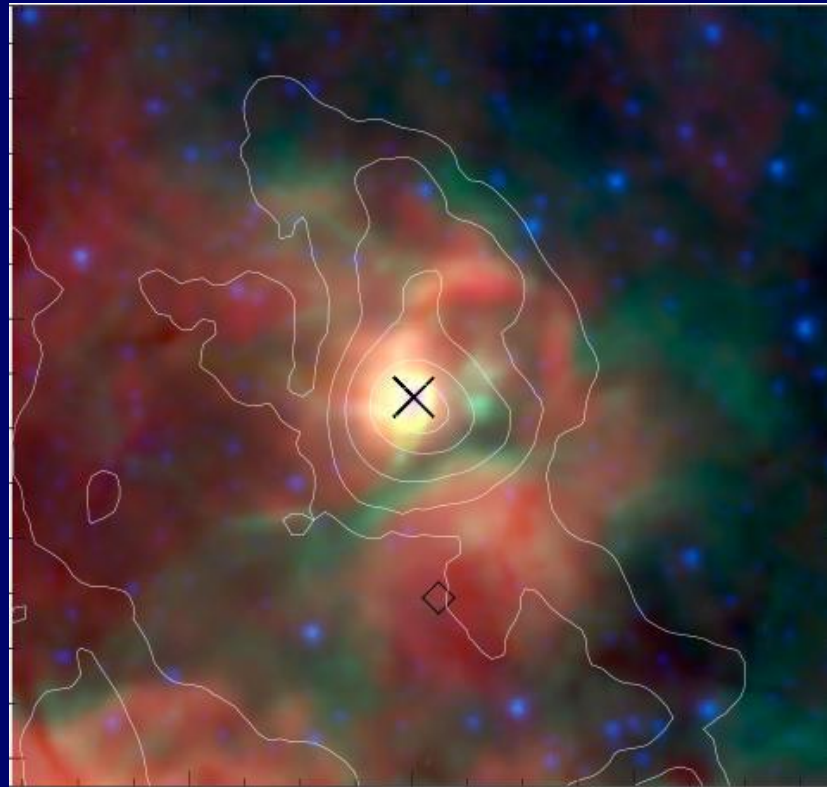


ISM Physics with SPICA

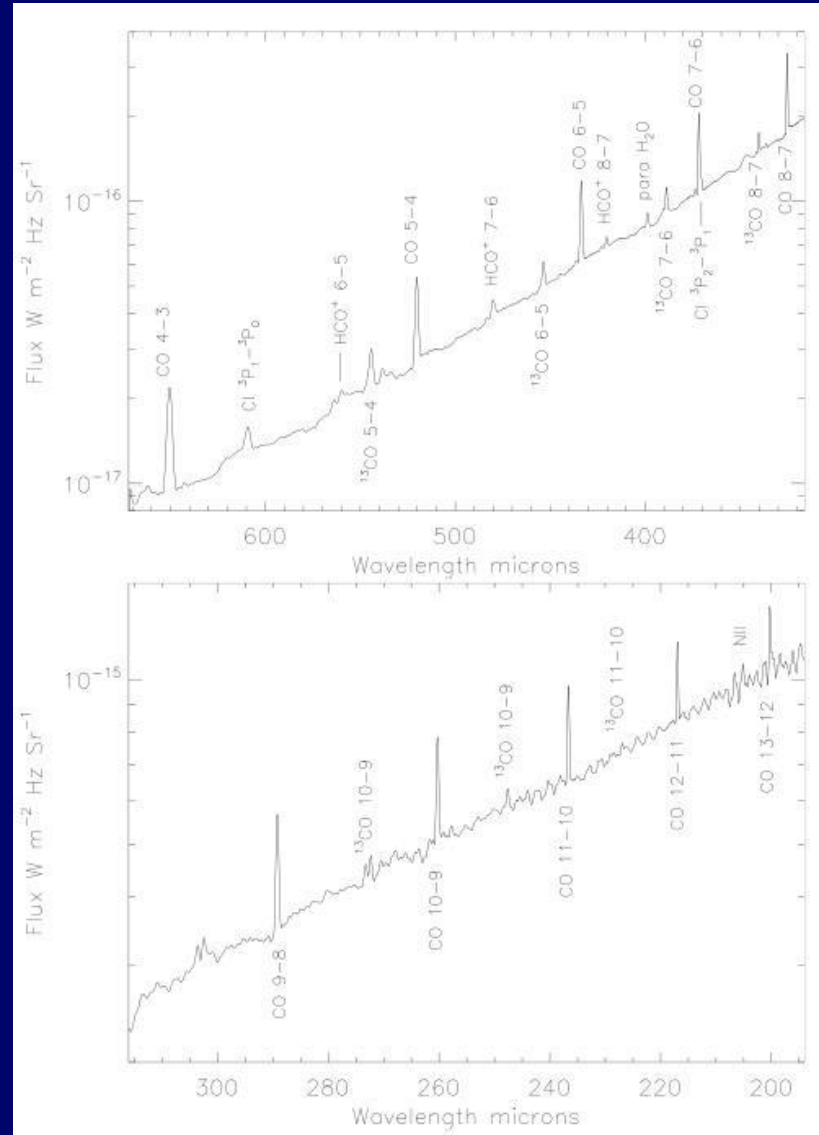


Professor Derek Ward-Thompson
Director, Jeremiah Horrocks Institute
University of Central Lancashire
SPICA UK Meeting, 2016 January 22nd

