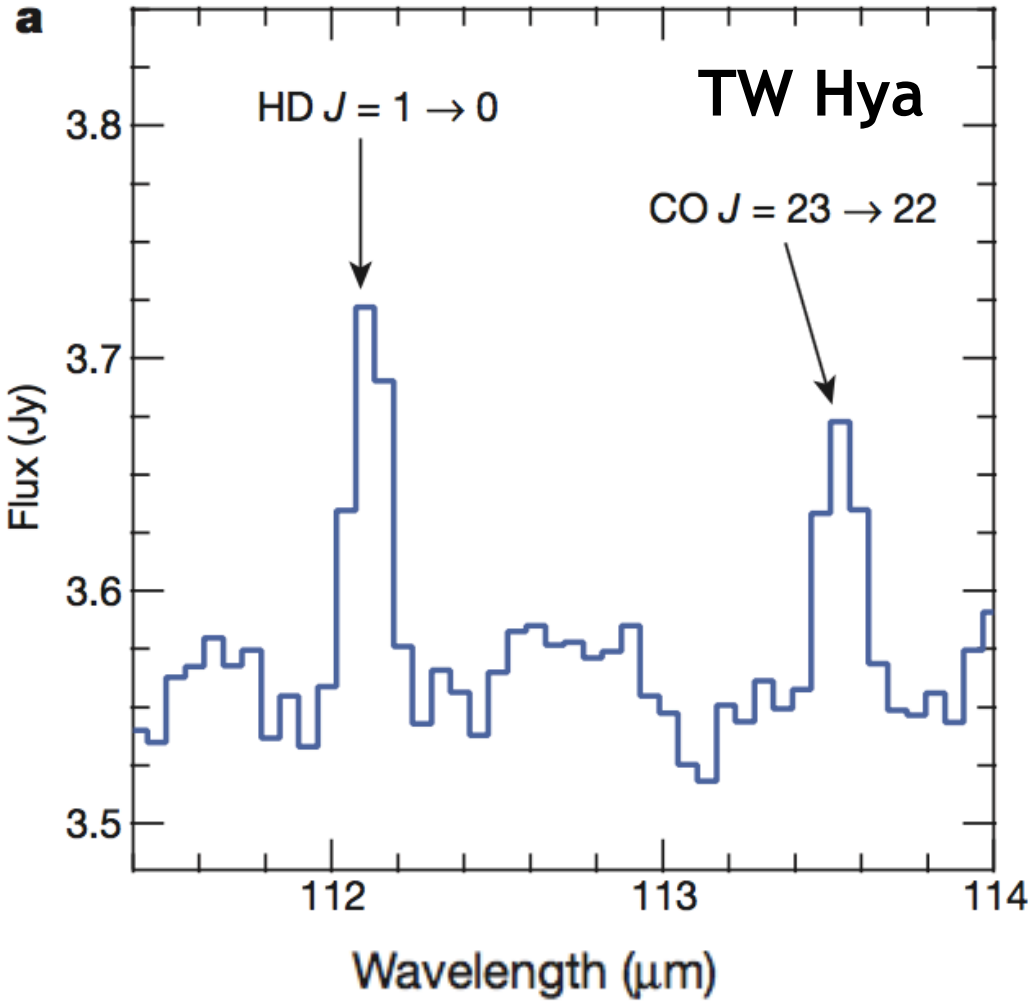
Circumstellar disks

HD follows H2
HD sensitive to gas mass

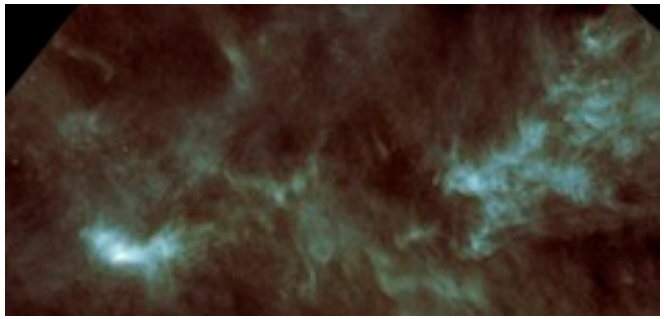
M_{gas}~0.05 M_o

(vs. 5x10^{-4} M_o inferred from CO!!)

