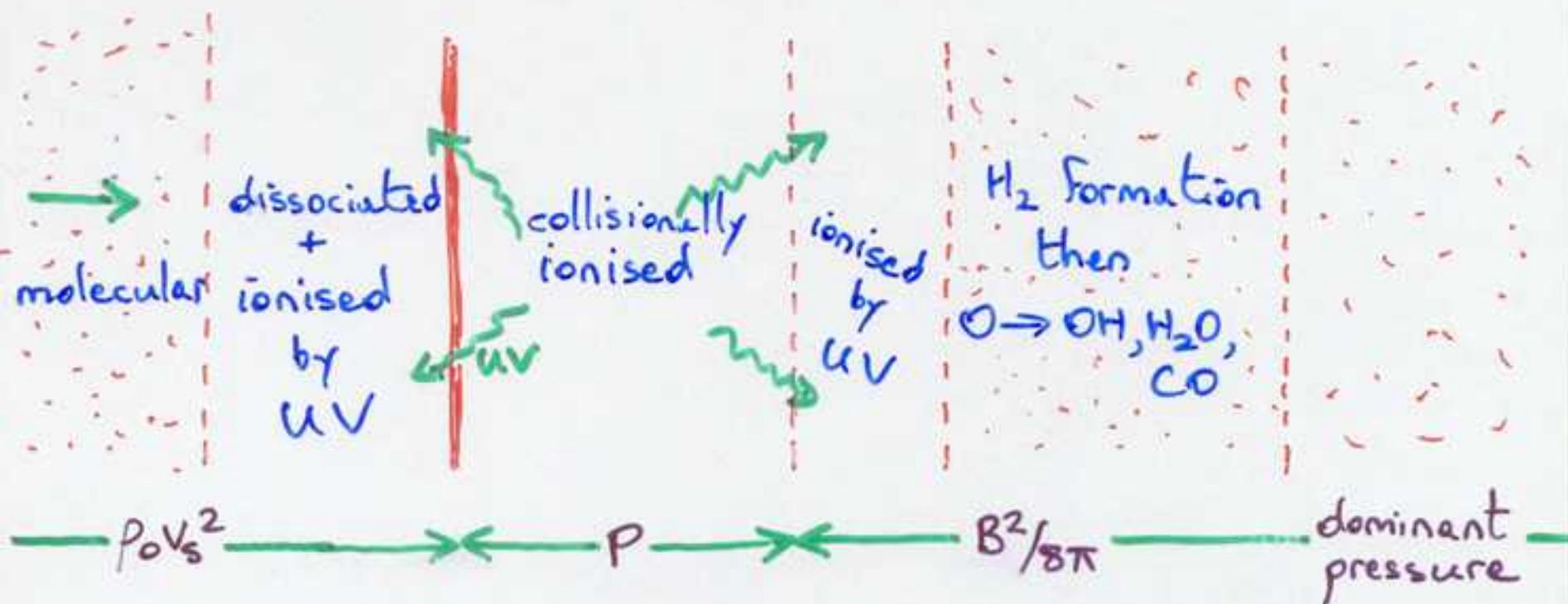


$v_s \gtrsim 40 \text{ km/s}$

"J-type", or "fast", or "dissociative" shocks

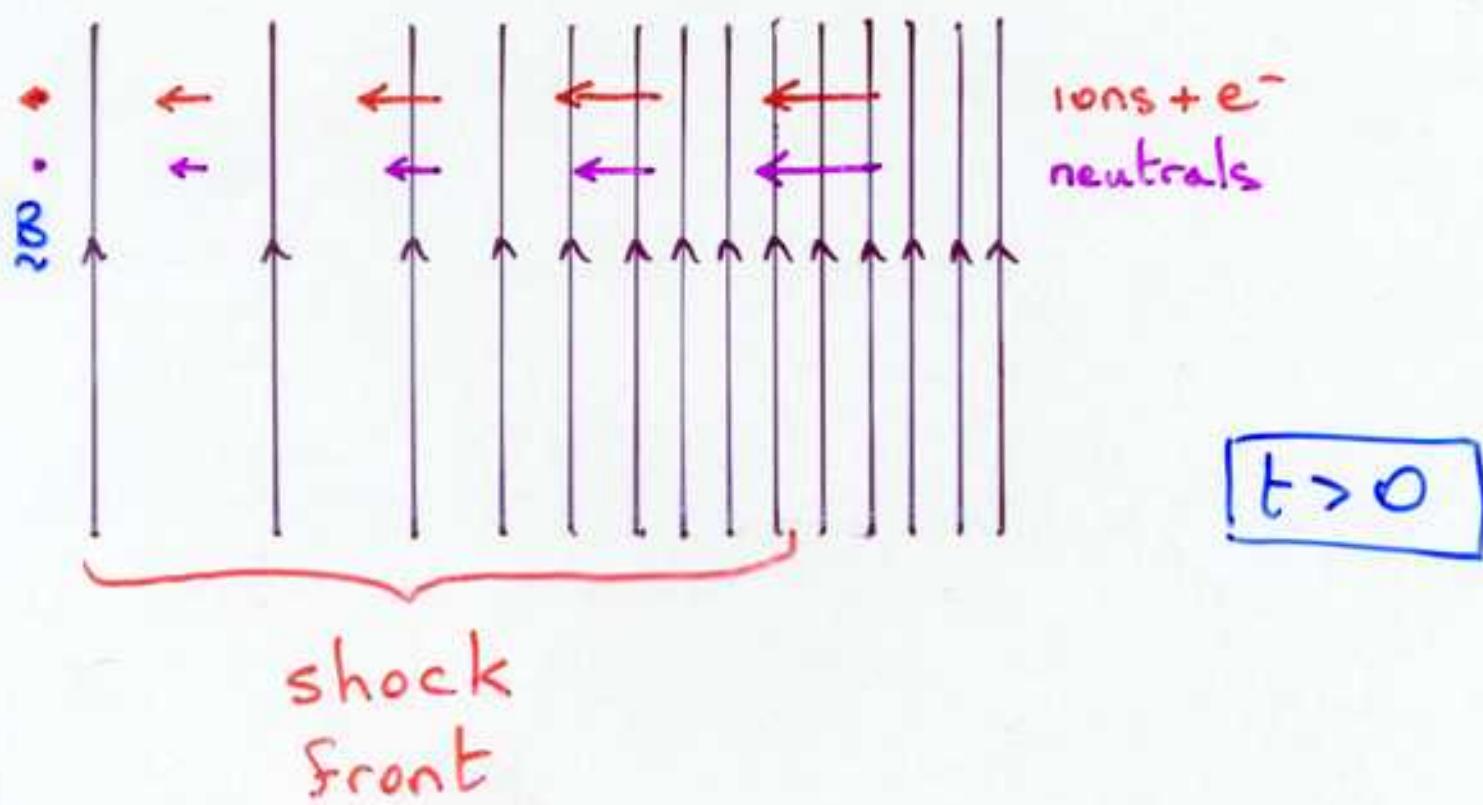
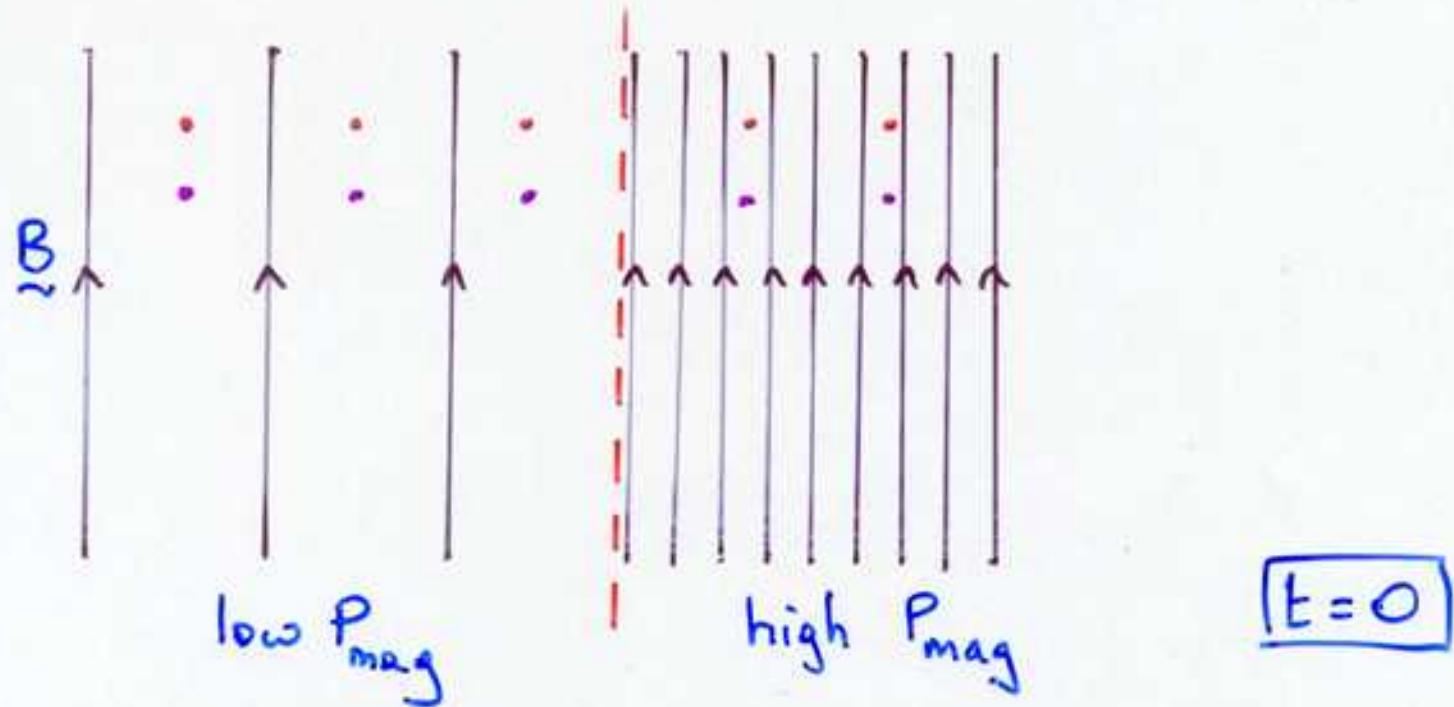


