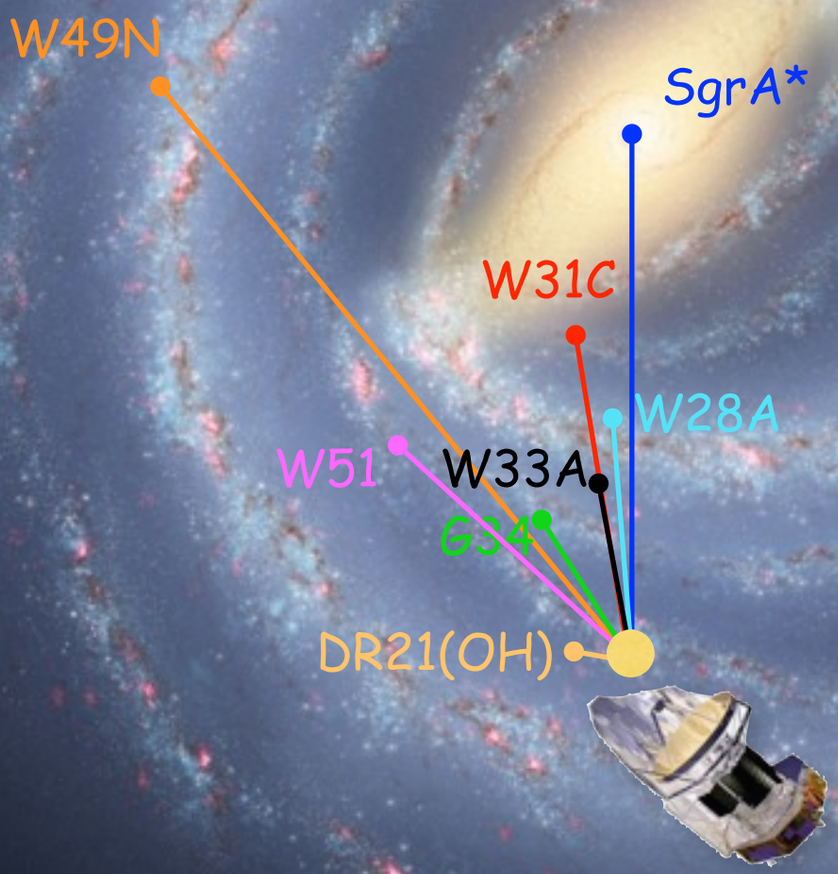
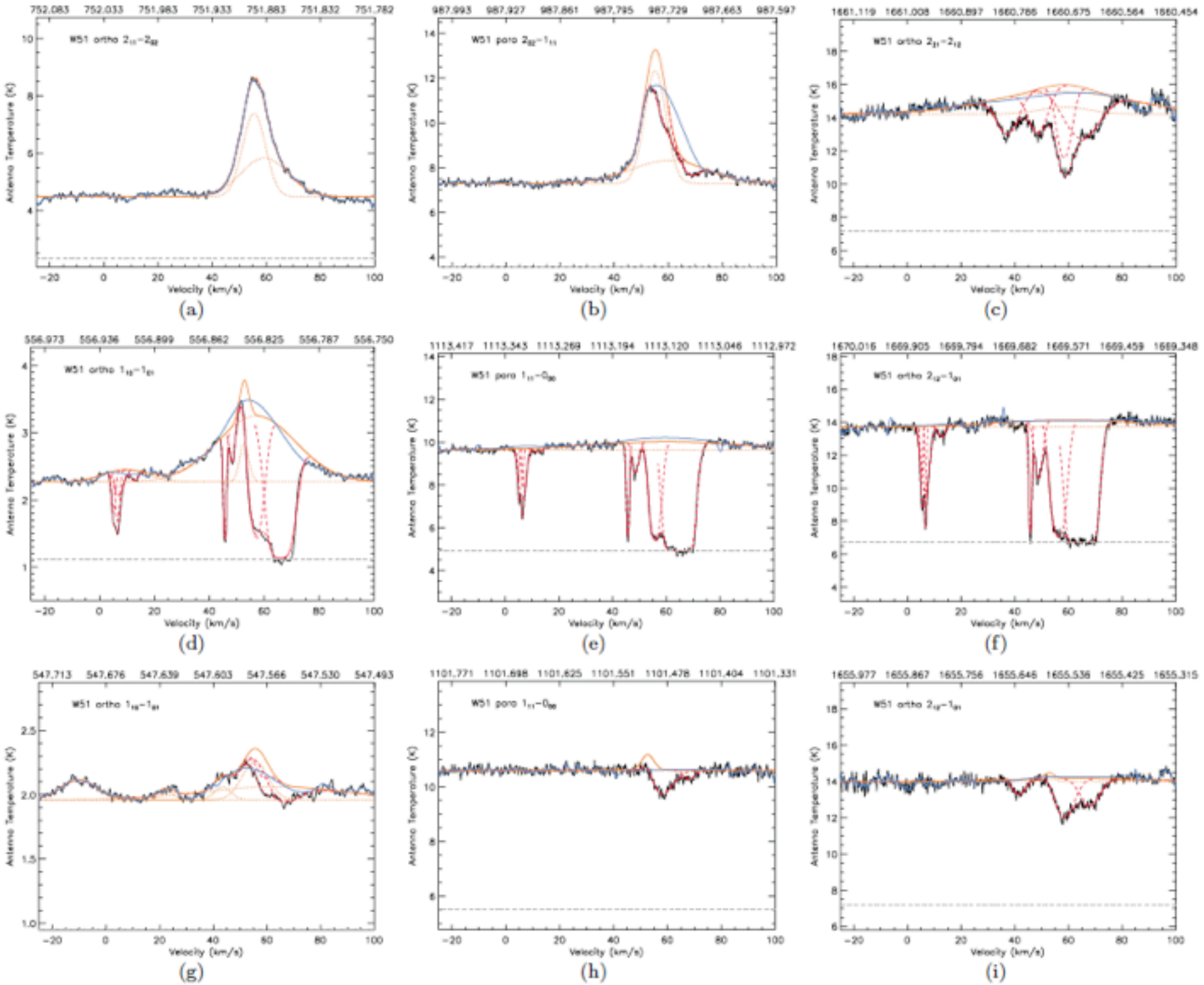
Water (and isotopologs) in the PRISMAS program