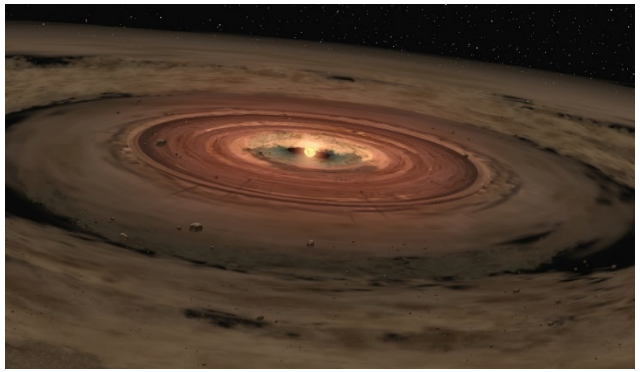
Bergin+13



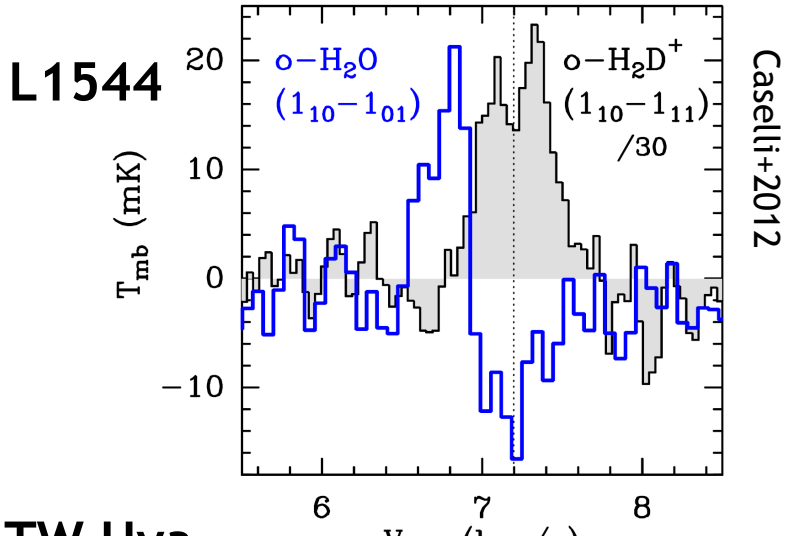
H_2O (@180μm): our origins

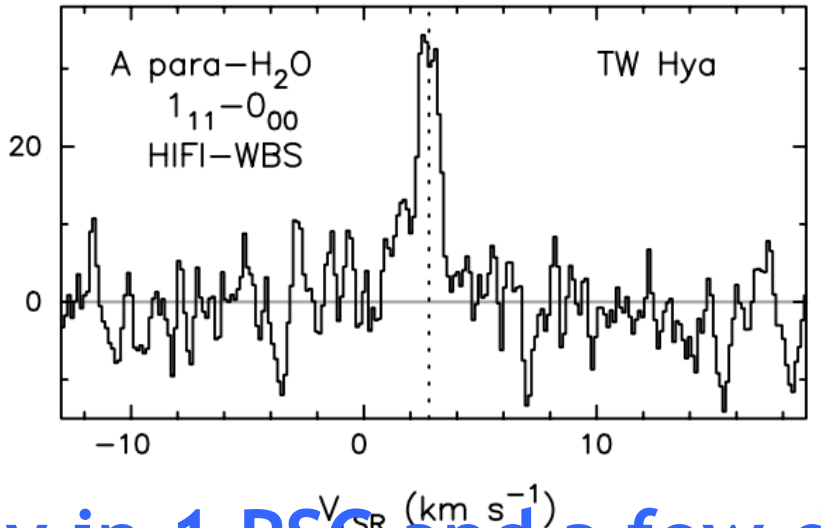


Pre-stellar Cores (PSCs)



Circumstellar disks

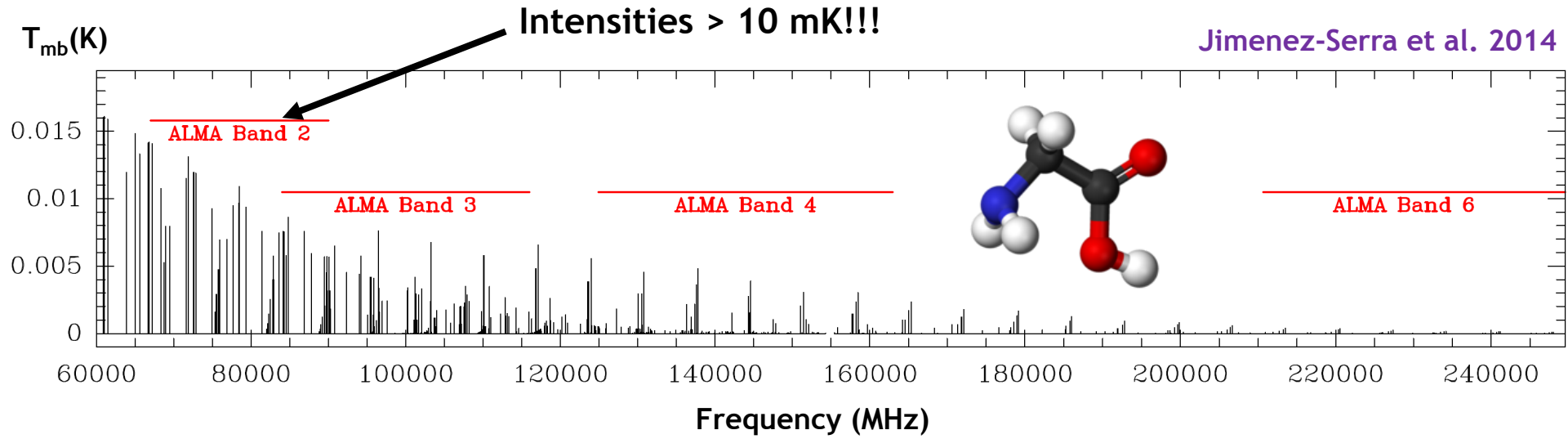




0.005 Earth Oceans!!

Cold H_2O detected only in 1 PSC and a few disks!!