T(K)	10	$10^5 \left(\frac{v_s}{100} \right)^2$	10^4	5000	500	100
N _H (cm ⁻²)	0		$\sim 10^{17}$	10^{18}	$10^{21}-10^{22}$	

- inefficient production of IR/FIR line emission
most energy UV → grains → FIR continuum
- $v_s \lesssim 100 \text{ km s}^{-1} \Rightarrow$ no ionisation precursor

C-type shocks

$v_s \lesssim 40 \text{ km/s}$



Consequences

1. Shock is much broader
2. Heating + cooling occur simultaneously
→ shock is cooler [typically 2000 K]
3. Molecules not destroyed
 - radiate away energy in molecular lines
eg H₂
4. Interesting chemistry occurs in front
 - warm, dense molecular gas
eg OI → OH → H₂O

C-type

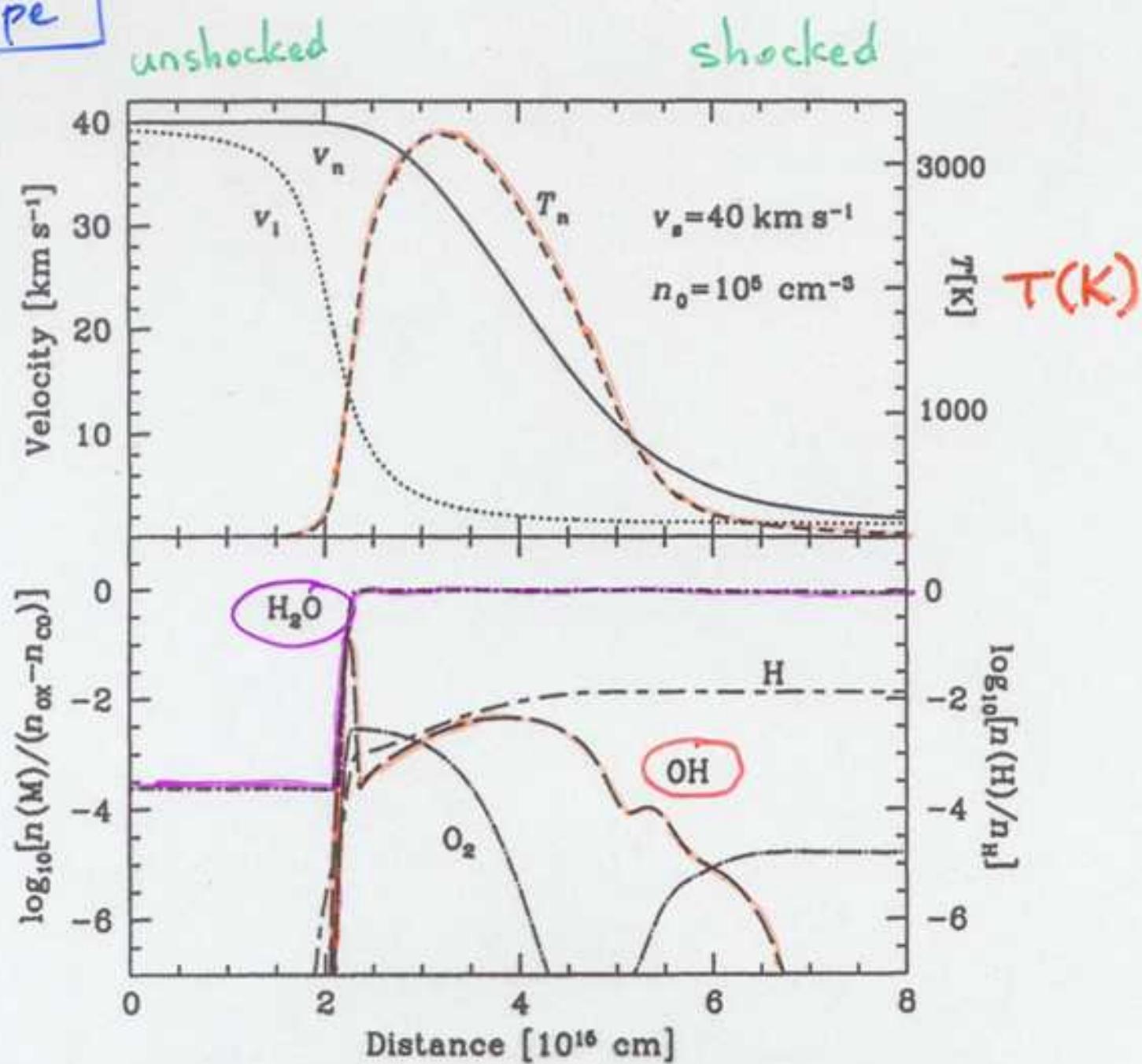


FIG. 1.—Shock profiles for a 40 km s^{-1} MHD shock propagating in gas of preshock H_2 density 10^5 cm^{-3} , and with a preshock magnetic field of $447 \mu\text{G}$. The upper panel shows the flow velocities of the neutral fluid (v_n) and the ionized fluid (v_i) and the temperature of the neutral fluid (T_n) as a function of distance through the shocked region. The lower panel shows the abundances of the species O_2 , OH , H_2O , and H [expressed relative to H nuclei in the case of H atoms (right axis) and relative to O nuclei not locked in CO in the case of O_2 , OH , and H_2O (left axis)].