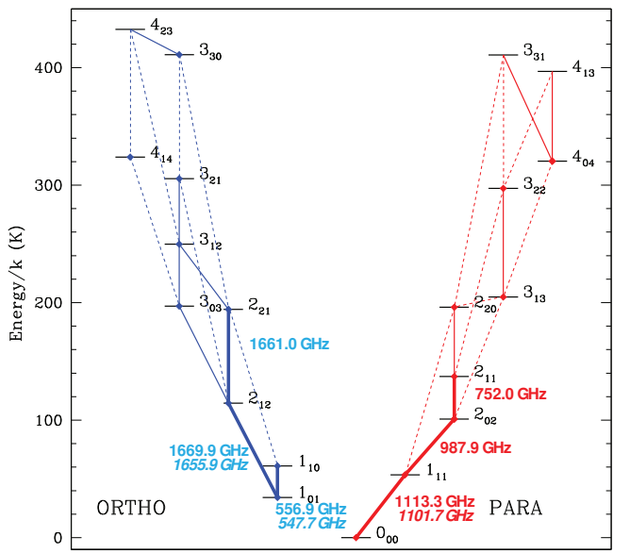
Charlotte VASTEL (IRAP, Toulouse)

Example: Water in W51



Complexe profiles with wings and self-absorption (Flagey et al. 2013)

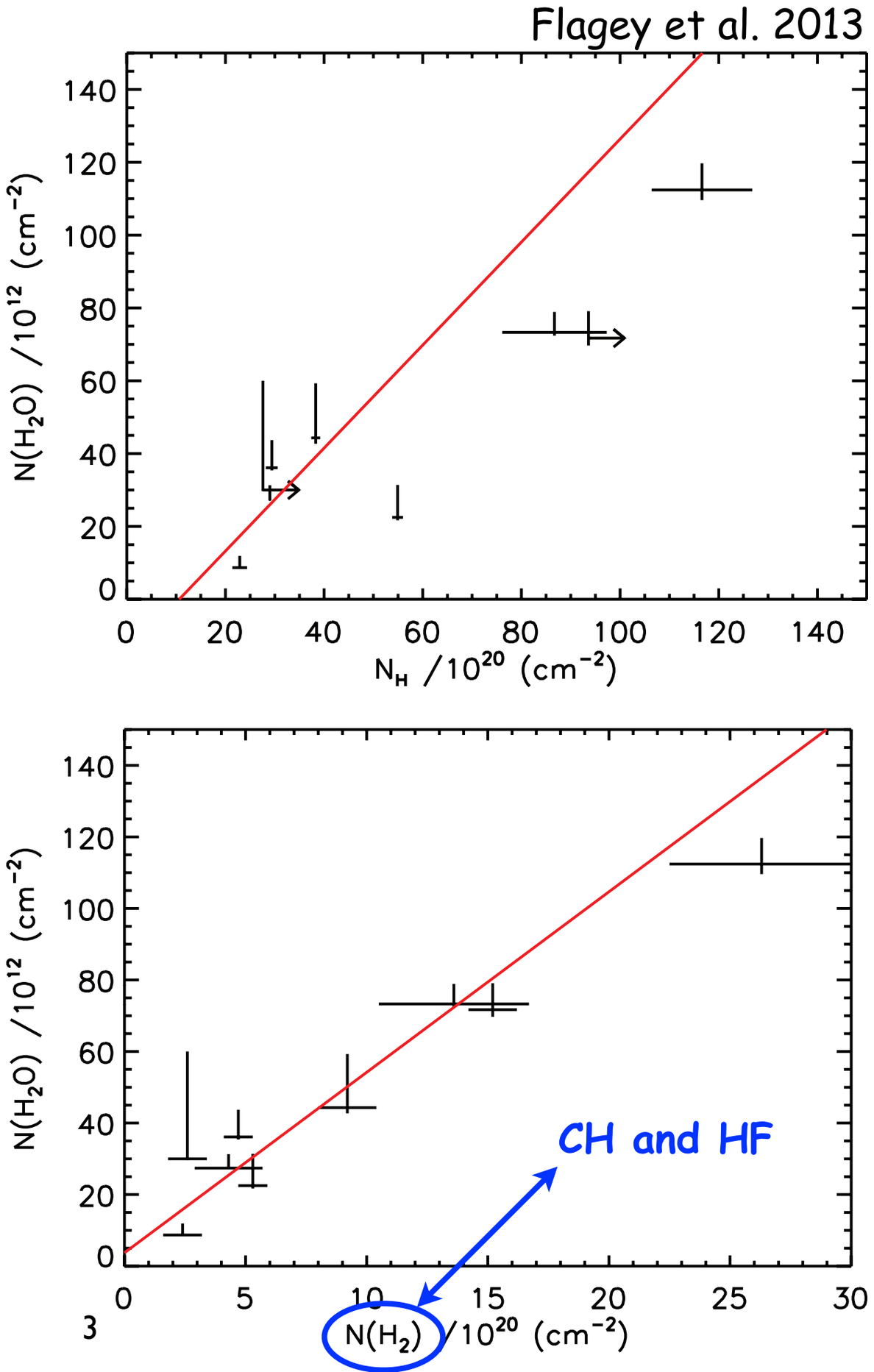
620 GHz maser line (Neufeld et al. in prep)