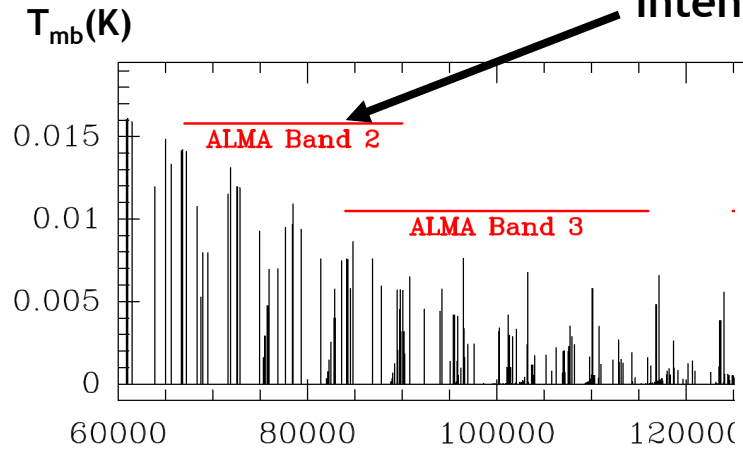
Simulations of Glycine in L1544



Simulations of Glycine in L1544

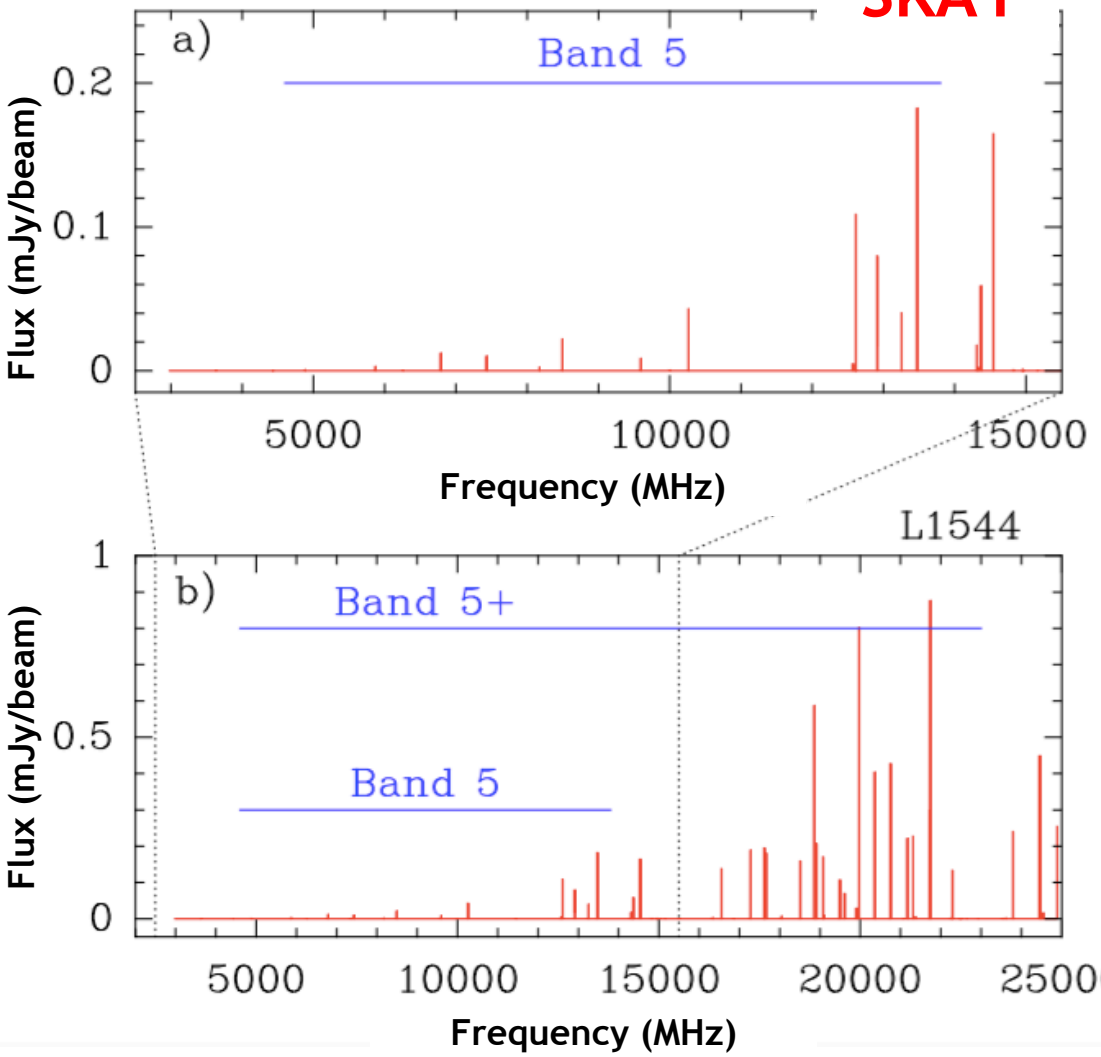
Intensities > 10 mK!!!