(Kaufman + Neufeld 1996)

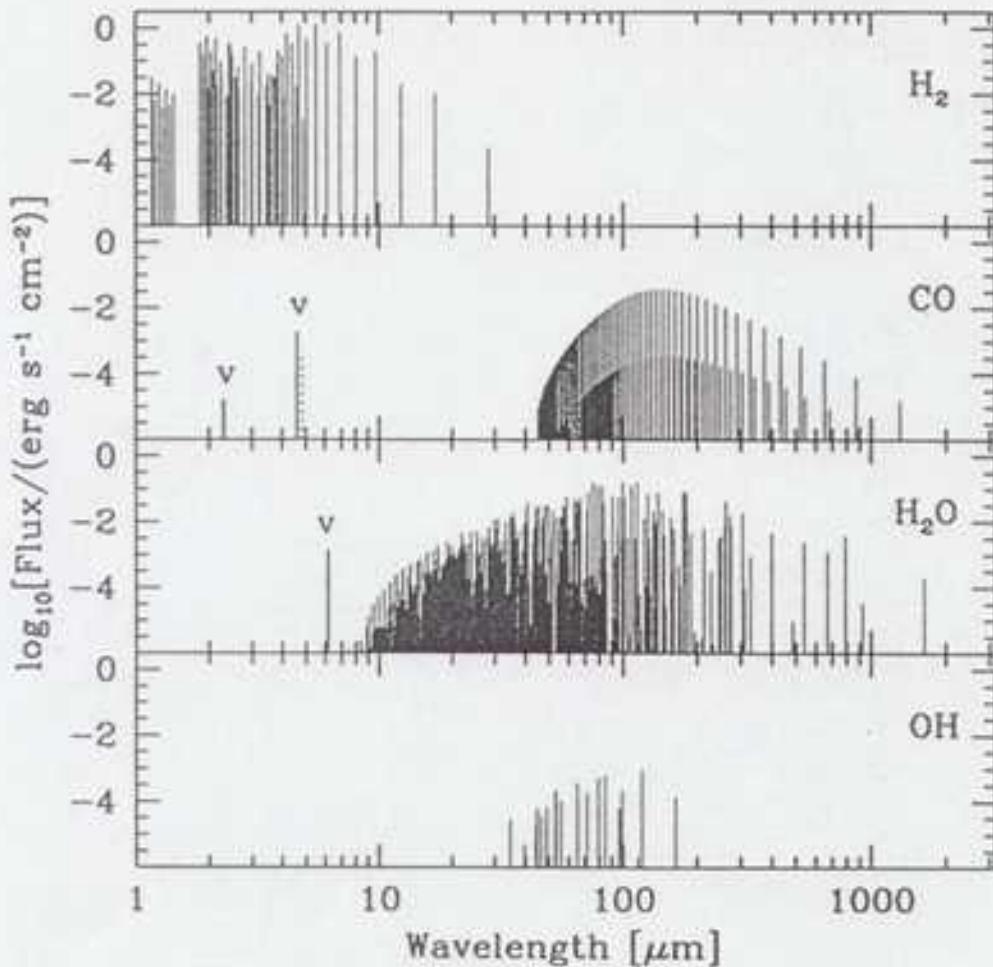
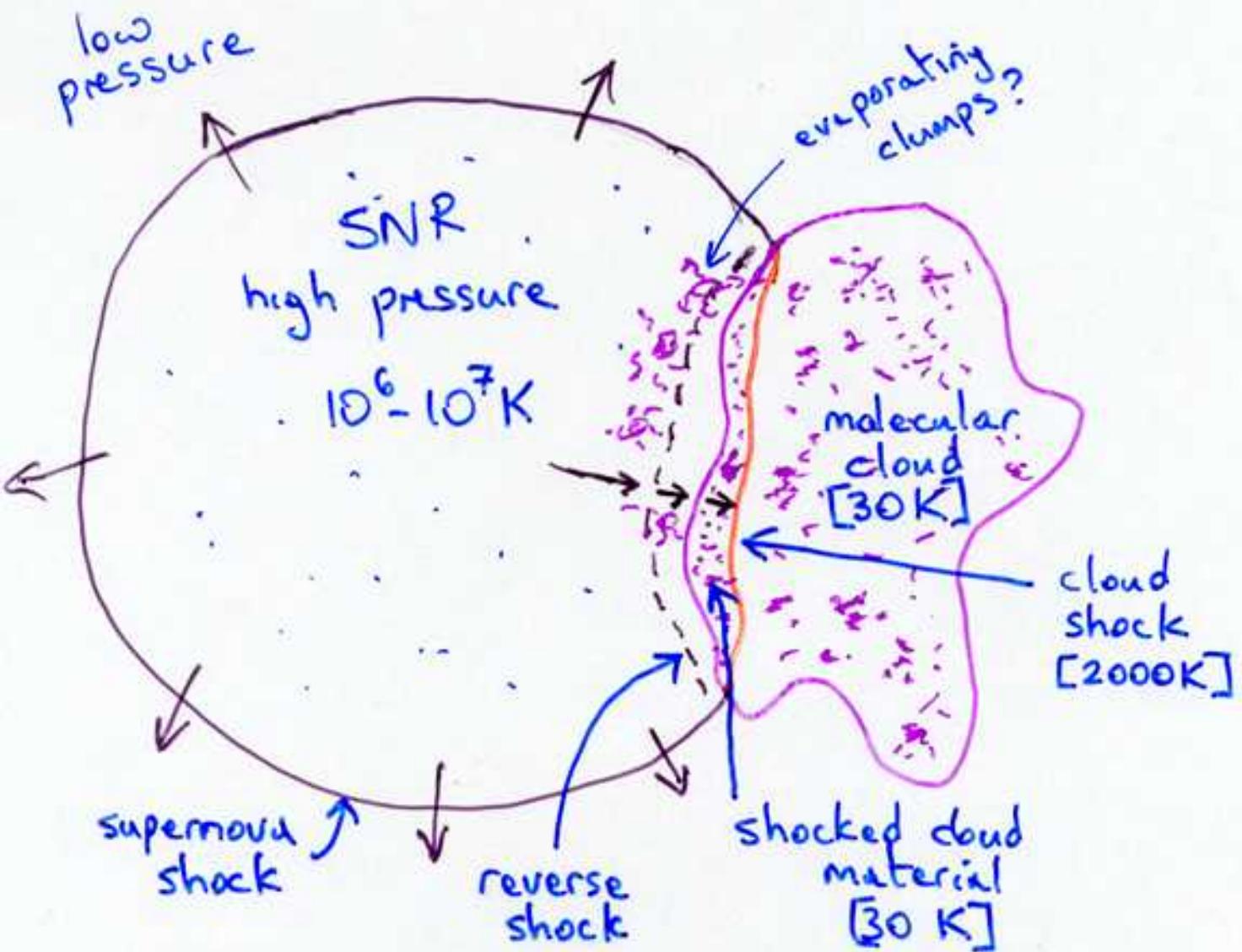
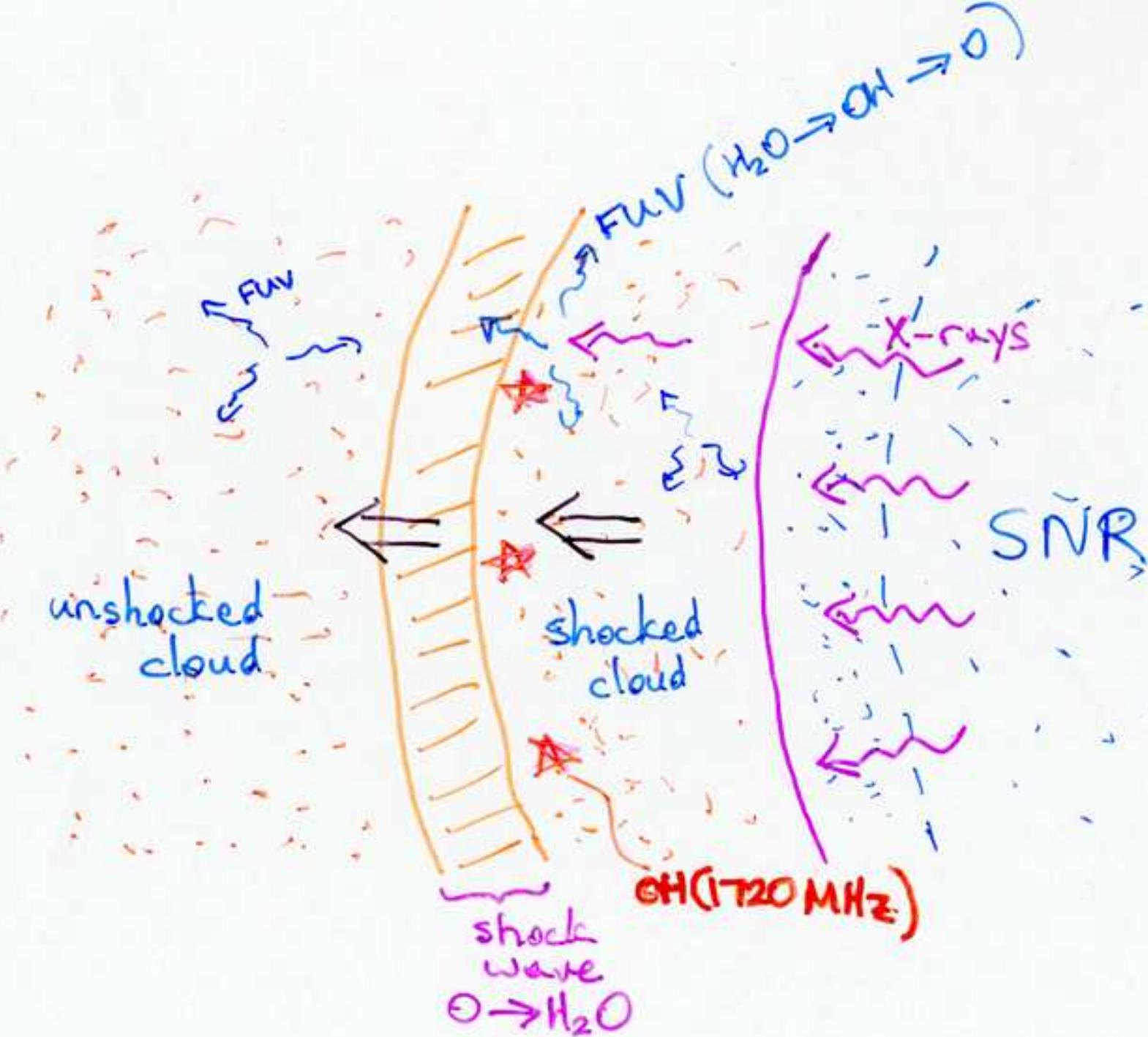