Abundance of water

Column density
- varies between a few 10^{12} and about 10^{14} cm^{-2}
- well correlated with N_H:
  $N(H_2O)/N_H \approx 10^{-8}$

Even better correlation with $N(H_2)$ over about 1 order of magnitude
$N(H_2O)/N(H_2) \approx 5 \times 10^{-8}$



Abundance of water

Variations of the abundance:

Scatter seems more important with N_H than $N(H_2)$
$N(H_2O)/N_H$ increases with f(H2) while $N(H_2O)/N(H_2)$ keeps constant
=> $N(H_2O)$ tracer of N(H2) rather than of N_H

Cloud	$N(\mathrm{H_2O})/N(\mathrm{H_2})$	$N(\mathrm{H_2O})/N_H$
DR21(OH) (4 to 18 km s^{-1})	$4.7^{+0.8}_{0.4}$	<0.77
G34.3+0.1 (8 to 16 km s^{-1})	$7.7^{+2.7}_{1.1}$	$1.2^{+0.3}_{0.1}$
G34.3+0.1 (22 to 34 km s^{-1})	$4.2^{+2.2}_{0.6}$	$0.41^{+0.17}_{0.02}$
G34.3+0.1 (42 to 55 km s^{-1})	<10.4	-
W33(A) (21 to 26 km s^{-1})	4^{+2}_{1}	$0.38^{+0.16}_{0.03}$
W33(A) (26 to 31.5 km s^{-1})	$4.8^{+2.3}_{0.8}$	$1.2^{+0.4}_{0.1}$
W49(N) (26 to 48 km s^{-1})	5^{+2}_{1}	$0.8^{+0.2}_{0.1}$
W49(N) (48 to 73 km s^{-1})	$4.3^{+0.9}_{0.7}$	$1.0^{+0.1}_{0.1}$
W51 (3 to 15 km s^{-1})	6^{+3}_{2}	$0.94^{+0.1}_{0.01}$
W51 (44 to 51 km s^{-1})	12^{+15}_{4}	<1.1