Jimenez-Serra et al. 2014



Codella+(2014)

SKA1



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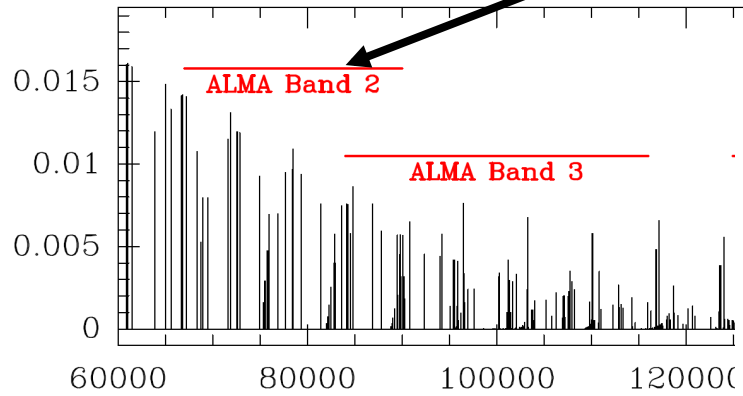

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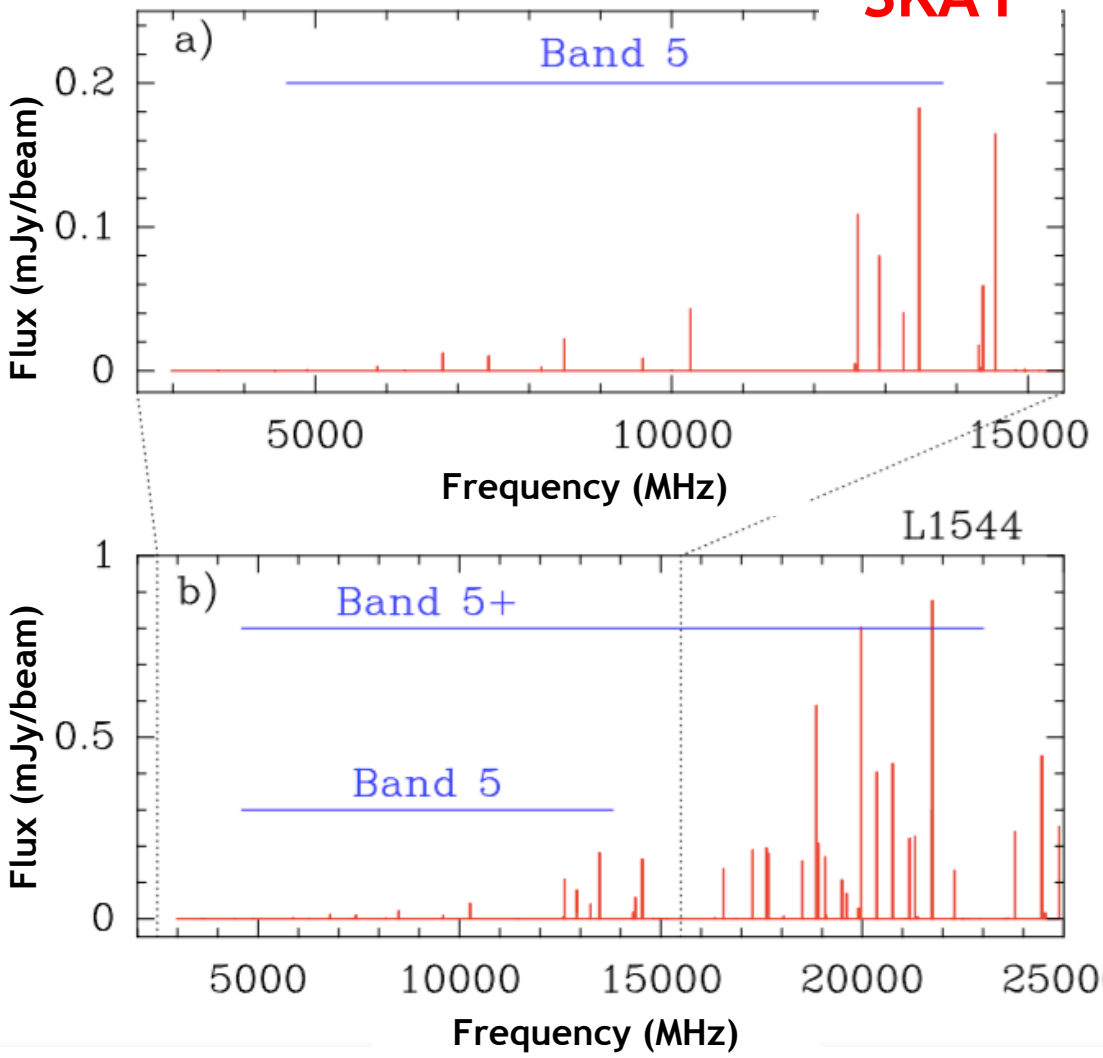
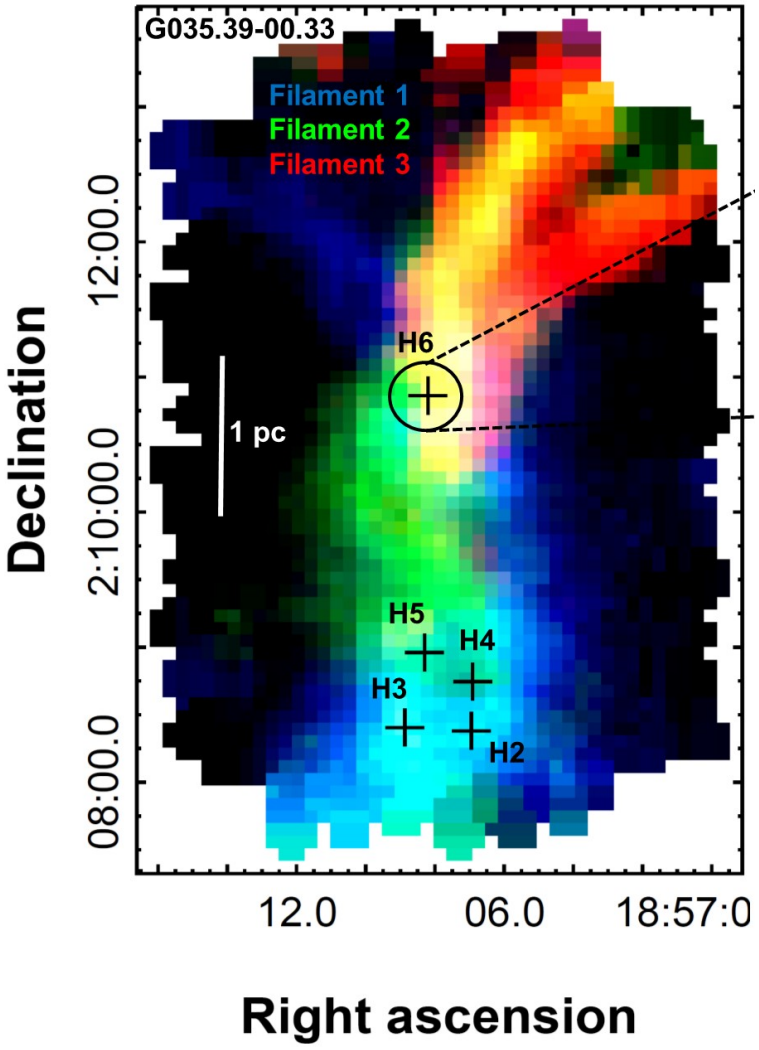