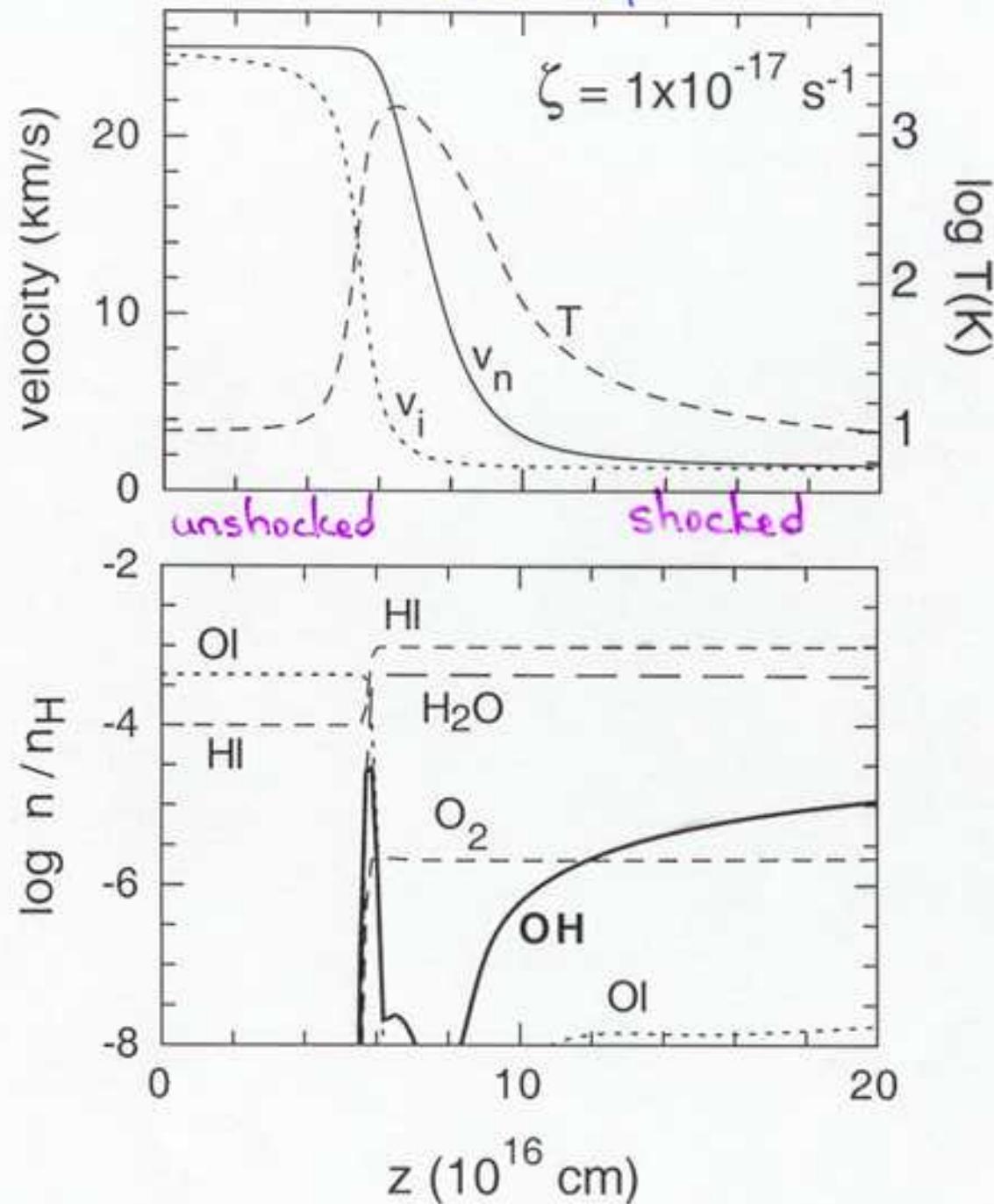
FIG. 4.—Line emission from a 40 km s^{-1} MHD shock wave propagating in gas with preshock density 10^5 cm^{-3} and with a preshock magnetic field of $447 \mu\text{G}$. Results are shown for rotational and ro-vibrational transitions of H₂ (*top panel*), rotational transitions of ¹²CO and ¹³CO (*second panel*), rotational transitions of H₂O (*third panel*), and rotational transitions of OH (*bottom panel*). Also shown are the total fluxes in the ¹²CO $v = 1-0$ and $v = 2-0$ vibrational bands near $4.6 \mu\text{m}$ and $2.3 \mu\text{m}$ (*solid lines*) and the $v = 2-1$ vibrational band near $4.6 \mu\text{m}$ (*dotted line*) and in the v_2 H₂O vibrational band near $6.2 \mu\text{m}$ (*solid line*).