Spectroscopy of molecular clouds:- DR21

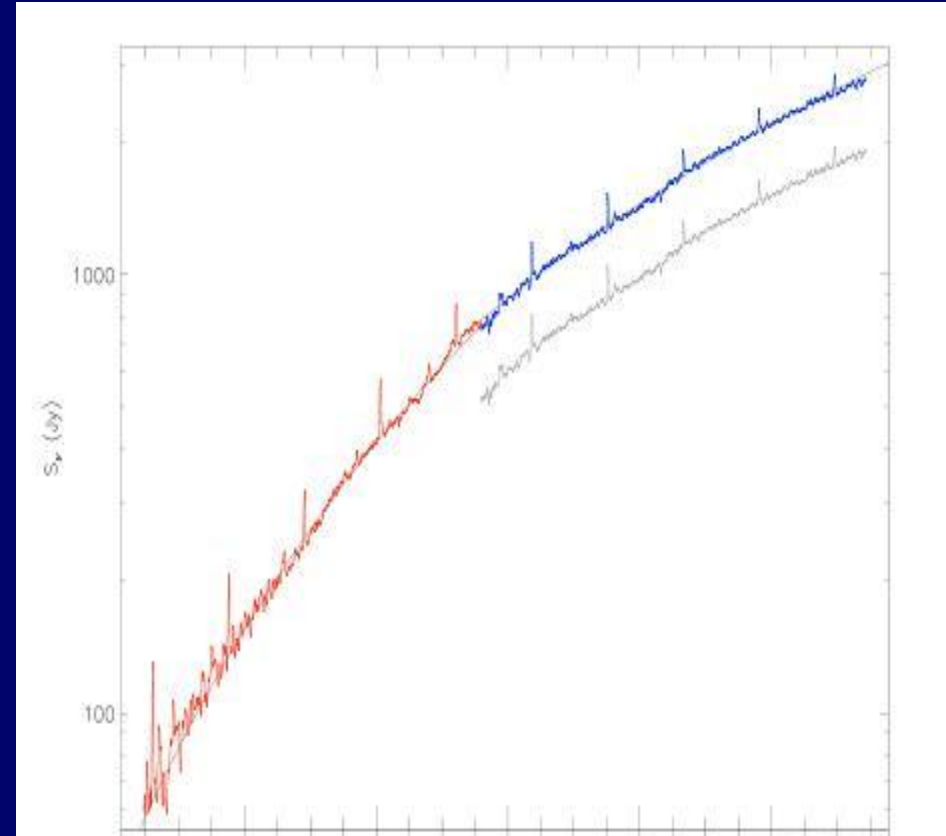
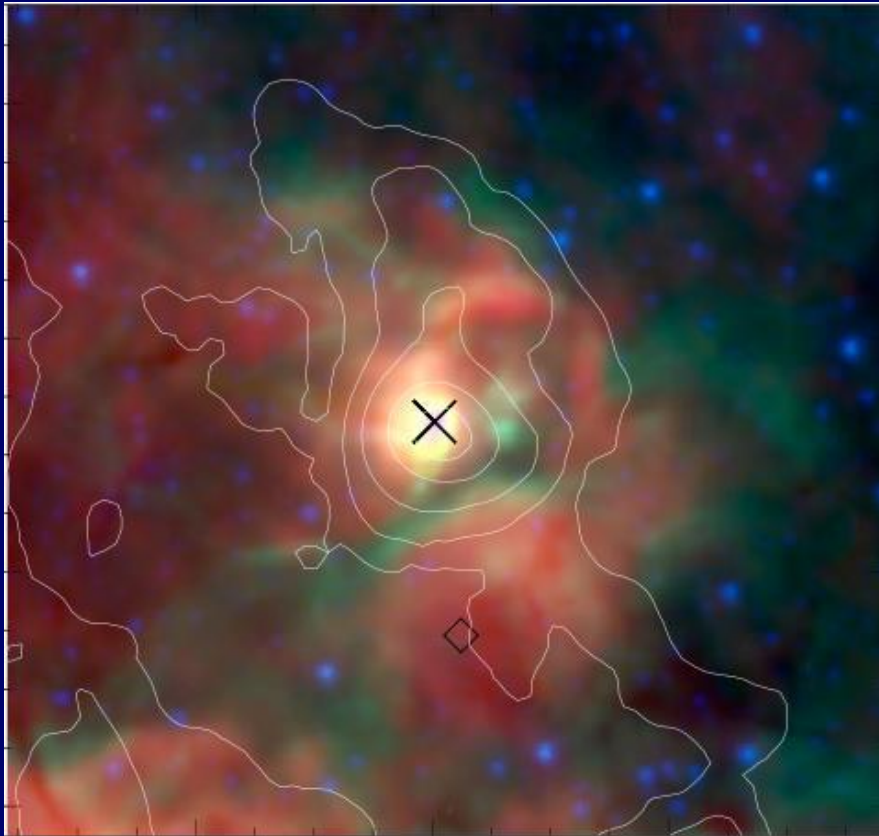
White et al.
(2010) A&A
518, L114

Herschel
FTS spectra



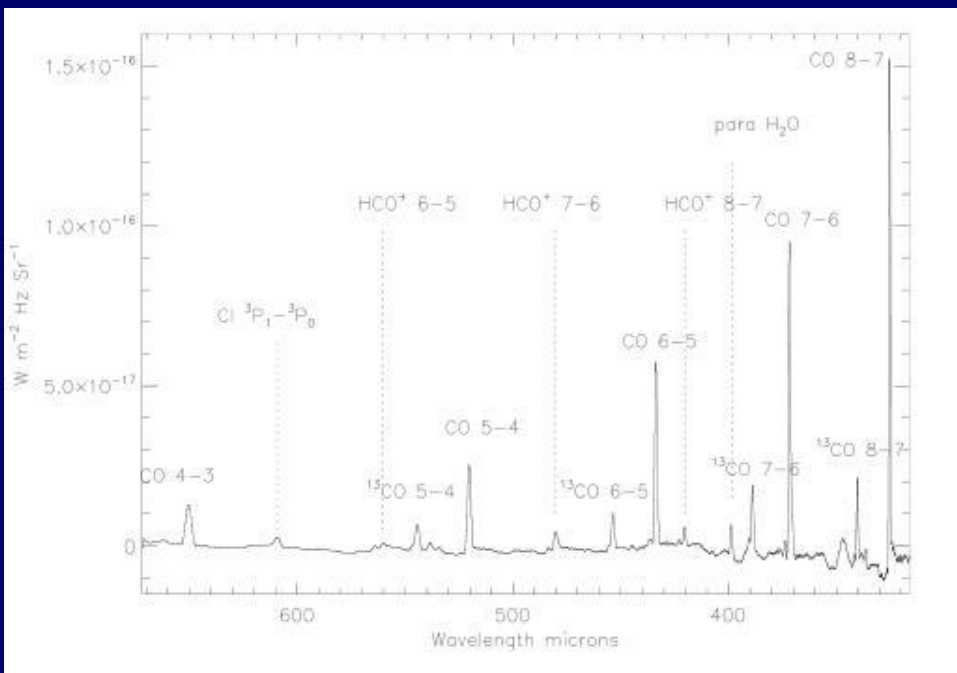
^{12}CO , ^{13}CO ,
HCO $^+$, H $_2$ O,
NII, Cl