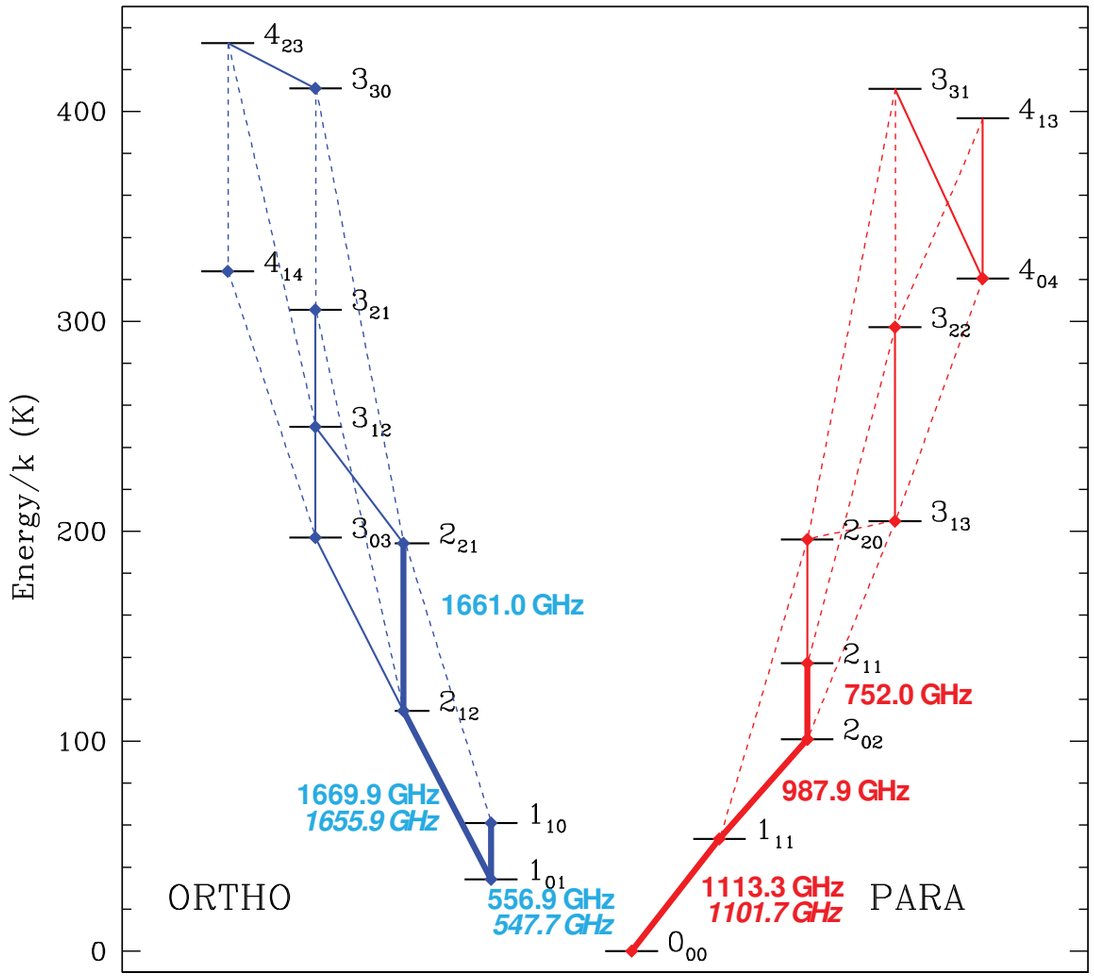
Note. — $N(H_2O)$ are in units of 10^{12} cm^{-2}. $N(H_2)$ and N_H are in units of 10^{20} cm^{-2}. Abundances are in units of 10^{-8}.