Kaufman + Neufeld 1996 ApJ 456 611

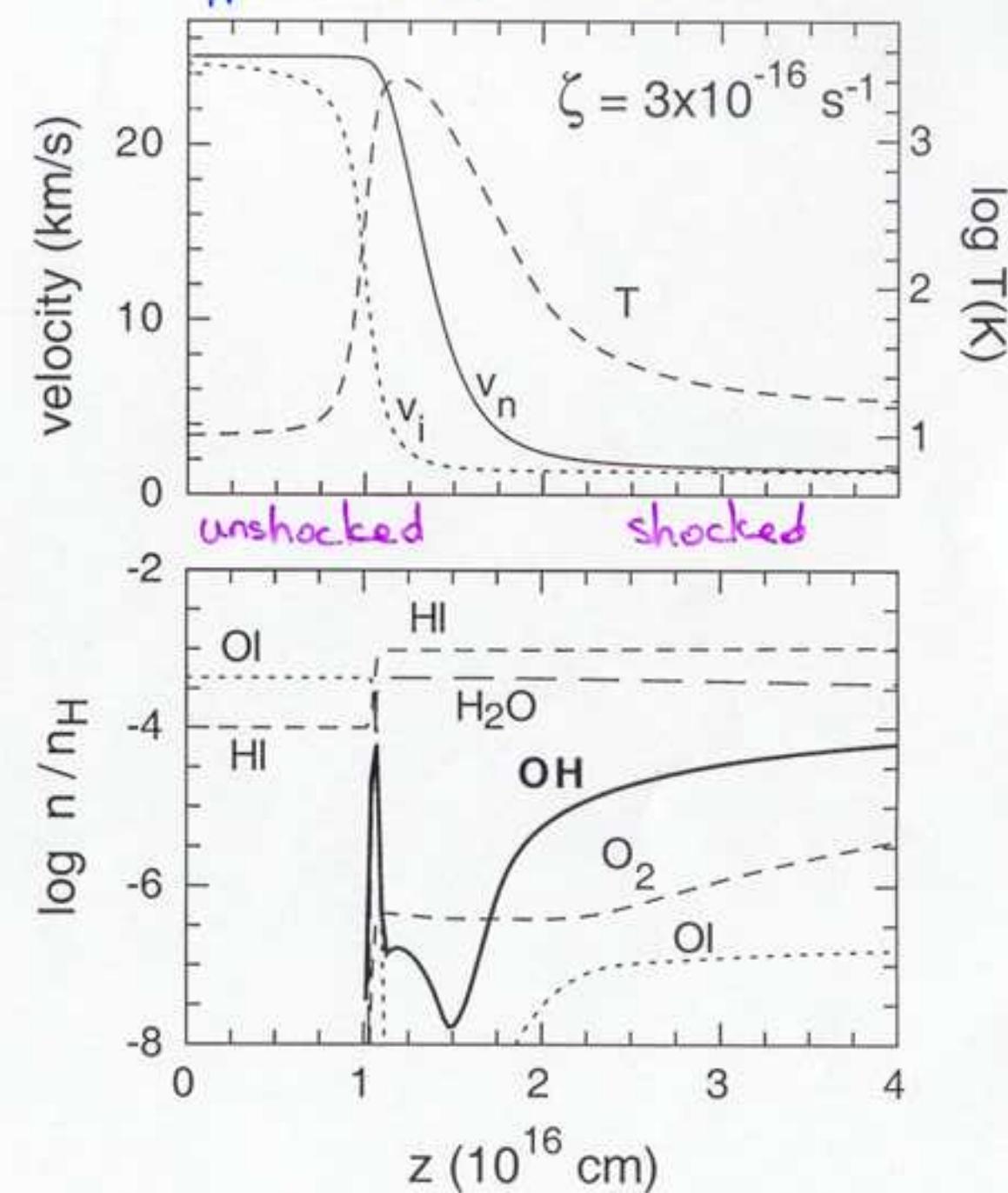




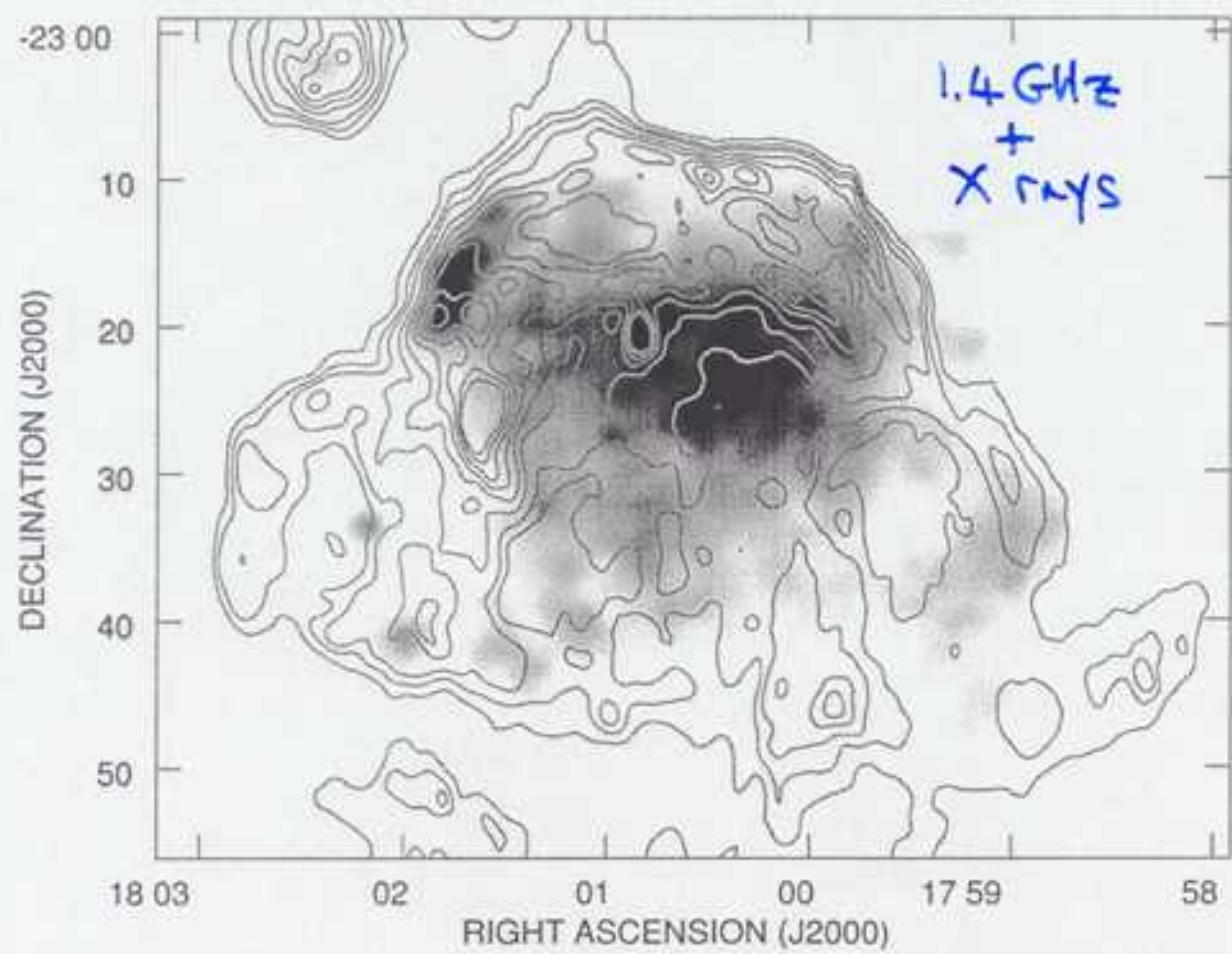