Spectroscopy of HII regions:- G29



Kirk et al., (2010) A&A 518, L89

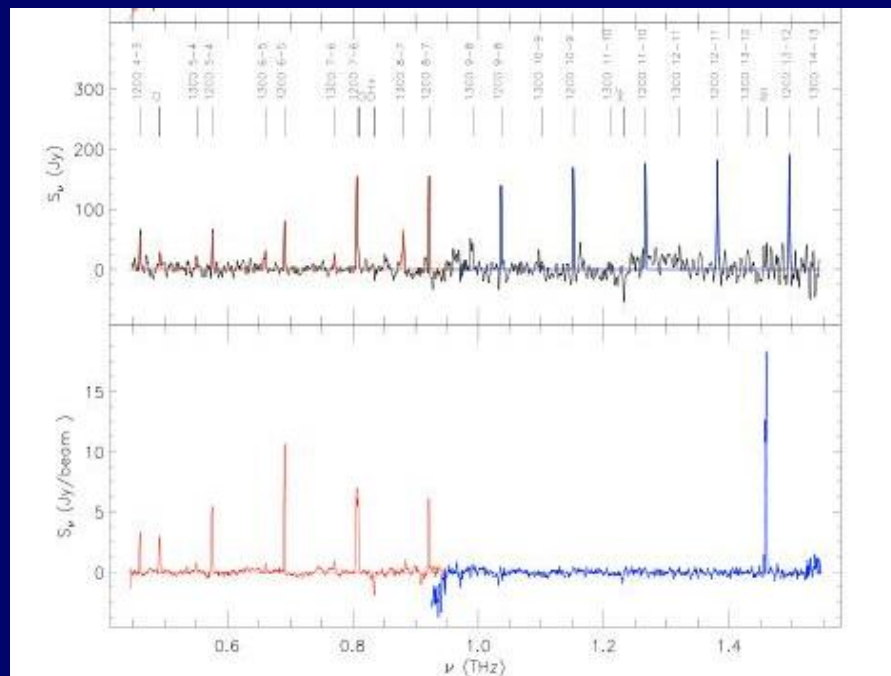
Line Spectroscopy:- Astrophysics



DR21

White et al., (2010) A&A 518, L114

$T_{kin} \sim 125$ K $n(H_2) \sim 7 \times 10^4$ cm⁻³

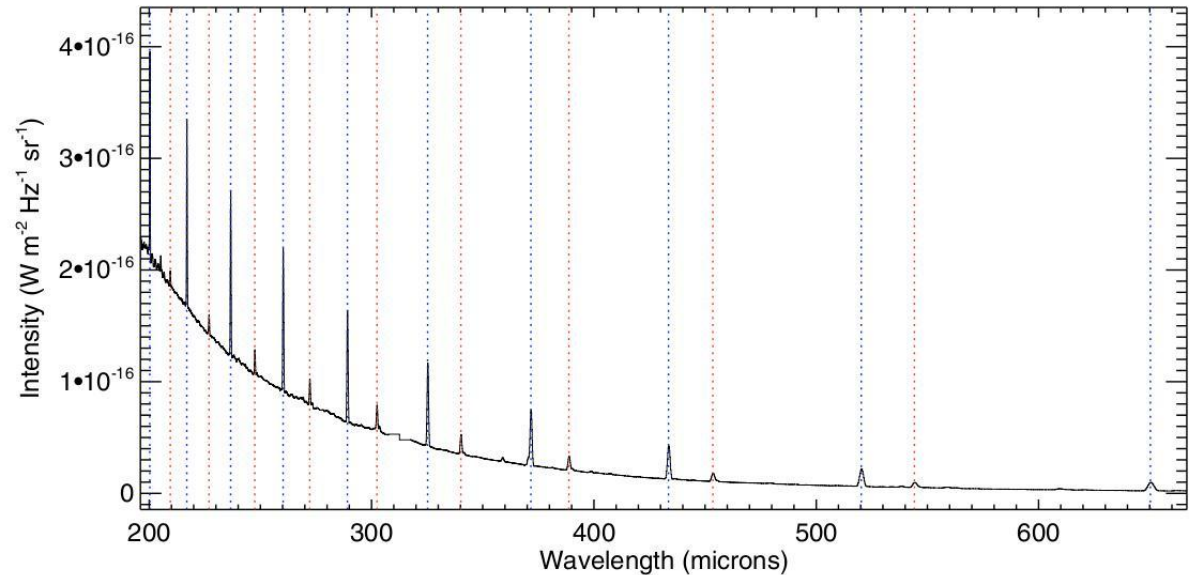
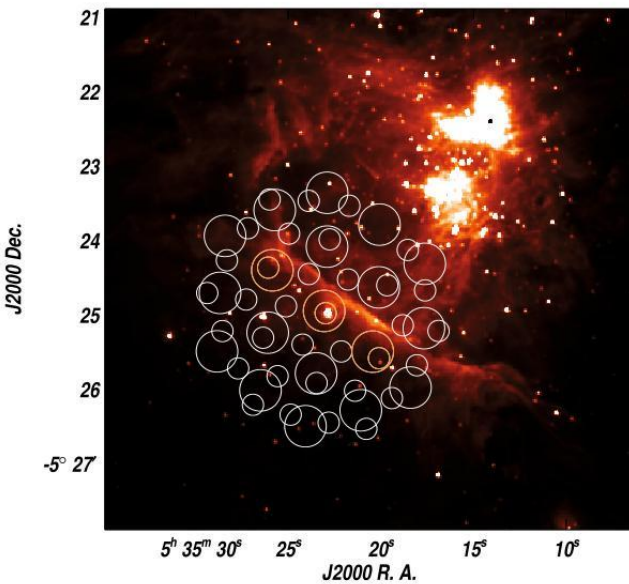


