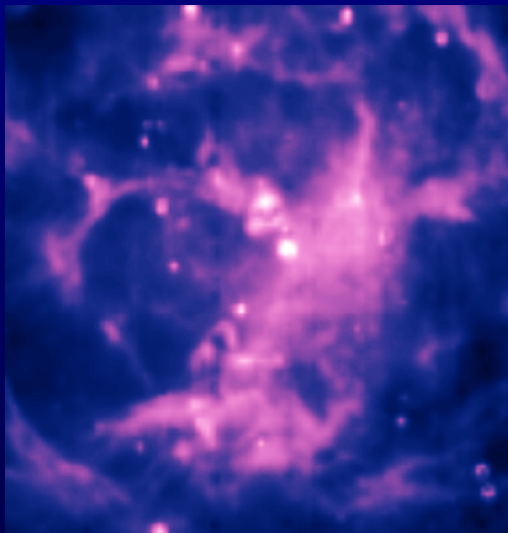
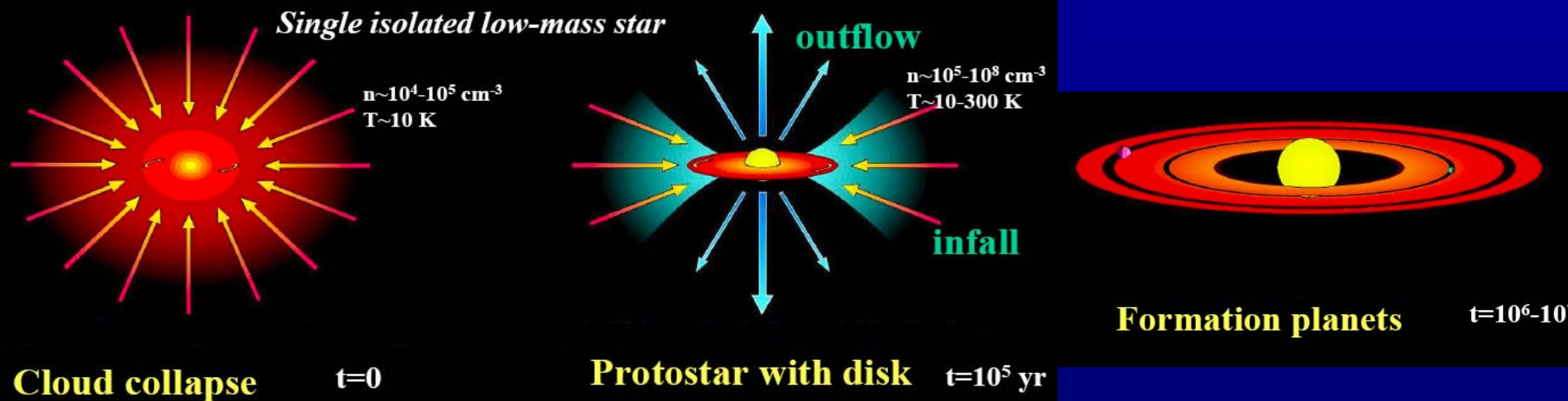


The ISO Legacy on Young Stellar Objects

Brunella Nisini
INAF-Osservatorio Astronomico di Roma



The mid and far-IR view of YSOs

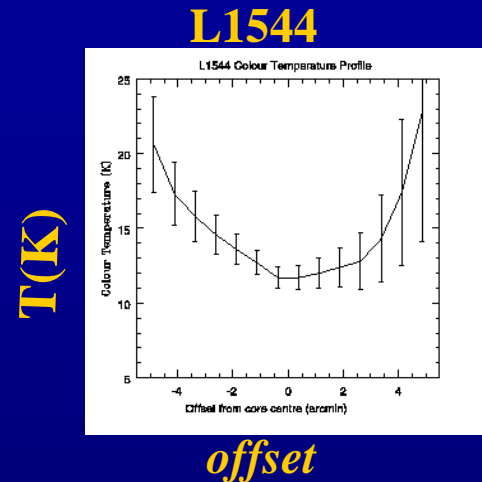
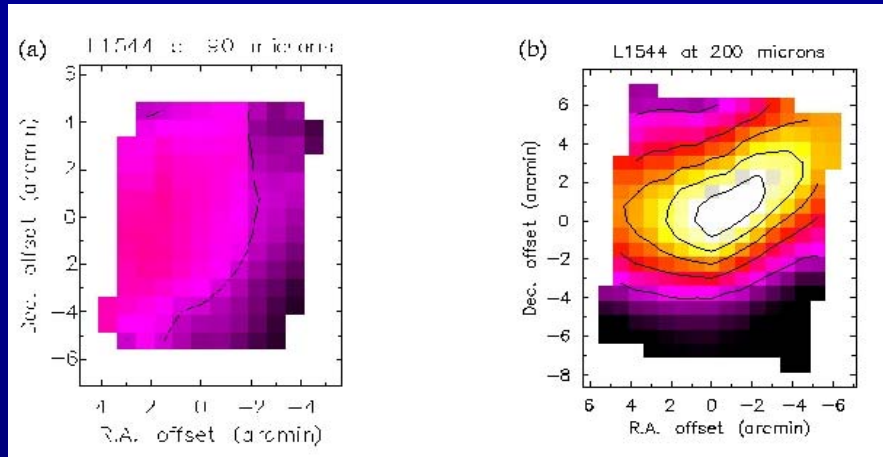