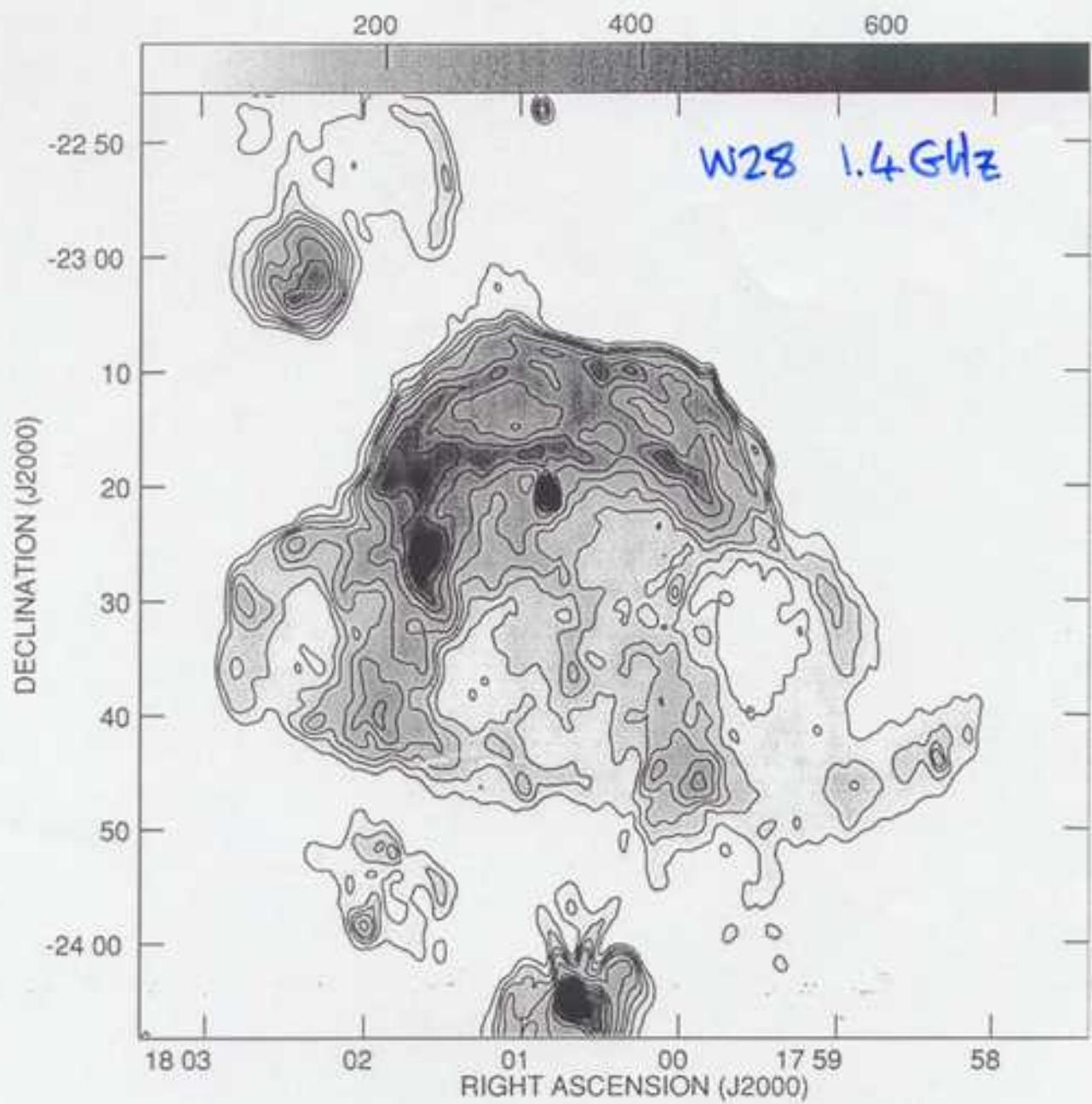
Normal cosmic-ray ionisation



Typical X-ray ionisation

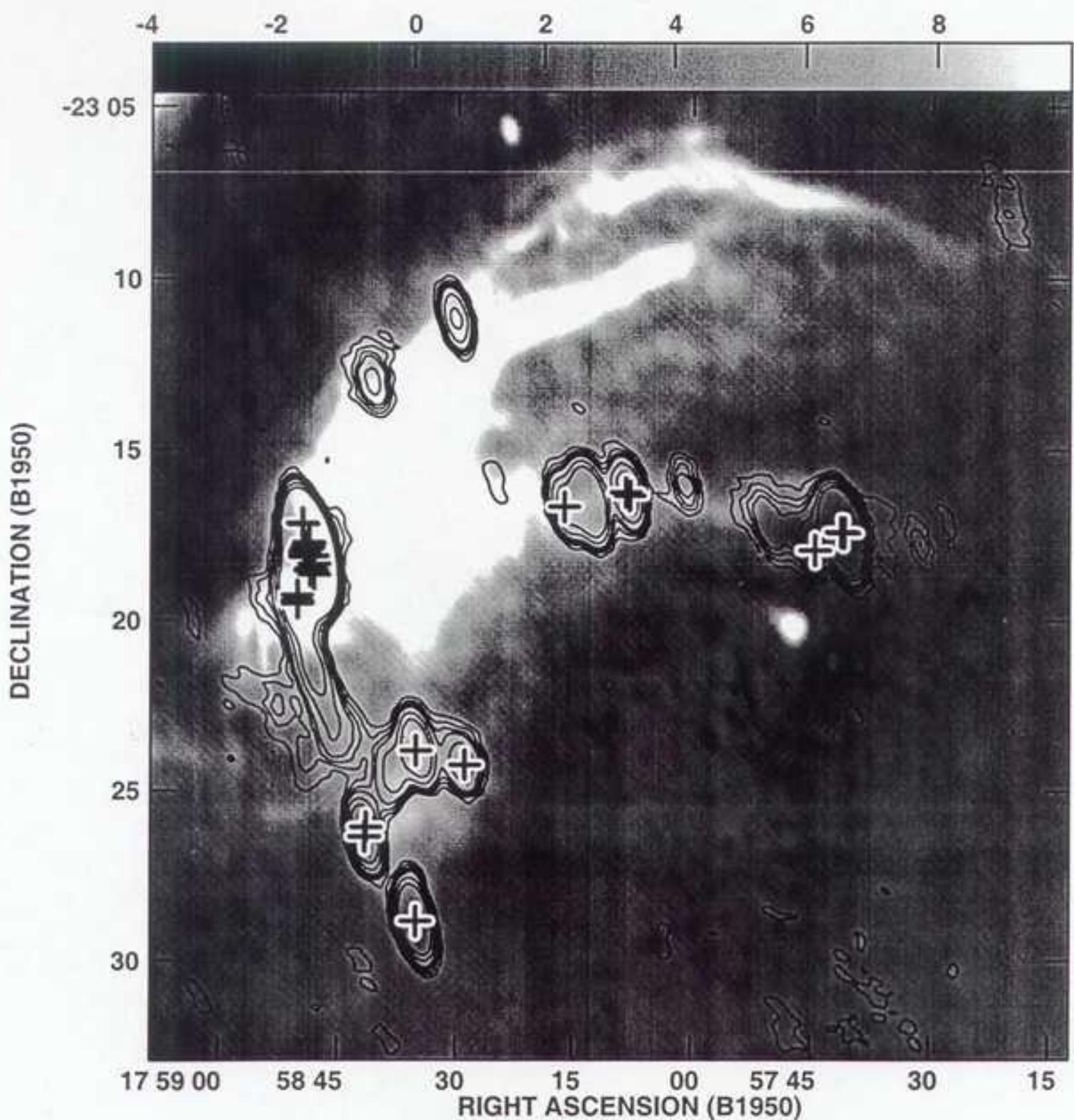


Wardle (1999)