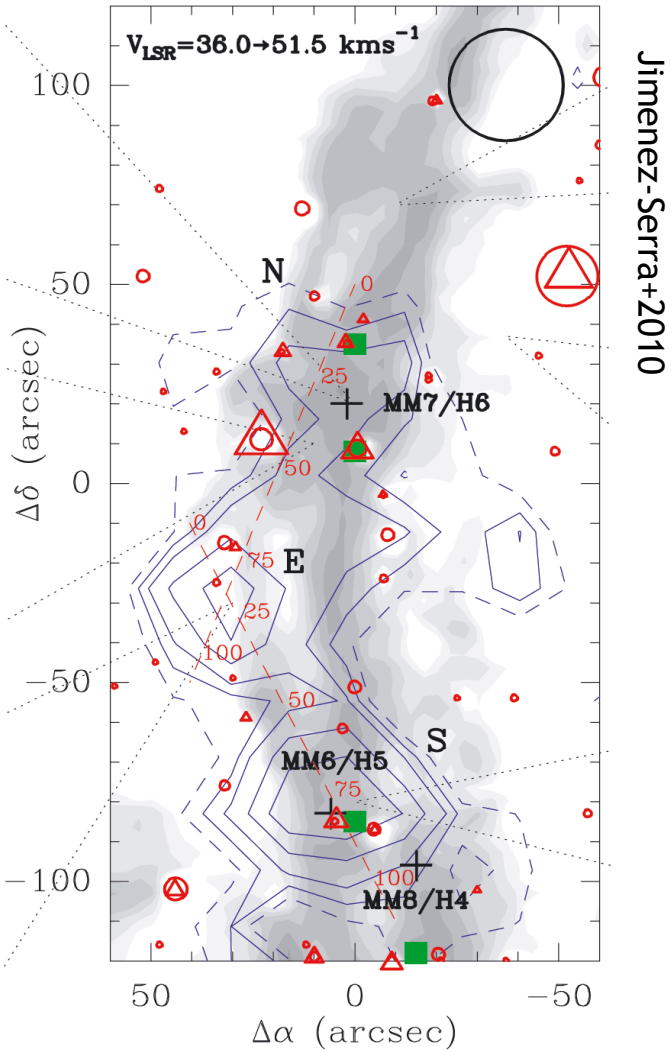
SPICA can probe the ice COM composition in the THz regime!!!

H_2O(@180μm) in IRDCs??