Probe of dust and gas heating and cooling processes

- ⇒ **Isolated star formation:** Interaction (proto-)star with its envelope
- ⇒ **Collective star formation:** Census of embedded objects, IMF

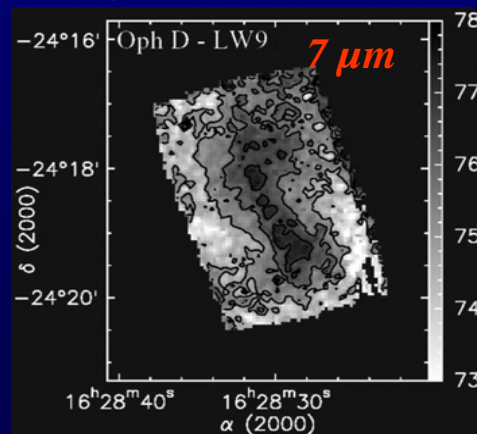
Pre-stellar cores

Temperature profiles probed with PHT-C



T(K)
offset
(Ward-Thompson et al. 2002)

Internal structure probed with CAM



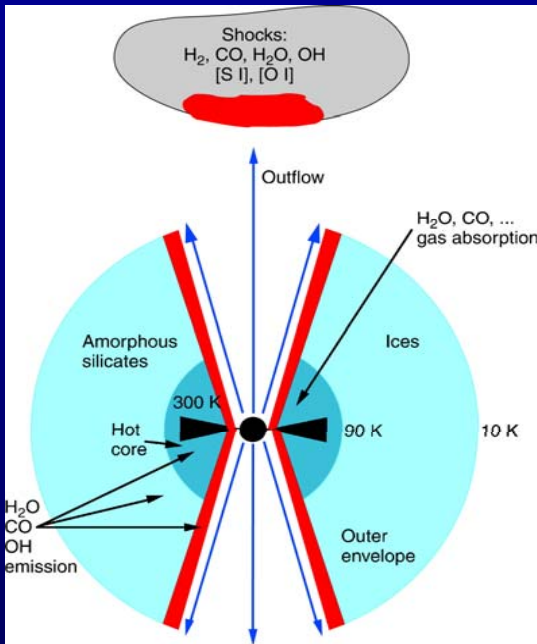
(Bacmann et al. 2002)

- external heating by ISRF
- absorption against MIR background

Low mass protostars: the class 0 objects

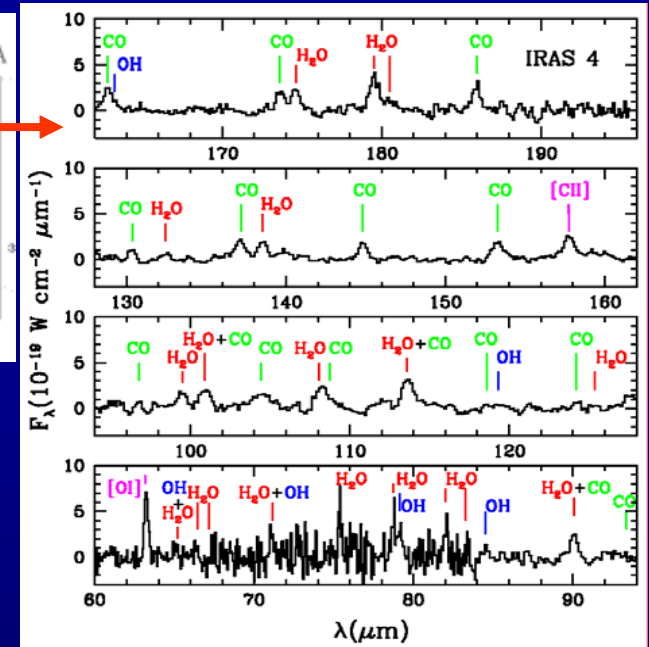
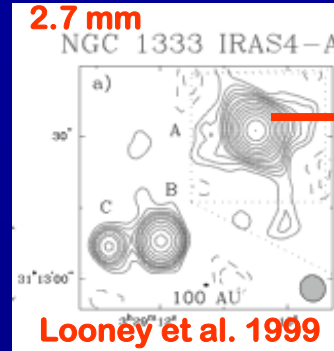
LWS line emission spectra