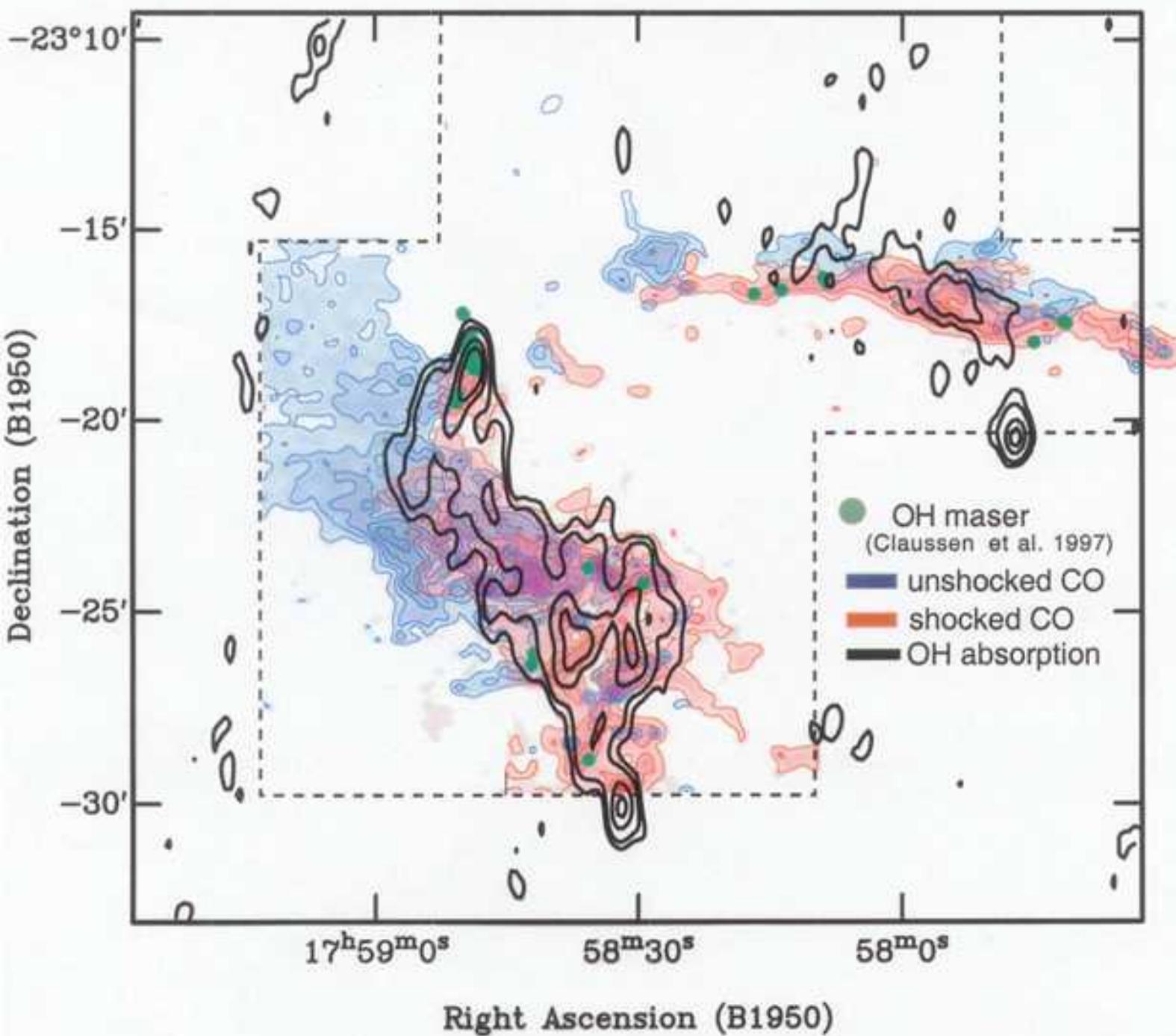
Dubner et al (2000)

W28



18 cm ctm + OH(1720 MHz) emission

W28



CO: Arikawa et al (1999)
(Wardle et al. in prep)

Water

* $6_{16} \rightarrow 5_{23}$ 22 GHz

* 640 K above ground

$$\left. \begin{array}{l} L \sim 10^{16} \text{ cm} \quad T \gtrsim 500 \text{ K} \\ n(\text{H}_2\text{O}) \sim 30 \text{ cm}^{-3} \end{array} \right\} \Rightarrow N_{\text{H}_2\text{O}} \sim 3 \times 10^{17} \text{ cm}^{-3}$$

* $\tau \sim 300 f \frac{N_{17}}{\Delta v_{\text{km/s}}} \frac{1}{T_{\text{ex}}(\text{K})} \gtrsim 1$ (maybe)

↑ H₂O fraction in 5₂₃

$$\Rightarrow T_b \sim T_{\text{ex}}$$
 in line

W28 SNR $T_b \sim 100 \text{ K}$ @ 1.4 GHz $\rightsquigarrow 0.2 \text{ K}$ @ 22 GHz
 $(S_\nu \sim \nu^{-0.35})$

* emission / absorption ?