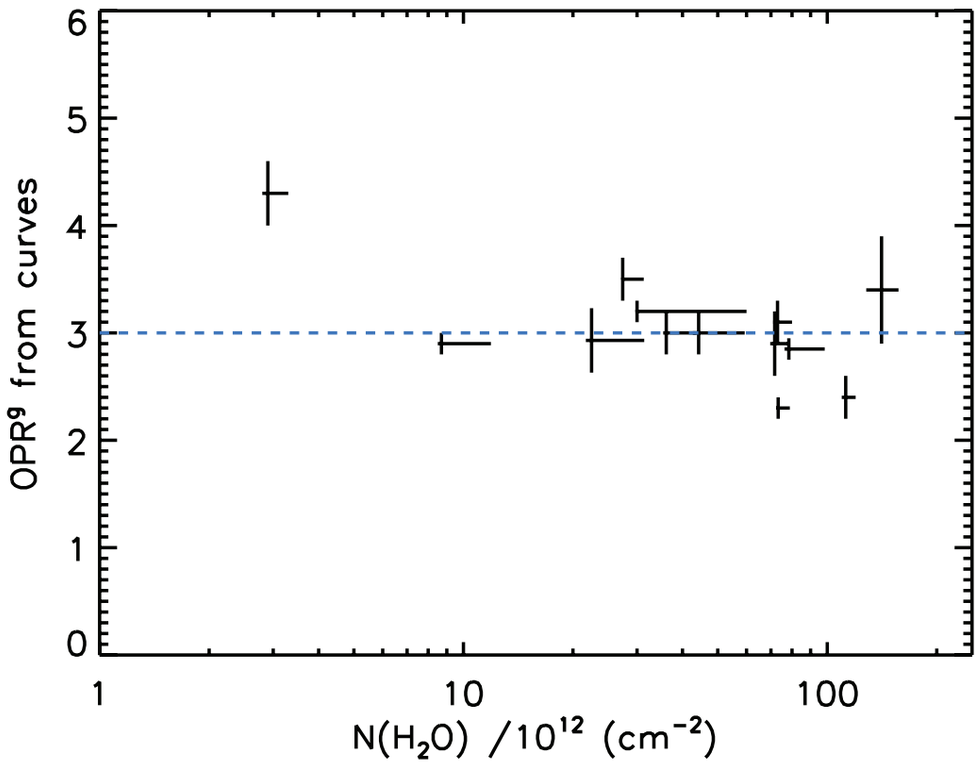
Ortho to para ratio

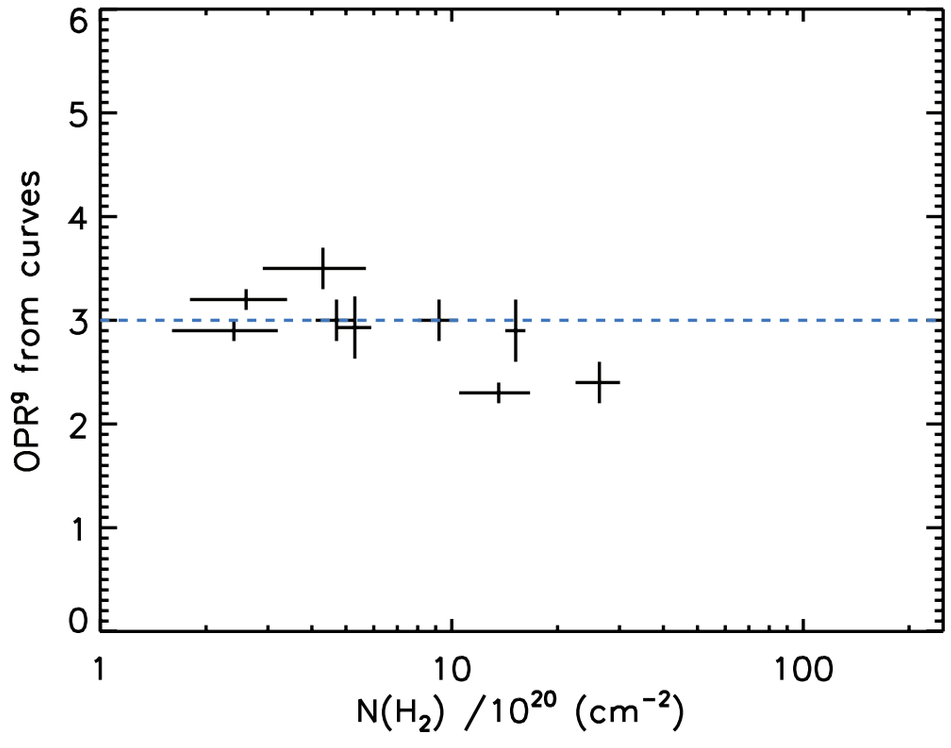
Value of 3 expected at high temperature (above ≈ 40K)

Herschel allows for the first time to actually measure the OPR rather than assuming a value of 3

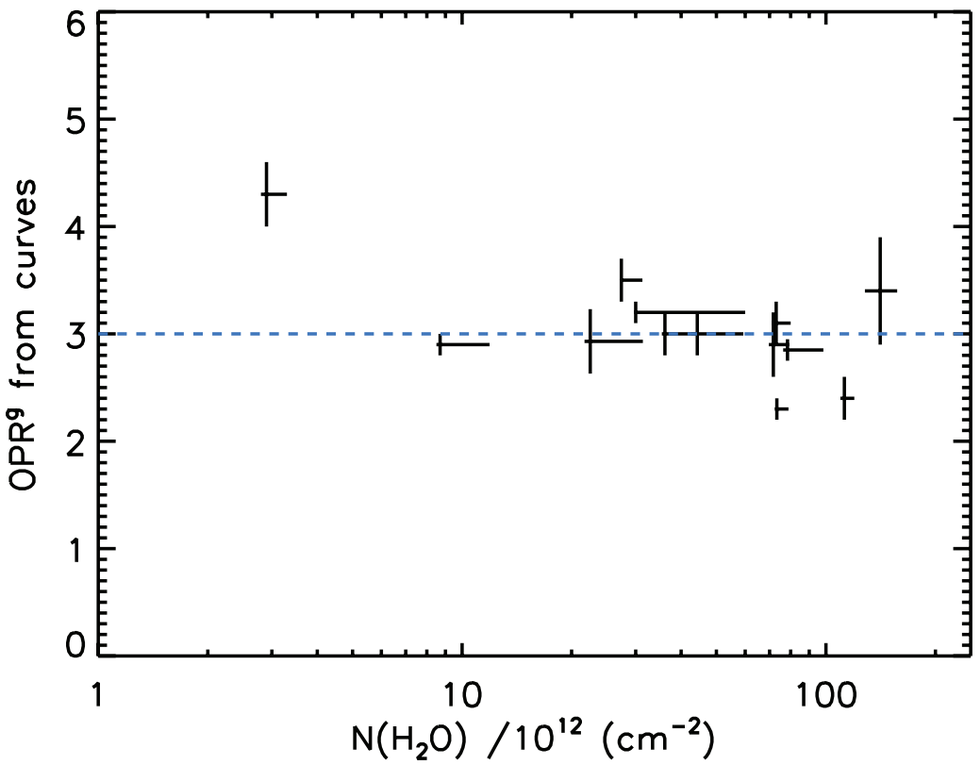
Temperature in the observed translucent clouds is expected to be 50-100 K (lower in most dense clouds)