Gas cooling in the proto- \dagger environment

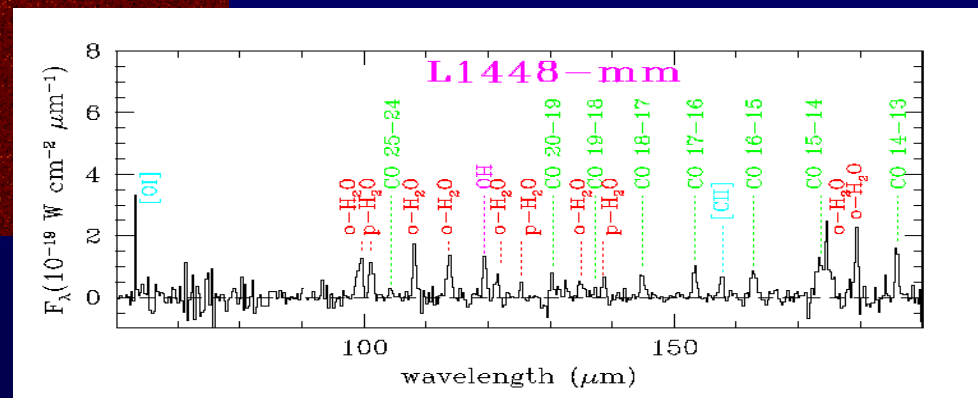
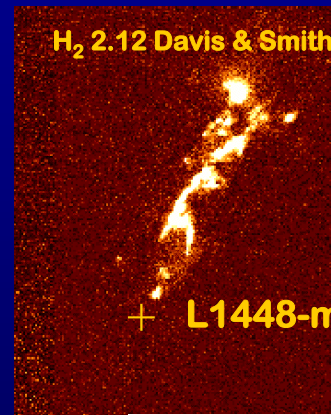


(From Van Dishoeck 2004)

- ⇒ First detection of water vapour lines
- ⇒ Radiative cooling in the warm circumstellar gas



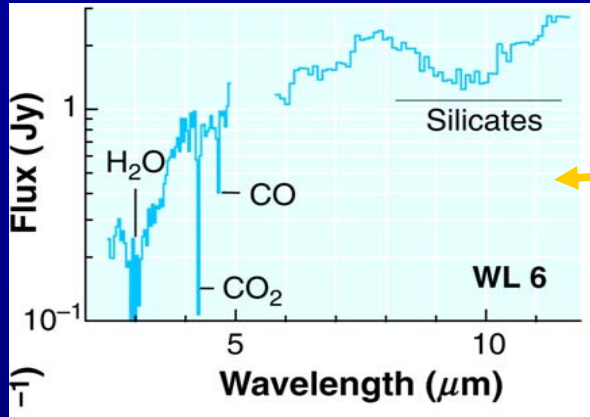
(Ceccarelli et al. 1998, Nisini et al. 1999, Giannini et al. 2001, Maret et al. 2002)



Low mass protostars: the class I

Ices and silicates Mid-IR absorption features reveal dust heating mechanisms

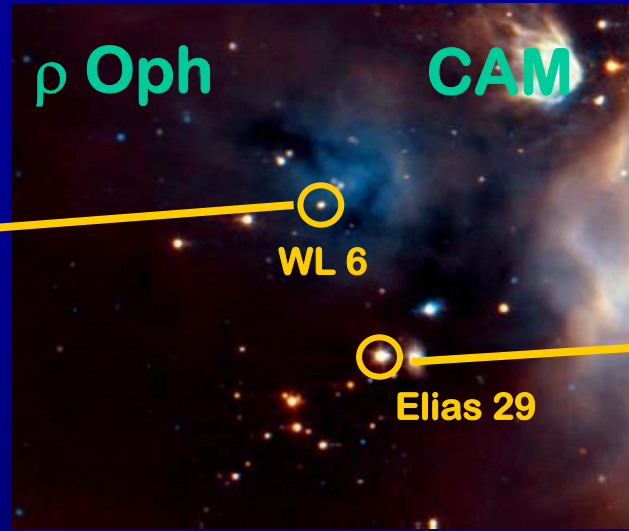
PHT-S



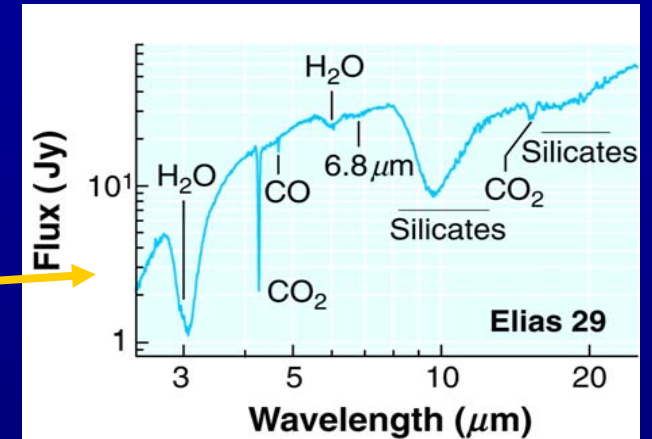
(van Dishoeck 2004)