G29

Kirk et al., (2010) A&A 518, L82

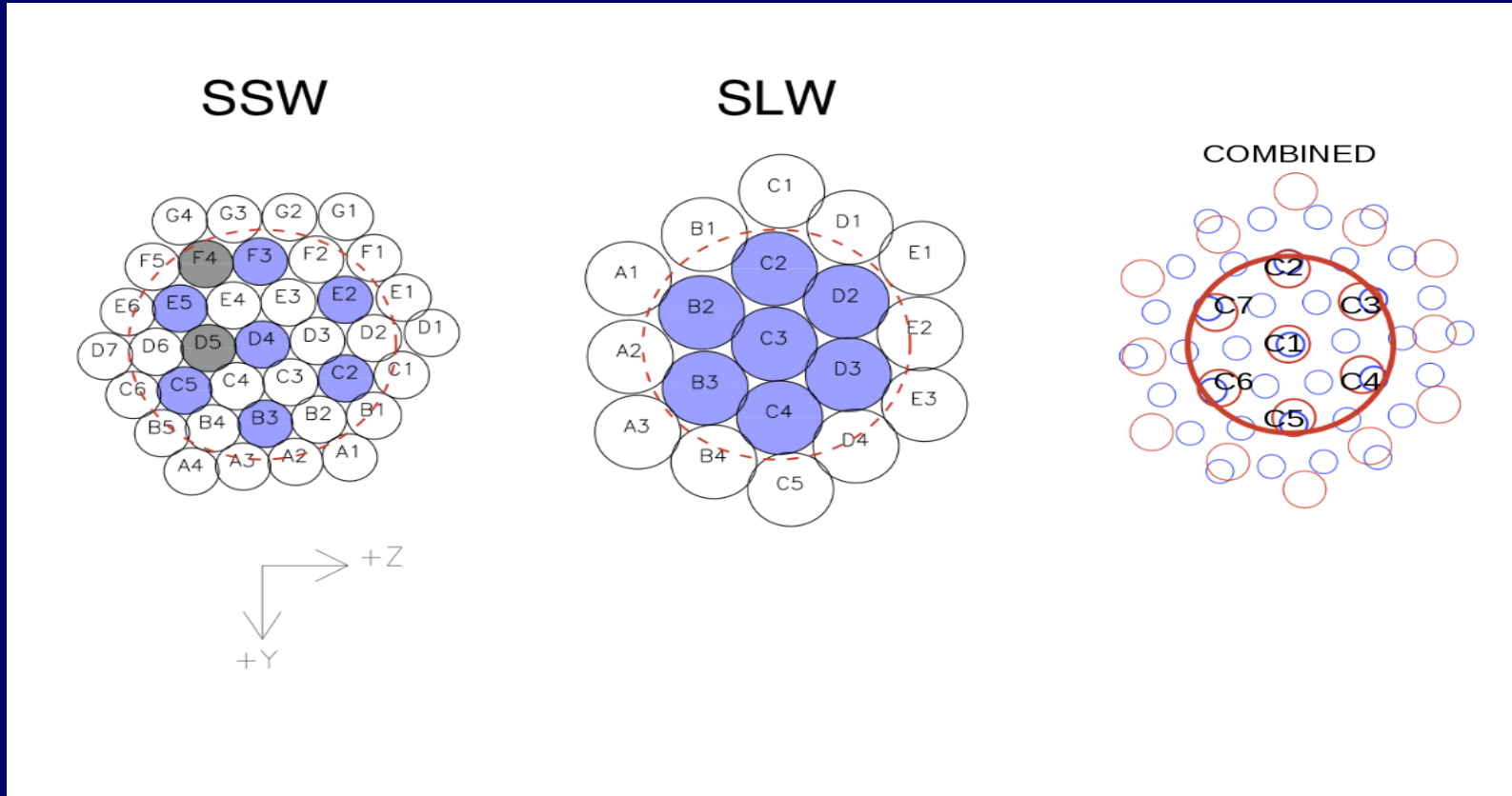
$T = 80$ K $M = 1500$ Mo

Spectroscopy of PDRs:- Orion Bar



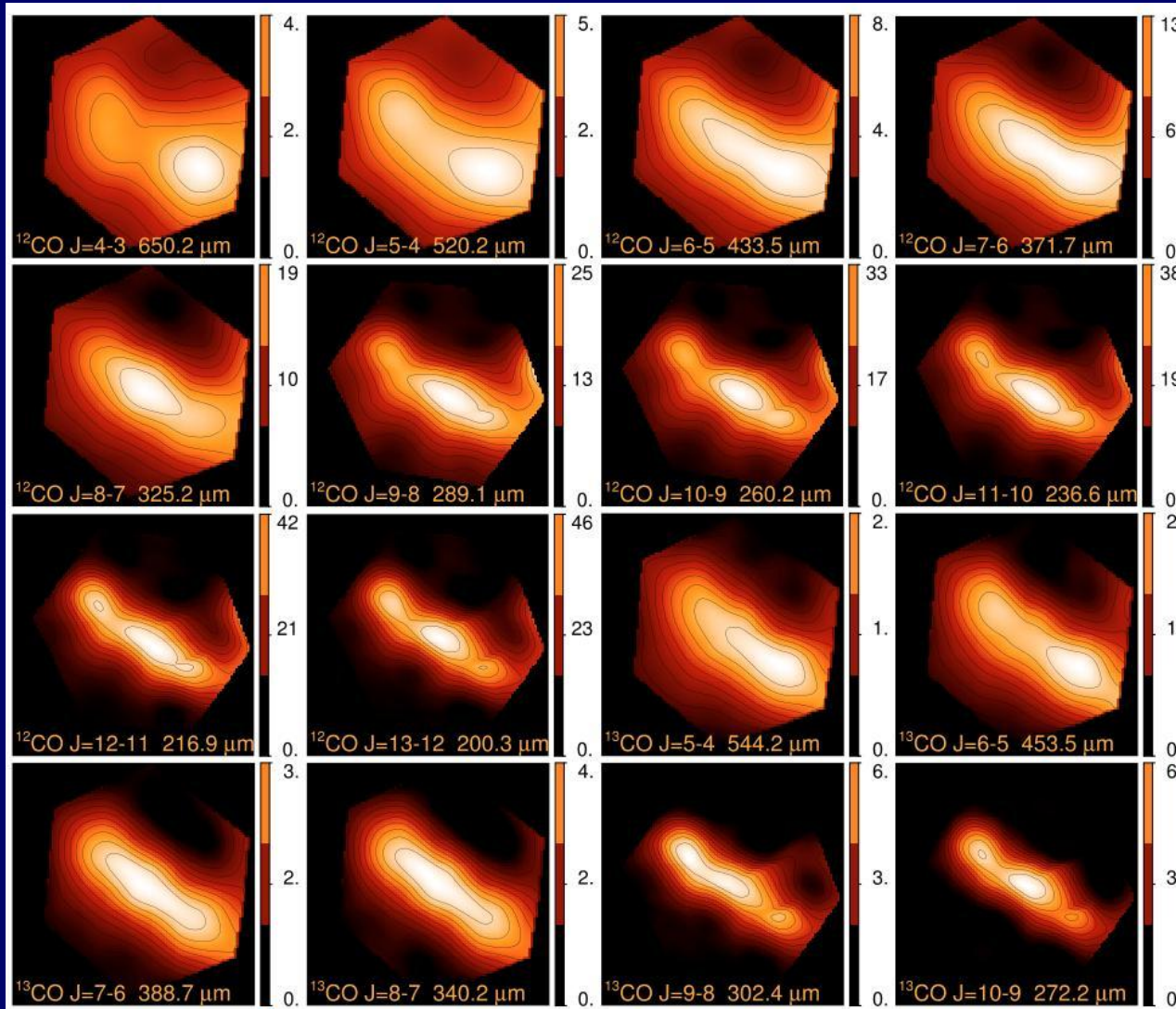