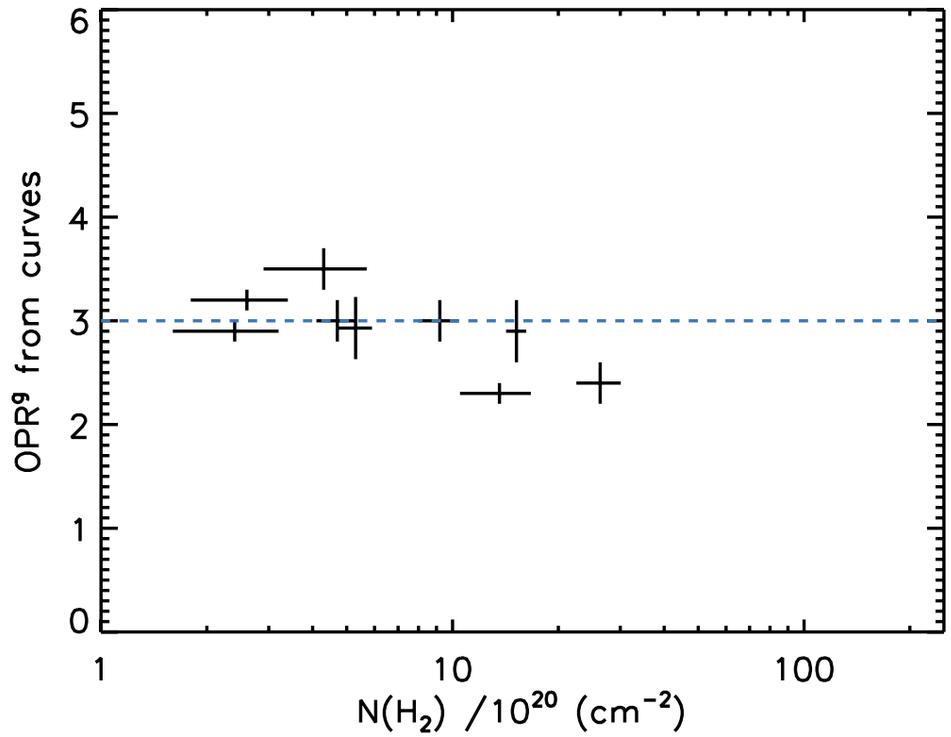






Ortho to para ratio





Out of 13 clouds, 10 have an OPR less than 3- σ away from a value of 3.0

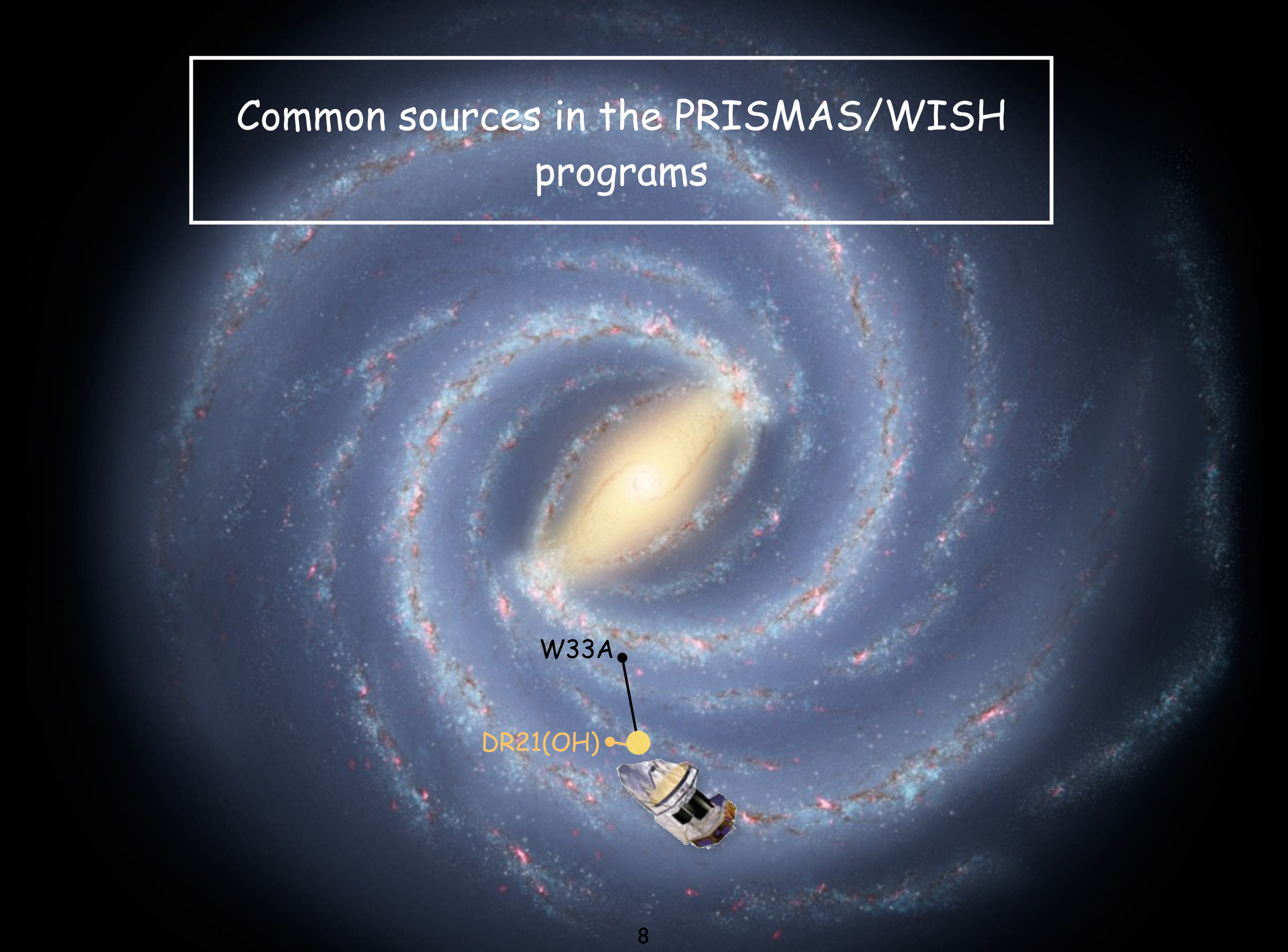
(1 cloud has an OPR above 3.0)