ρ Oph

CAM



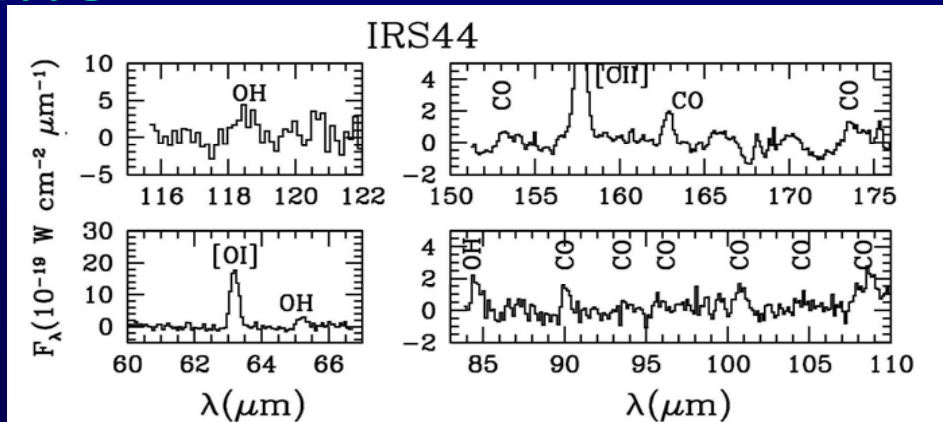
SWS



(Boogert et al. 2006)

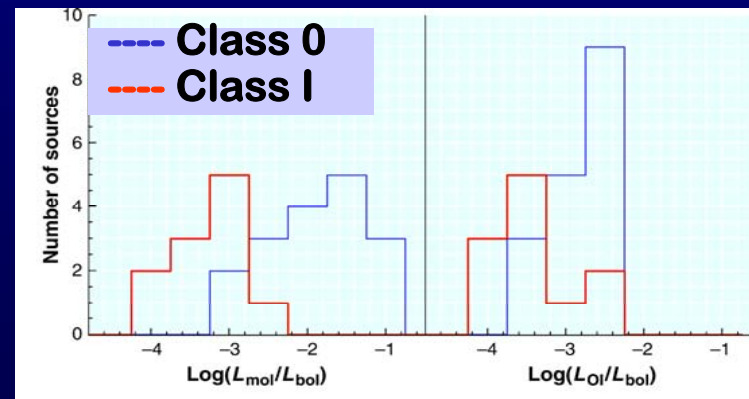
LWS

Evolution in the gas cooling channels probed by LWS



NO WATER !

(Nisini et al. 2002)