Habart et al., (2010) A&A 518, L116

Mapping Spectroscopy:- Herschel SPIRE-FTS



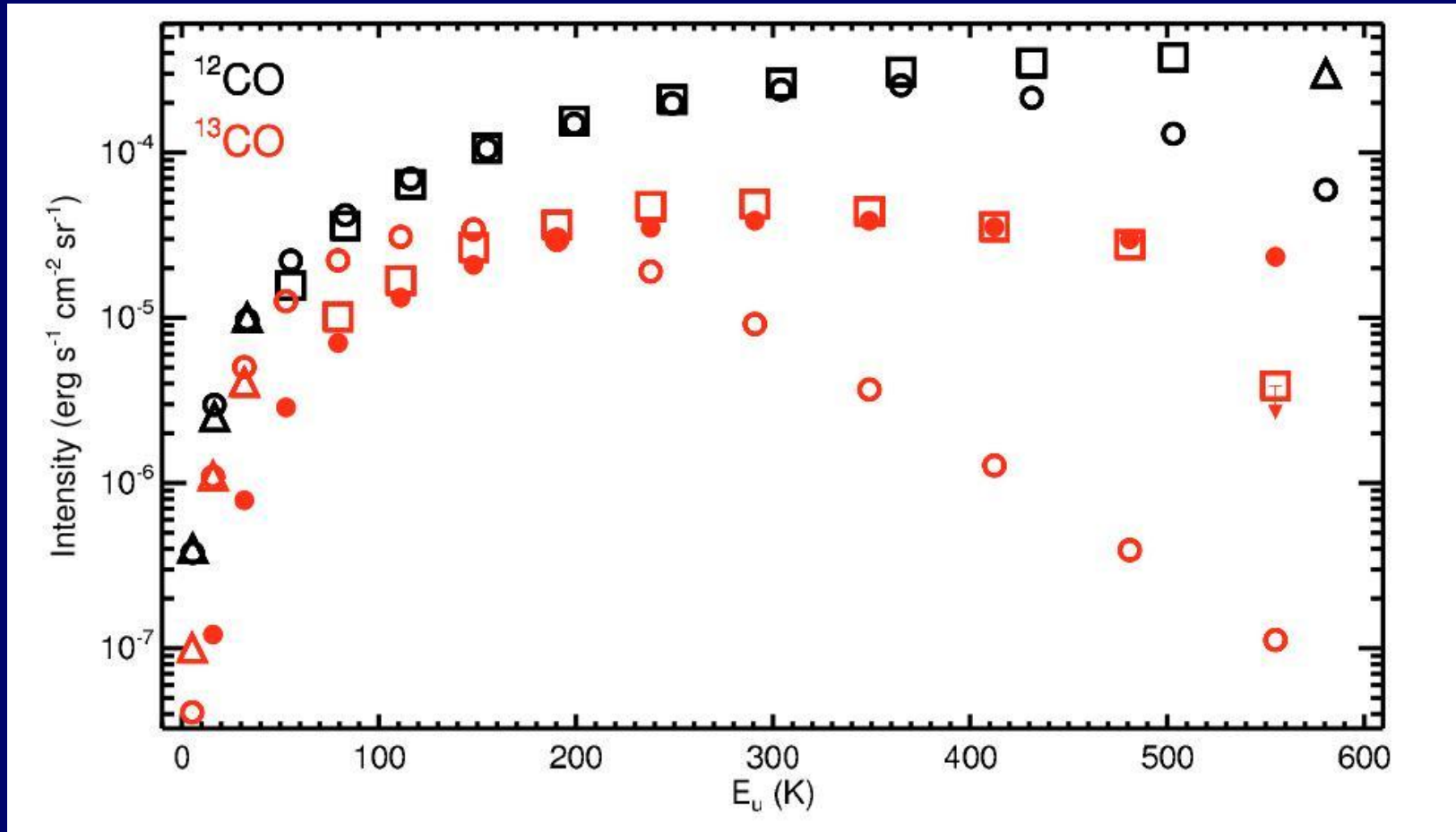
Sparse-sampled mapping
Griffin et al., (2010) A&A 518, L3