Lowest OPR values are in two clouds with the highest column density. Expected temperature lower than 50K. In their densest parts, water could be stuck on grains. Cold water released from ice. Longer thermalisation time in translucent (10^7 years) than opaque regions (10^5 years) because of lower density.

Water in the Galaxy

- Most complete set of observations of water in Galactic translucent clouds
- Column density of water (10^{12}-10^{14} cm^{-2}) very well correlated with that of molecular hydrogen:
  $X(H_2O) = 5 \times 10^{-8}$
- Ortho ground state transitions allow constrain of excitation temperature (< 5K) and fractional abundance in excited levels (<< 1%)
- OPR in agreement with value of 3 except in two clouds with high column density which relates to cold event in the history of the water molecules

Common sources in the PRISMAS/WISH programs



HDO level diagram

E/k (K)

150

100

50

0

J

0

1

2

3

$3_{1,2}$

$2_{2,0}$

$2_{2,1}$

$3_{1,3}$

$3_{0,3}$

225.897

753.411

$2_{1,1}$

$2_{1,2}$

$2_{0,2}$

241.562

848.962

599.927

490.596

919.311

$1_{1,0}$

$1_{1,1}$

$1_{0,1}$

80.578

509.292

893.639

464.924

$0_{0,0}$

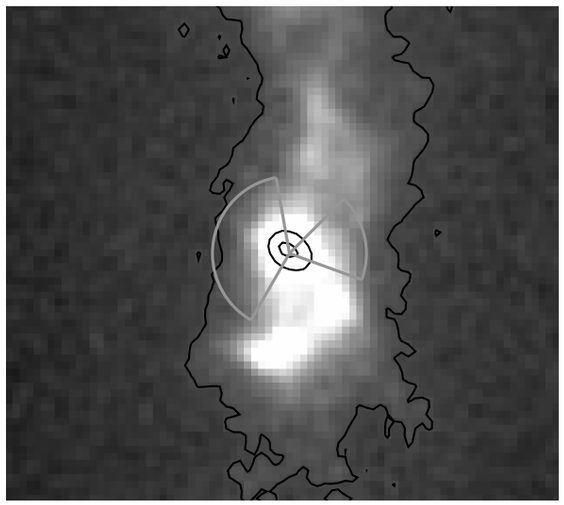
IRAM-30m

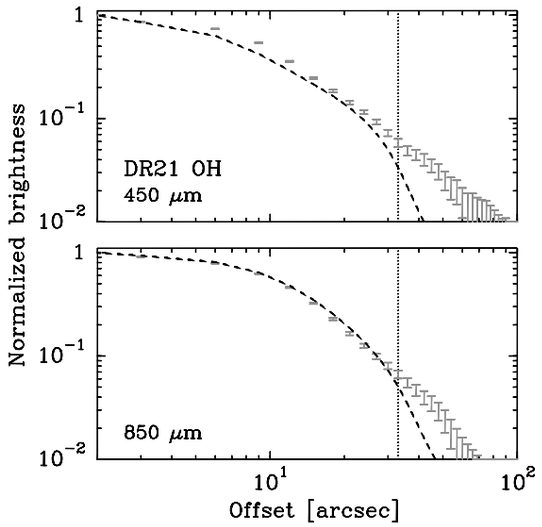
HIFI-KP

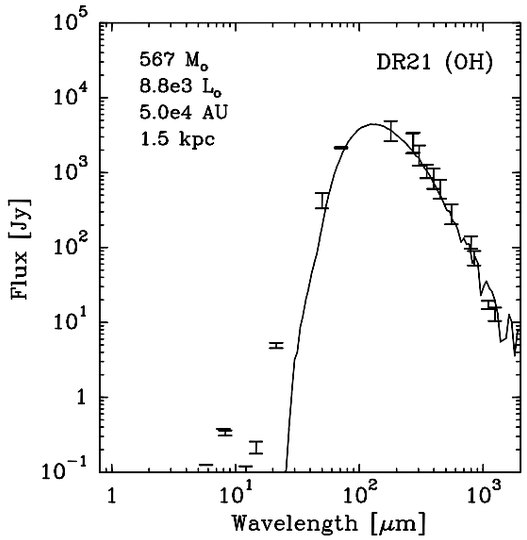
CSO

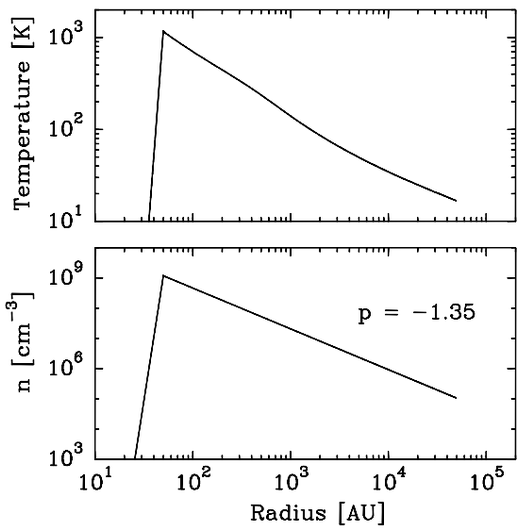
HIFI-OT

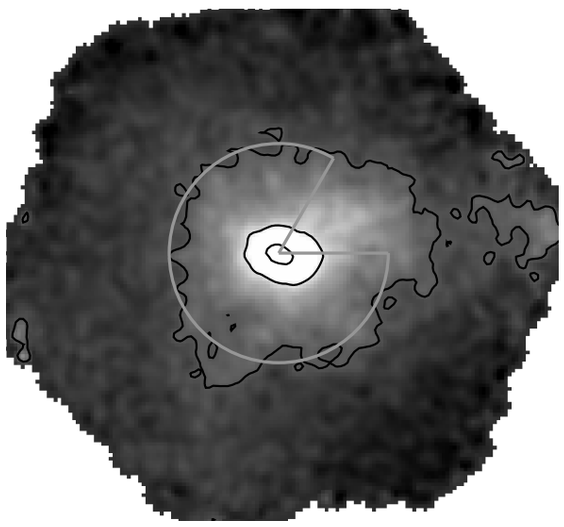
+ 226 GHz
IRAM maps

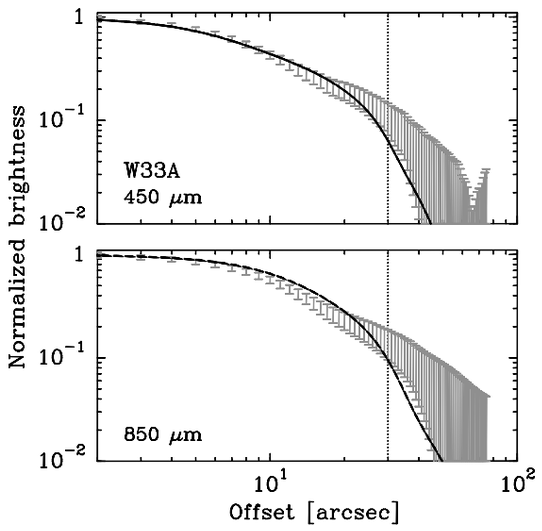


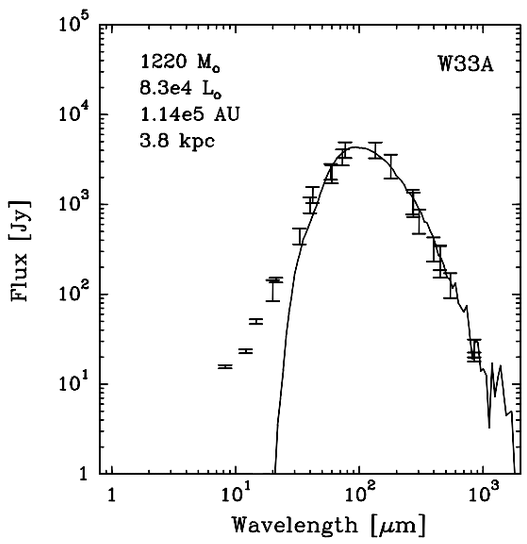


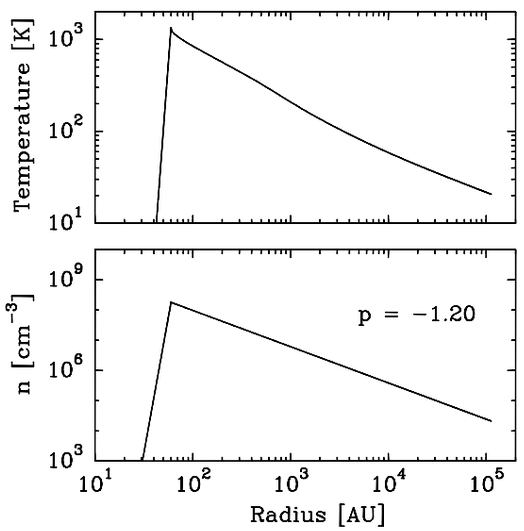












Luis Chavarria: W33A, DR21(OH)

Density profiles and source size were estimated using SCUBA data. Mass and luminosity estimations are from the SED fitting.