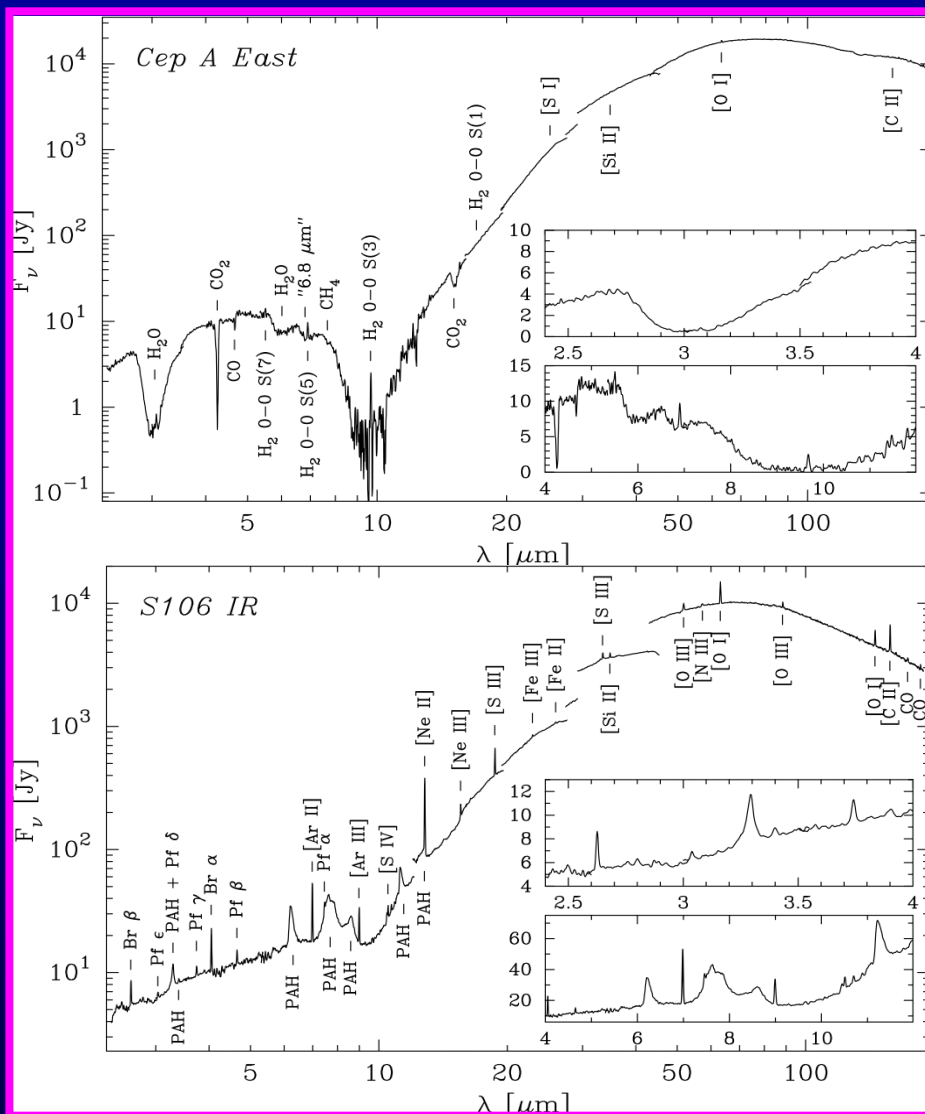


$L_{\text{mol}}/L_{\text{bol}}$

$L_{\text{OI}}/L_{\text{bol}}$

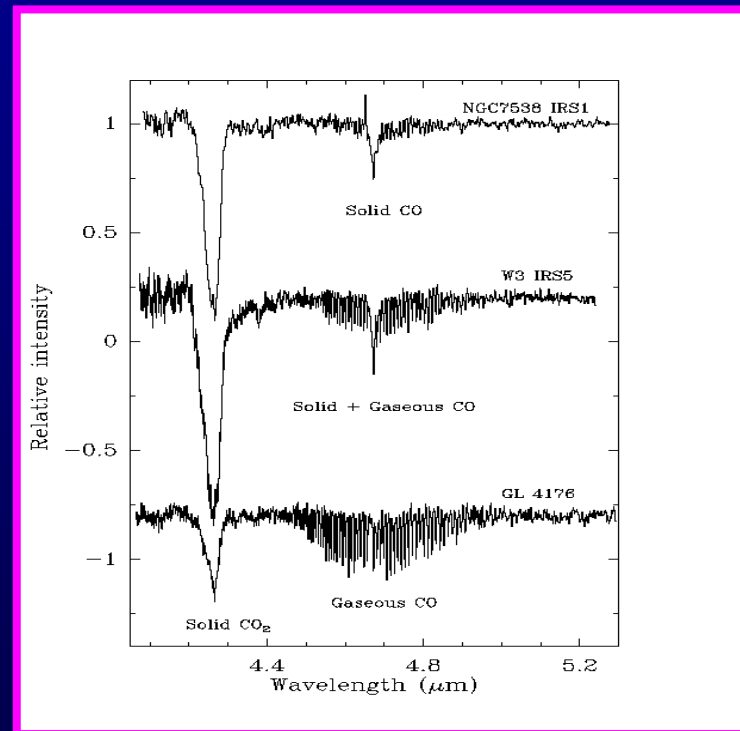
High mass protostars

SWS+LWS



Van den Ancker et al. 2000

- evolution from a deeply embedded phase to a compact HII phase
- evolution from solid-state to gaseous features

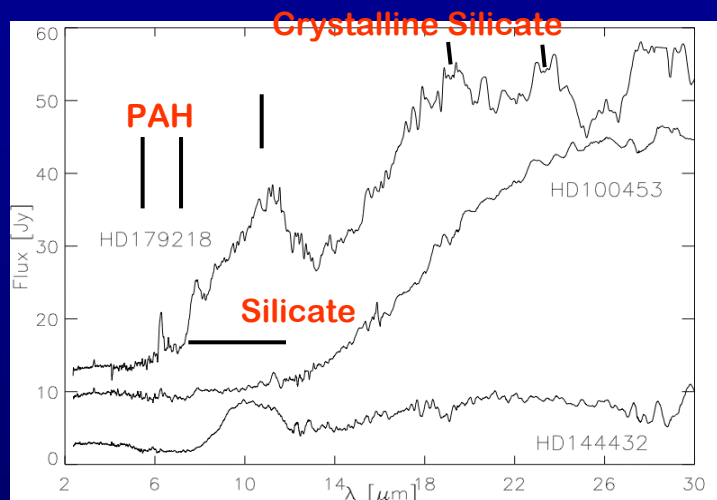


Van Dishoeck et al. 1998

Pre-main sequence stars

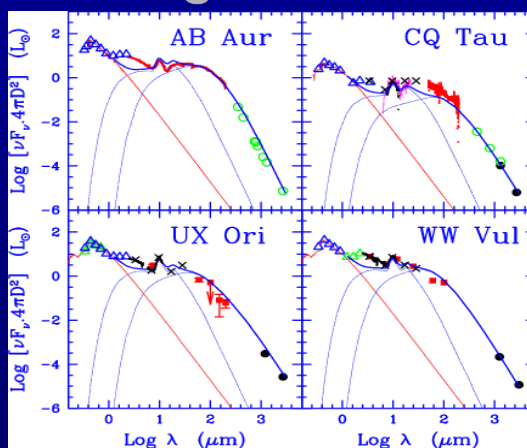
Circumstellar disks in HAeBe stars

Correlation between spectral features and IR excess



(Meeus et al. 2001)