Jimenez-Serra+2014



SiO (2→1)



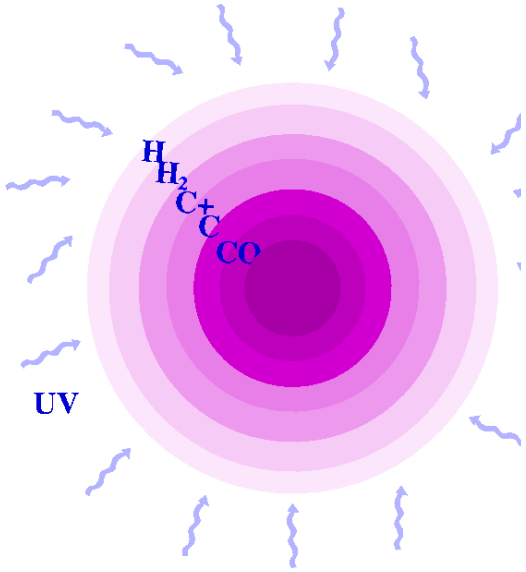
Jimenez-Serra+2010

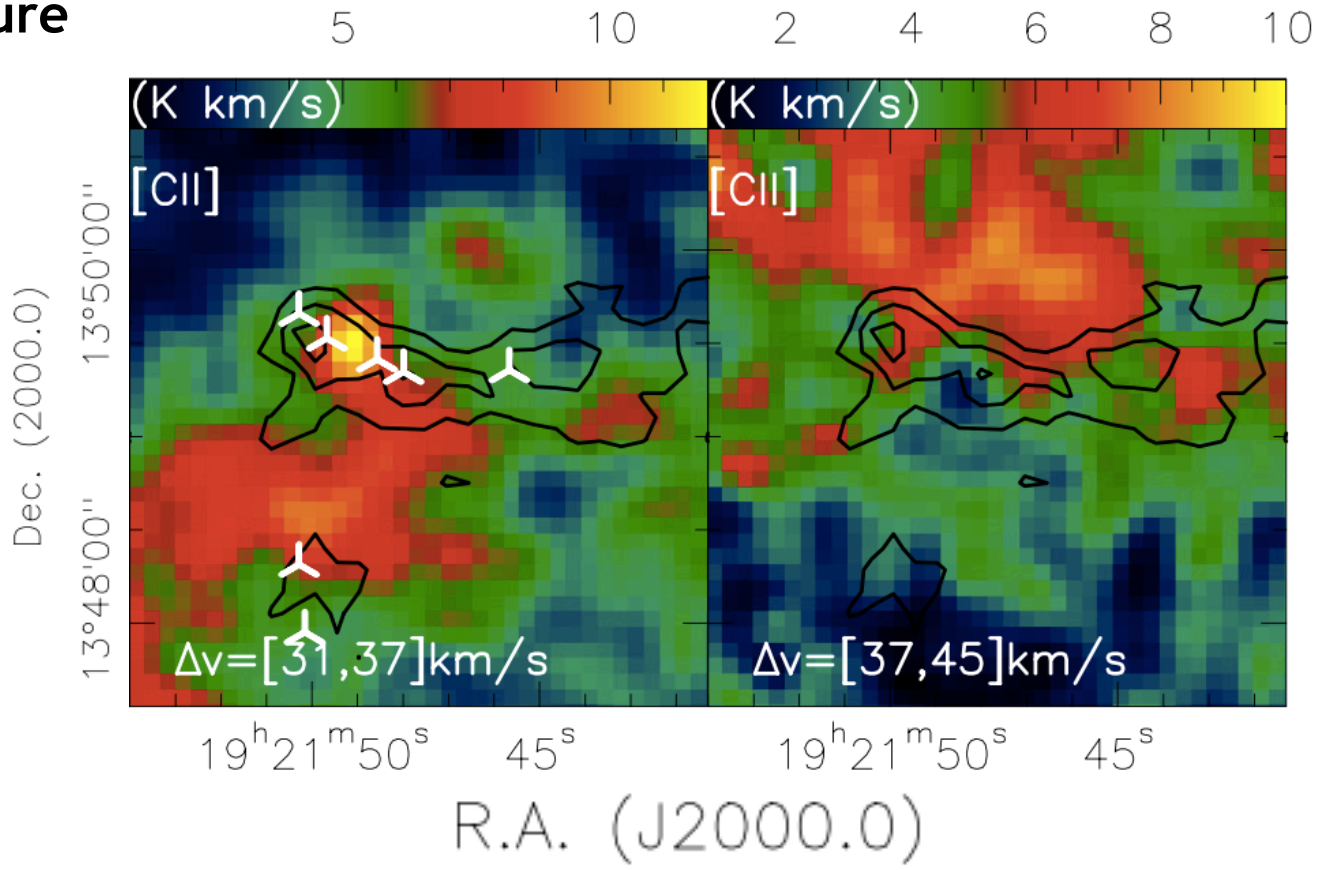
Cold H_2O as probe of cloud-cloud collisions