Line Mapping Spectroscopy:- Orion Bar



Habart et al.,
(2010) A&A
518, L116

Line Spectroscopy:- Astrophysics

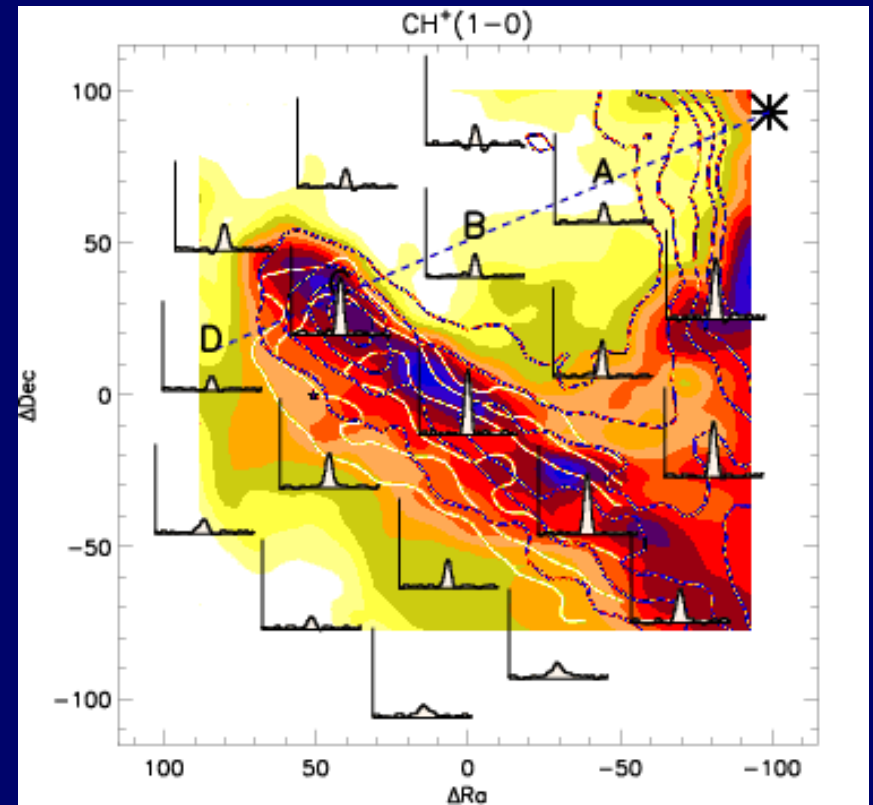
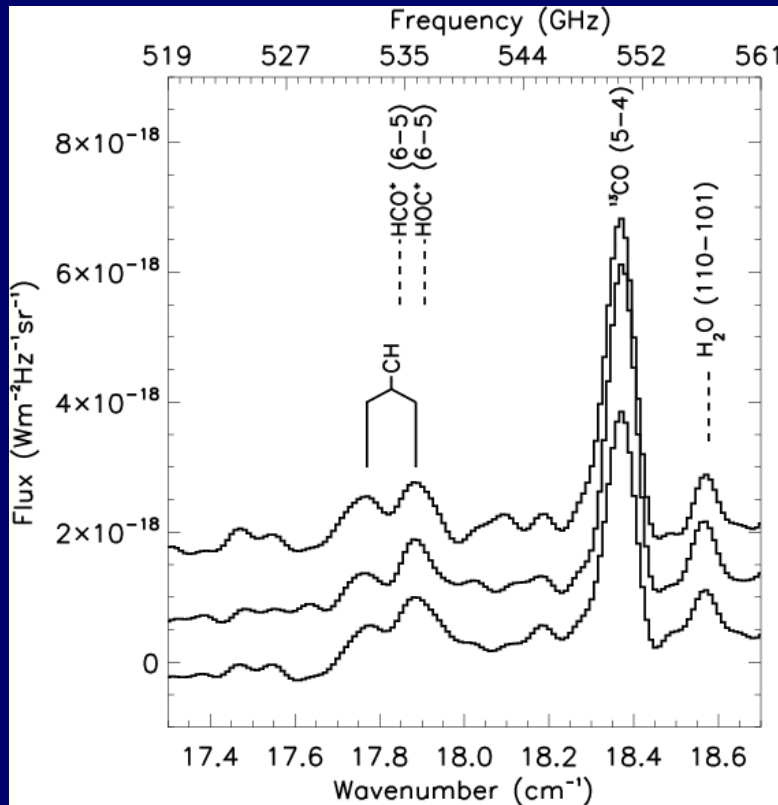


Orion Bar :- Habart et al., (2010) A&A 518, L116

T = 120 K N(¹³CO) = 2 x 10¹⁶ cm⁻²

(squares & triangles are data; circles are different models)