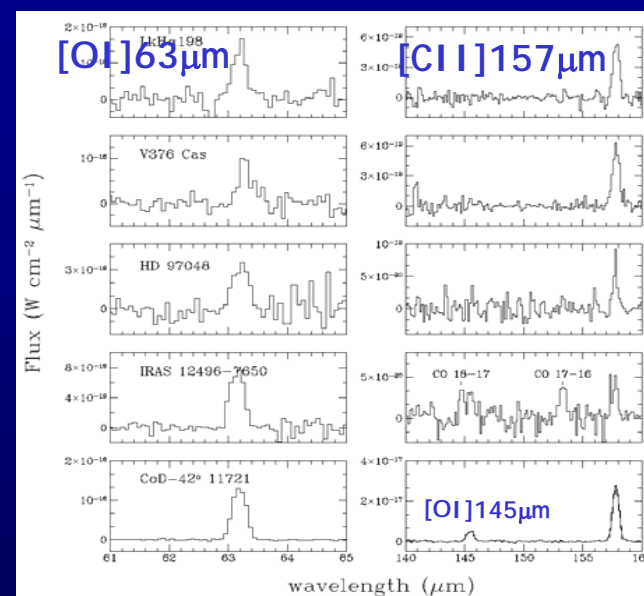
Modelling of the SEDs



(Natta et al. 2001)

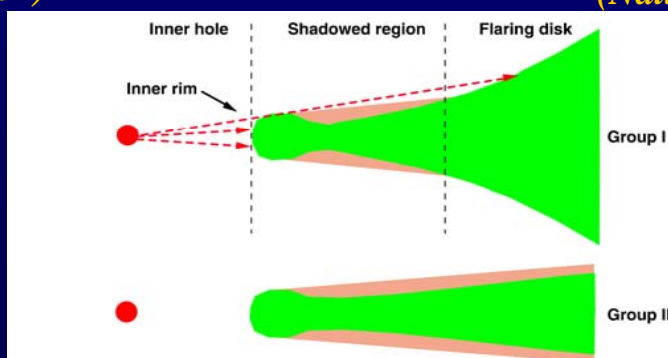
PDR in the HAeBe envelopes

LWS



(Lorenzetti et al. 1999)

SWS

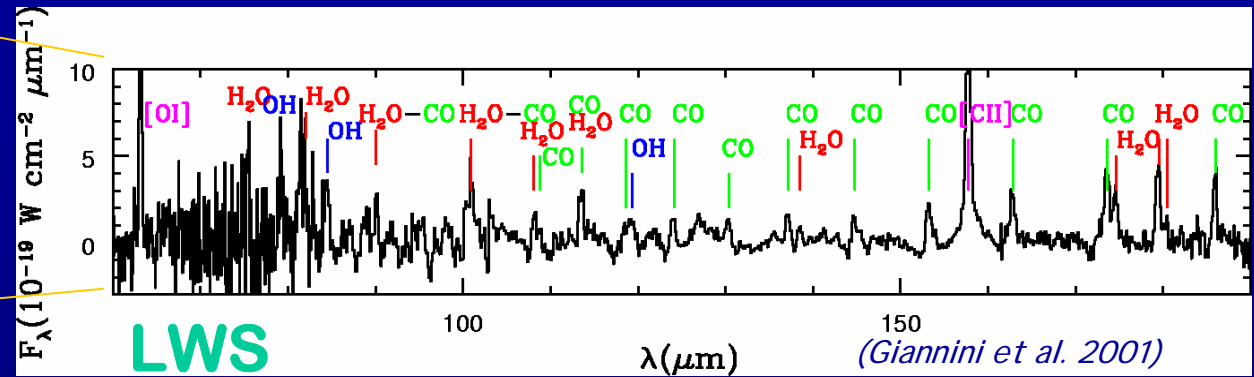
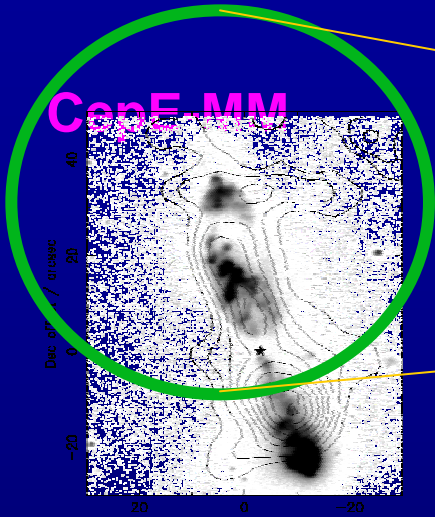


(Dullemond & Dominik 2004)