C^+(@158μm): diffuse gas in IRDCs

Beuther+2014

Canonical PDR structure



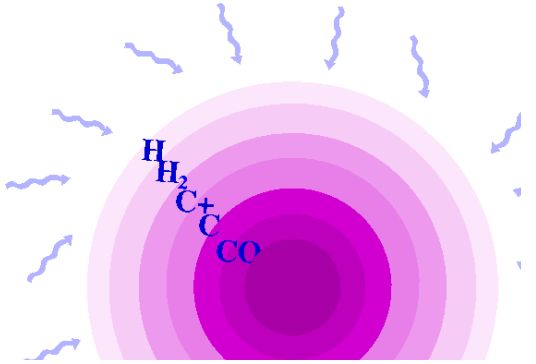


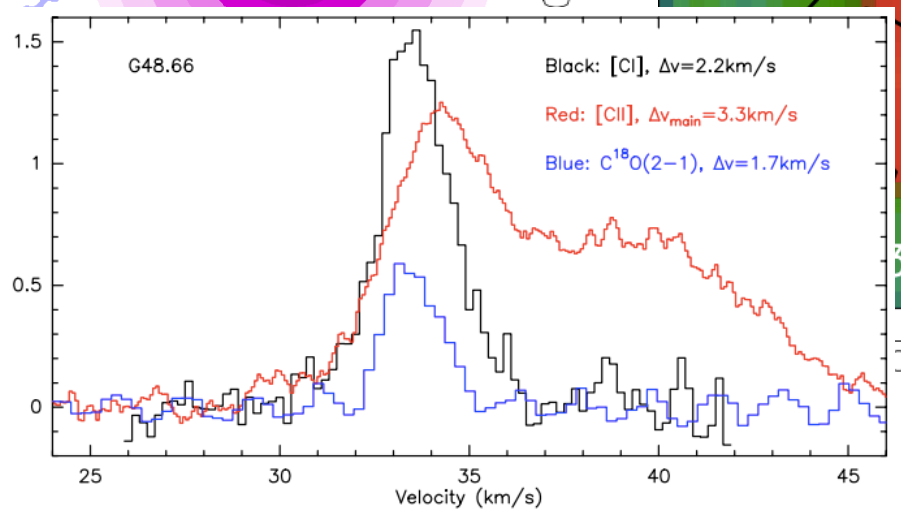
C^+ probes turbulence and kinematics of gas in IRDC environment