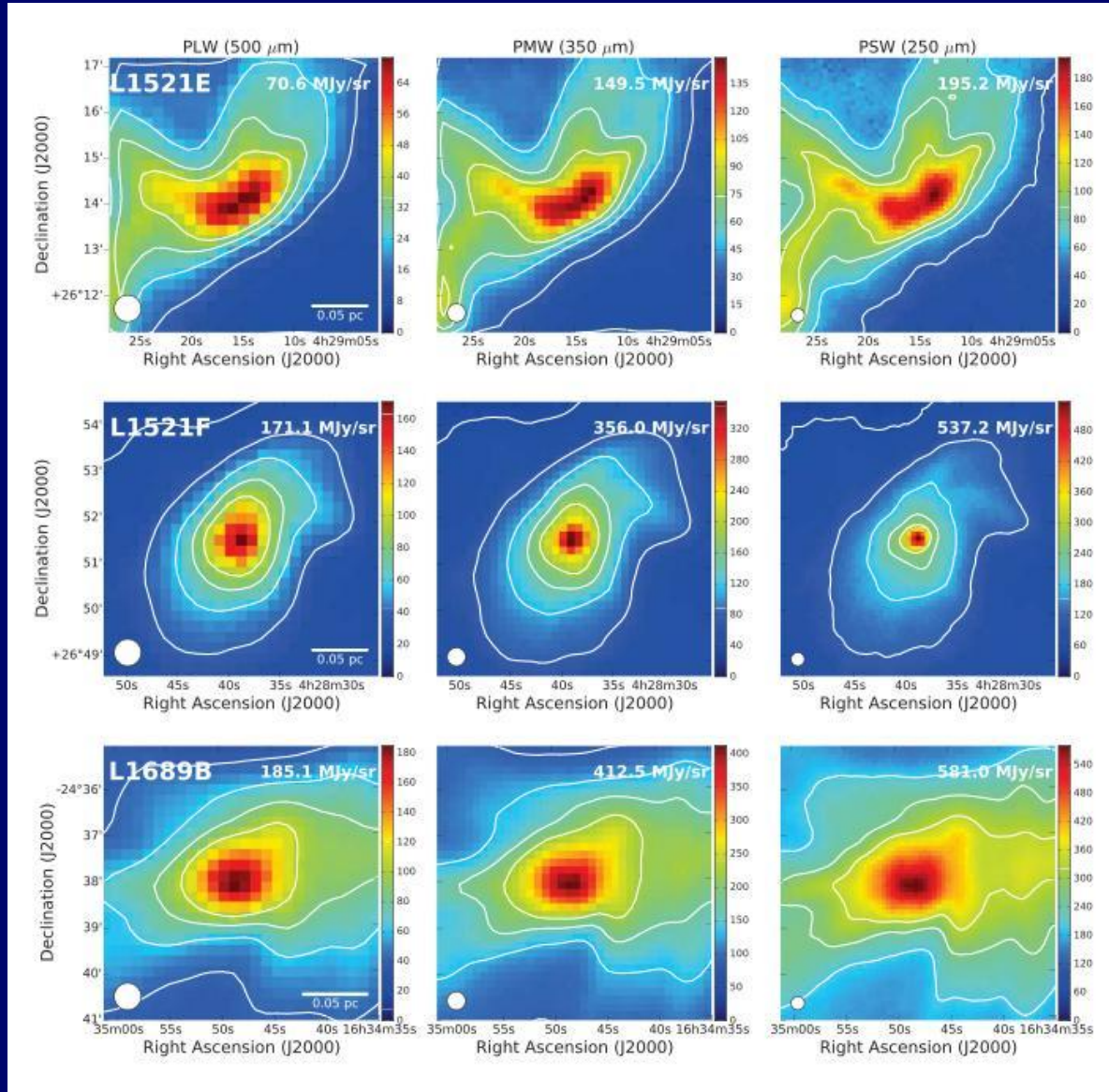
Interstellar Chemistry



CH & CH^+ :- where interstellar hydro-carbon chemistry starts
Naylor et al., (2010) A&A 518, L117