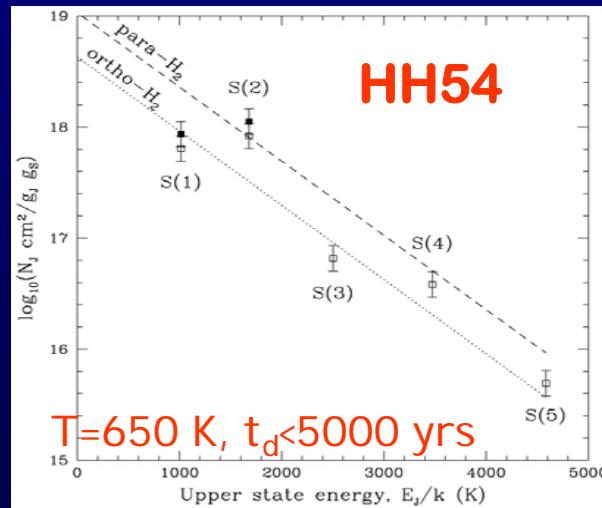
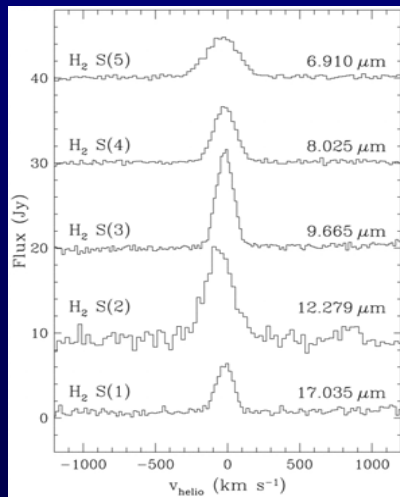
PHT

Outflows and HH objects

Embedded outflows gas cooling channels



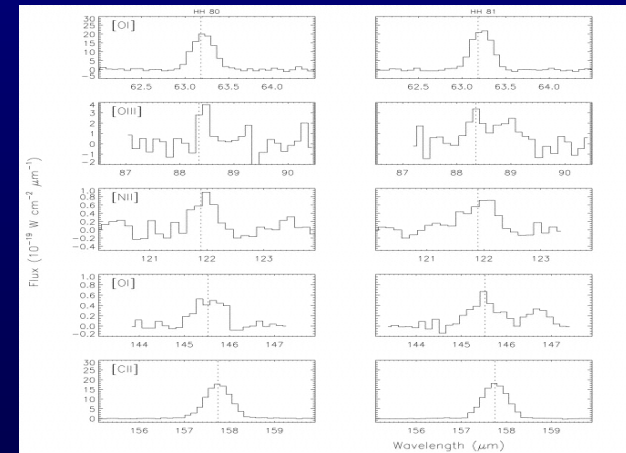
H₂ non-equilibrium para/ortho ratio



Ionic lines in HH objects

HH80

HH81



(Molinari et al. 2001)

SWS

(Neufeld, Melnick & Harwit, 1998)

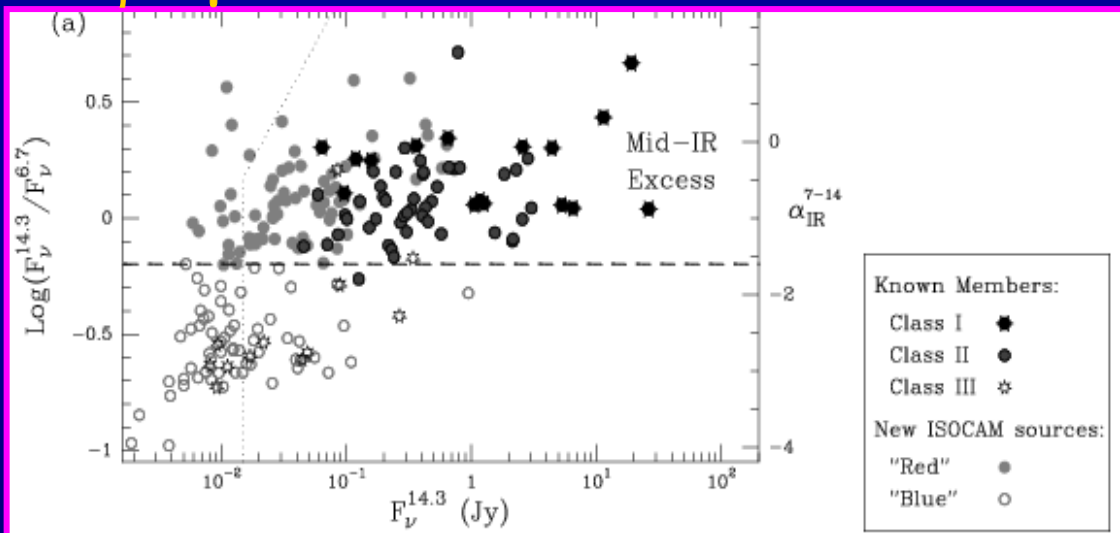
LWS

(Molinari et al. 2001)

[OI]
[OII]
[NII]
[OI]
[CII]