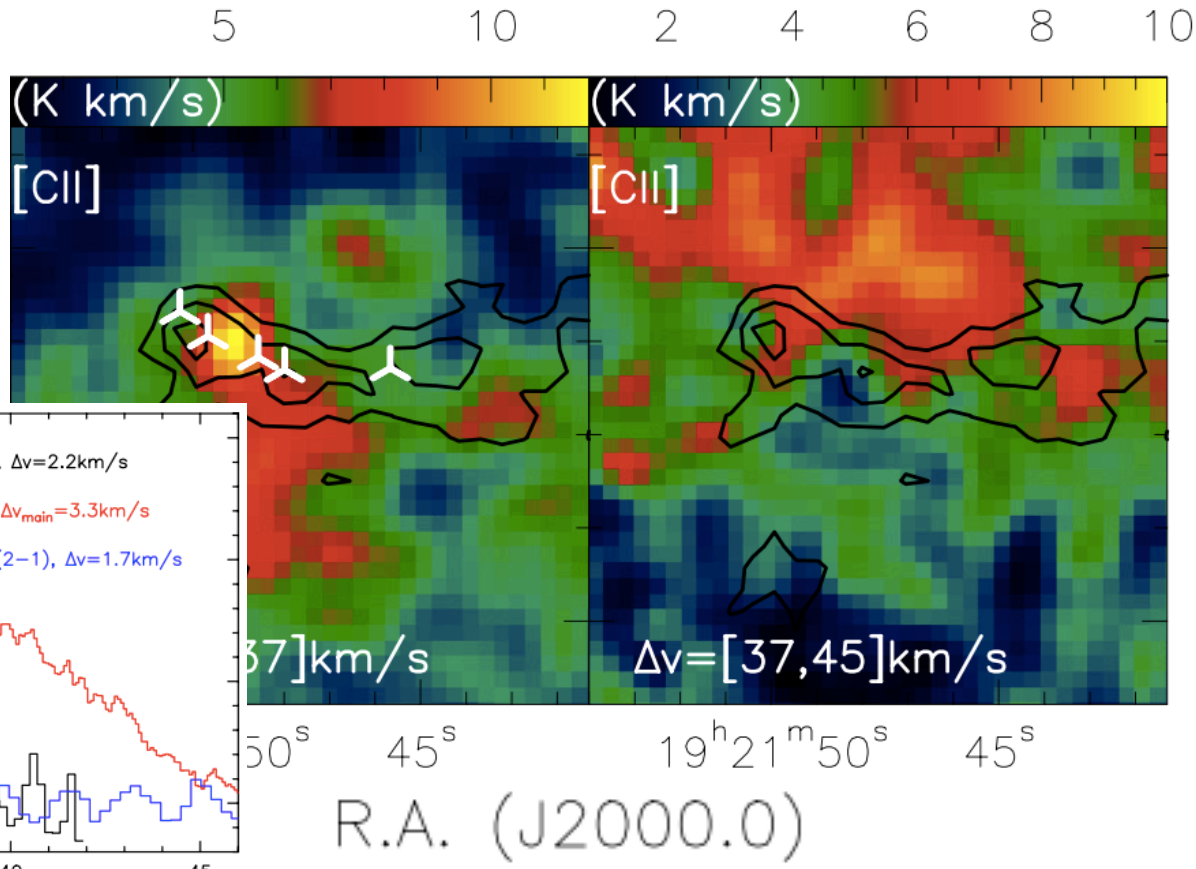
C⁺(@158μm): diffuse gas in IRDCs

Beuther+2014

Canonical PDR structure

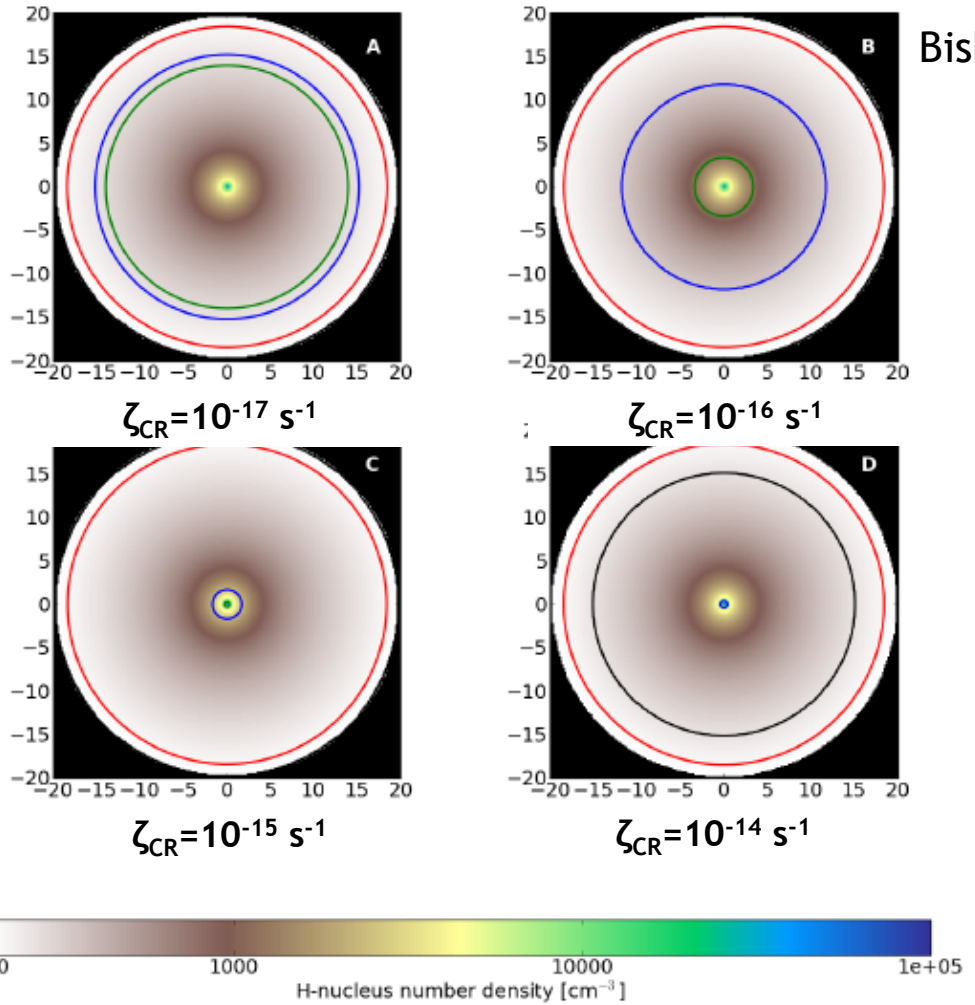






C⁺ probes turbulence and kinematics of gas in IRDC environment

Diffuse PDR gas diagnostics



Bisbas+2015

H/H_2/C^+/C/CO transitions vary in Av depending on metallicity, density, UV field, and cosmic ray ionization rate!!!

Diffuse PDR gas diagnostics

- **O:** present in both atomic and molecular gas
  65μm/145 μm transitions diagnostic of optical depth
- **CII:** a true tracer of the PDR zone if HII contribution small (<30% - Vasta et al. 2010)
- **OI/CII:** diagnostics of temperature, density, UV radiation field
- **O→ OH → H_2O: study of the PDR transition from atomic to molecular gas by using the oxygen budget**

Potential Project:

Comprehensive study of the 3D distribution of atomic/molecular gas in nearby galaxies to trace the transition from atomic to molecular gas

Motivation:

High spectral resolution observations toward single positions in a few tracers & high spatial maps in other tracers → lack of consistent 'ensemble' of data

Comprehensive study to determine the density and temperature structure of a galaxy

What we could address:

With 3D surveys of key transitions of OI, CII, OH and H_2O we could get the average gas contained within each component (HII, PDR, neutral) for *each* type of galaxy → **how do the contributions differ across types of galaxies?**

HD in nearby galaxies??

UCL-CHEM

X(HD)	N_H	T	c.r
5.3e-5	1000	50-100	1
6e-5	10^4-10^5	50-100	1
6e-5	1000	50-100	10
7e-5	10^4-10^5	50-100	10
1e-4	1000	50-100	100
2e-4	10^4-10^5	50-100	100

If X(HD)~5x10^{-5}, n(H_2)~10^3 cm^{-3} and source size 1pc
S_{nu}(HD)~150 mJy at 50 kpc

HD detected with S/N>9 in SMC/LMC in the worst case scenario