Broad-band Continuum Spectroscopy

Makiwa et al., (2016)
MNRAS
submitted



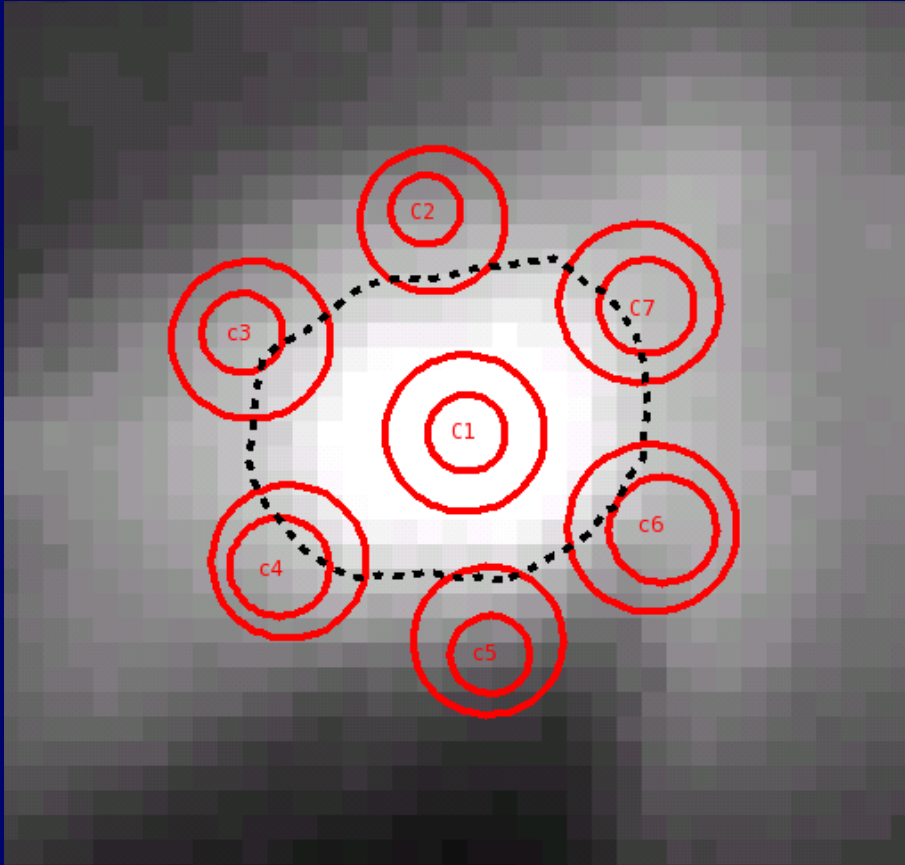
Continuum
imaging at
500, 350 &
250 μm

Broad-band Continuum Spectroscopy

Makiwa et
al., (2016)
MNRAS
submitted

Beta gives:
grain
growth,
ice mantles,
and mass

Continuum Mapping Spectroscopy:- L1689B



Pre-stellar core L1689B was mapped by Herschel FTS – red circles show pixel positions of SSW & SLW respectively on the 250-um image – spectrum is of central position –

T and Beta can be fitted to this spectrum
(Eyres, Kirk, Ward-Thompson et al, in prep)

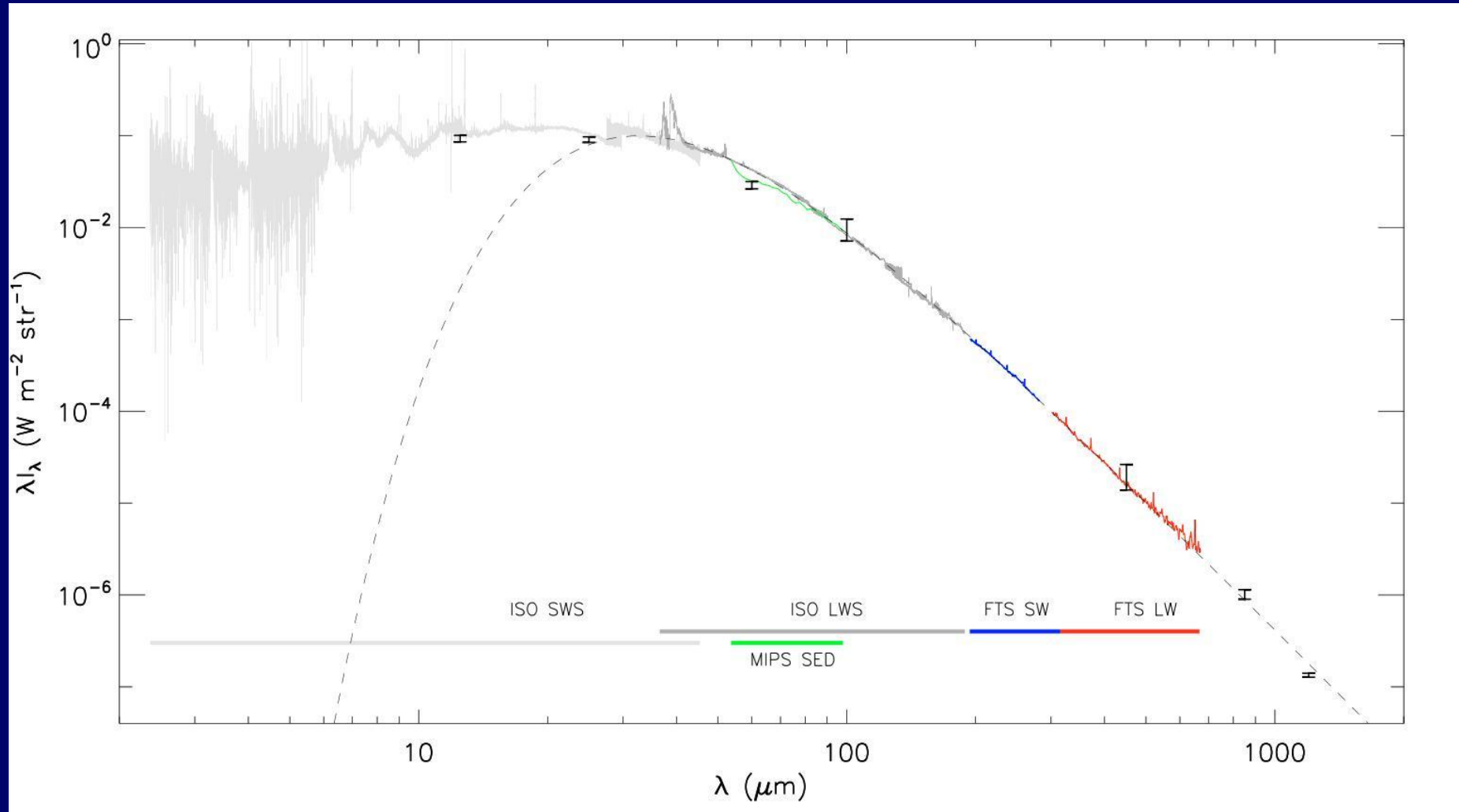
Spectroscopy:- Dust Physics

Grey-bodies
can also be
fitted to
these curves

Variations
in Beta can
be traced –
grain
growth,
ice mantles,
crystalline,
amorphous,
etc.

Surrounding
positions

Combining Herschel & ISO:- G29



Kirk et al., (2010) A&A 518, L89

Conclusions

- Much still needs to be done in inter-stellar astrophysics:
 - Line spectroscopy of molecular clouds, PDRs, HII regions, etc., to study gas phase, excitation, etc.
 - Broad-band spectroscopy of clouds and cores to study dust physics, grain growth, etc.
 - Astro-chemistry, CH, CH⁺, etc.
- Need FIR spectroscopy
- Need SPICA