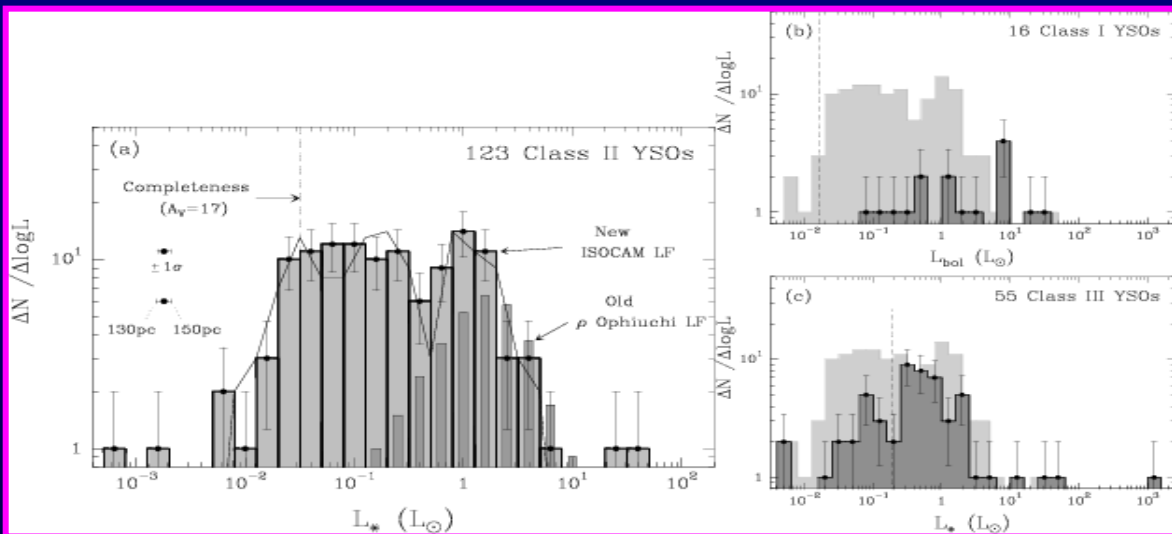
Census of YSOs

The ρ -Oph embedded cluster



ISOCAM survey of near-by clouds

- census of IR-excess population (twice as large as known from Near-IR)
- classification of IR-excess population
- LF (down to $0.03 L_{\odot}$) : $\sim 20\%$ of sources putative brown dwarfs with disks

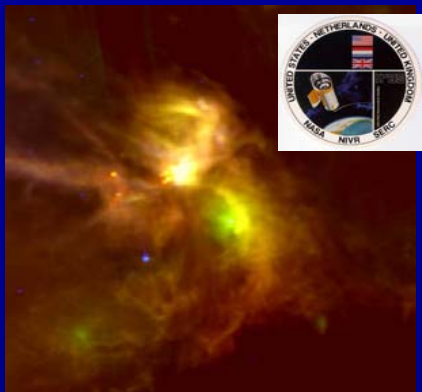


~ 20 clouds observed

(Bontemps et al. 2001)

Putting ISO in a contest

Past

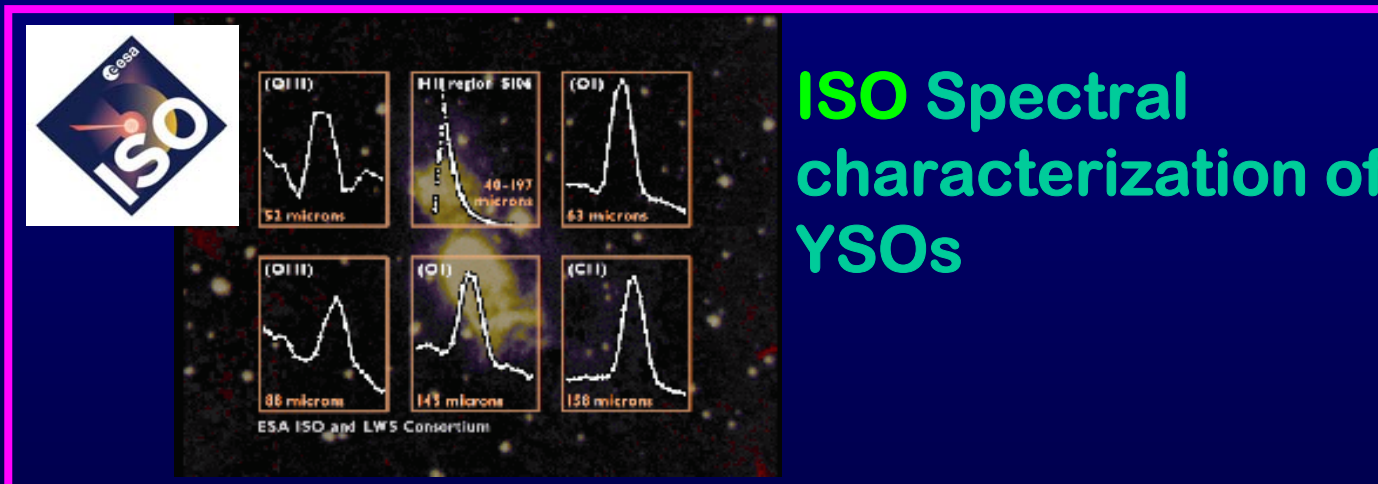


IRAS First census of protostellar sources

Present



Spitzer Deep mid-IR surveys of mol. clouds



ISO Spectral characterization of YSOs

The image displays the ISO logo on the left. To its right, six spectral plots are arranged in a 2x3 grid. The top row shows plots for (OI) at 53 microns, HII region S104 at 40-197 microns, and (OI) at 63 microns. The bottom row shows plots for (OI) at 86 microns, (OI) at 143 microns, and (CI) at 156 microns. The text 'ESA ISO and LWS Consortium' is at the bottom of the plots.

Future



JWST