SiO/SiO_2

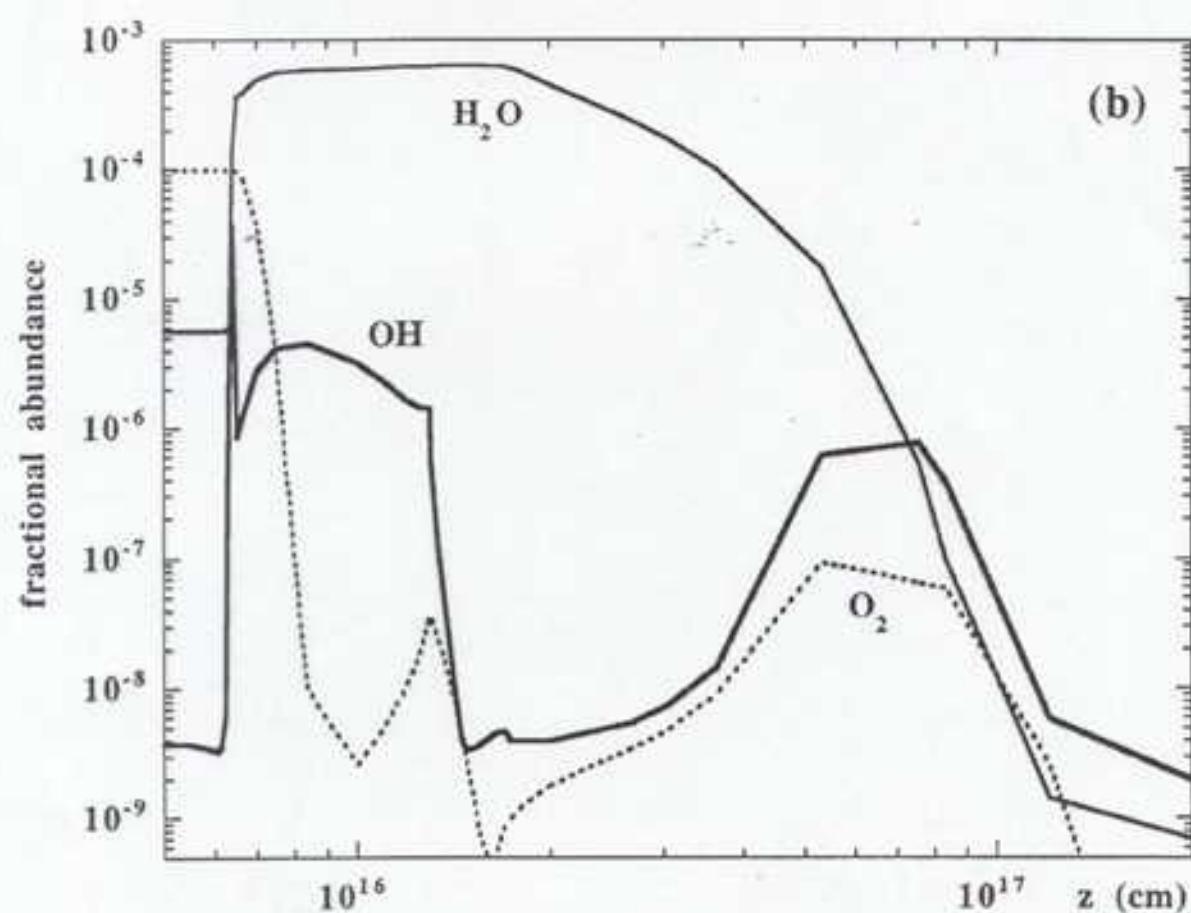
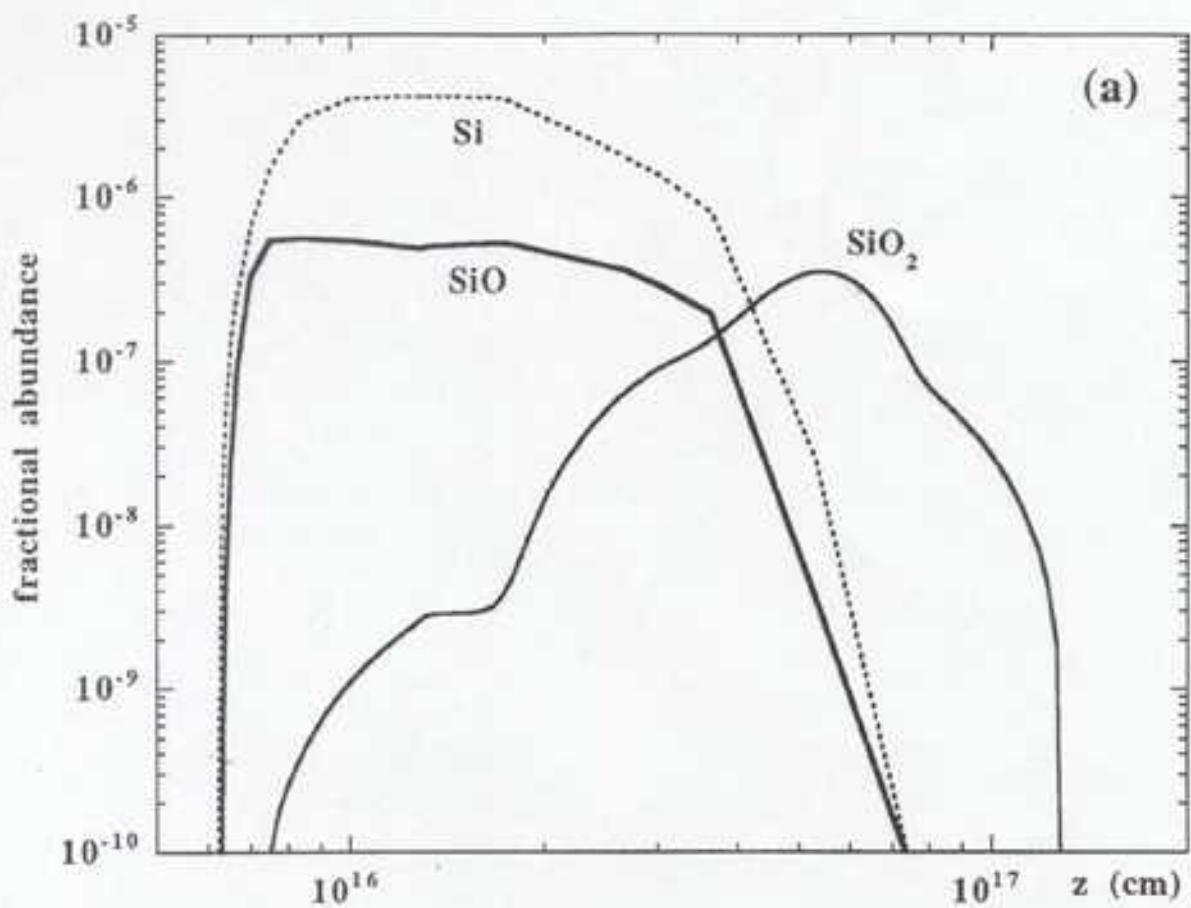


Fig. 2a and b. Fractional abundances, relative to $n_{\text{H}} = n(\text{H}) + 2n(\text{H}_2)$, of a Si- and b O-bearing species for the same model as in Fig. 1. The elemental Si is confined to the cores of the (charged) grains in the preshock gas and is released into the gas phase, within the shock, through sputtering by heavy neutral species .

Schilke et al 1997 A+A 321:293

SiO in L1448

contours : SiO 2-1

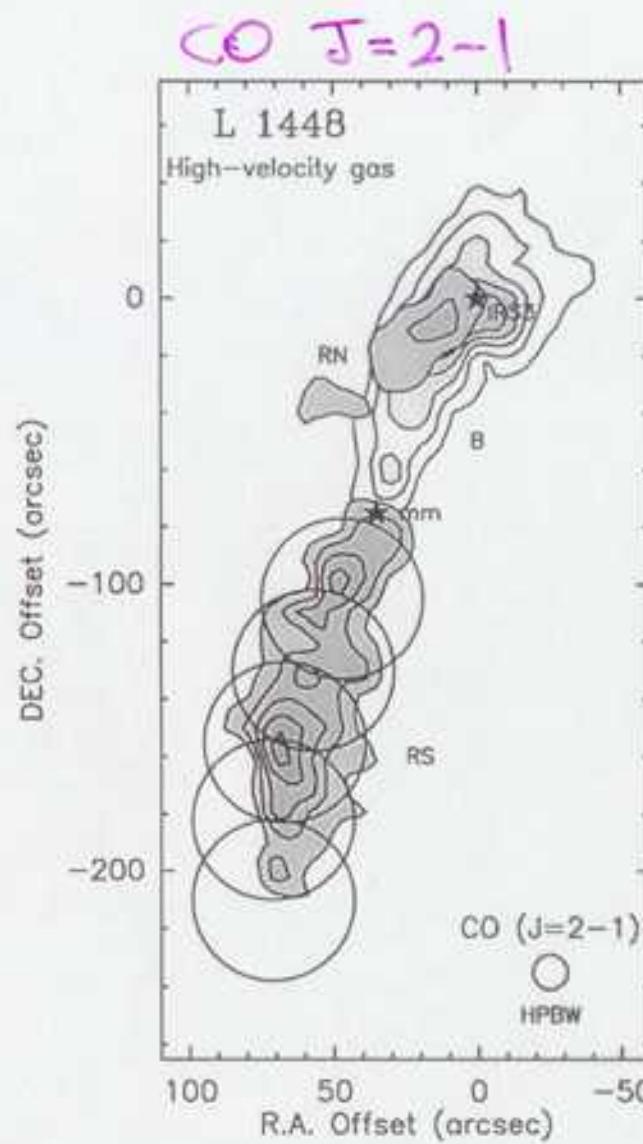


Fig. 1. In grey scale, map of the CO $J=2-1$ emission observed at the 30-m radiotelescope (resolution $11''$). The 5 circles show the location of the fields observed with the PdBI.

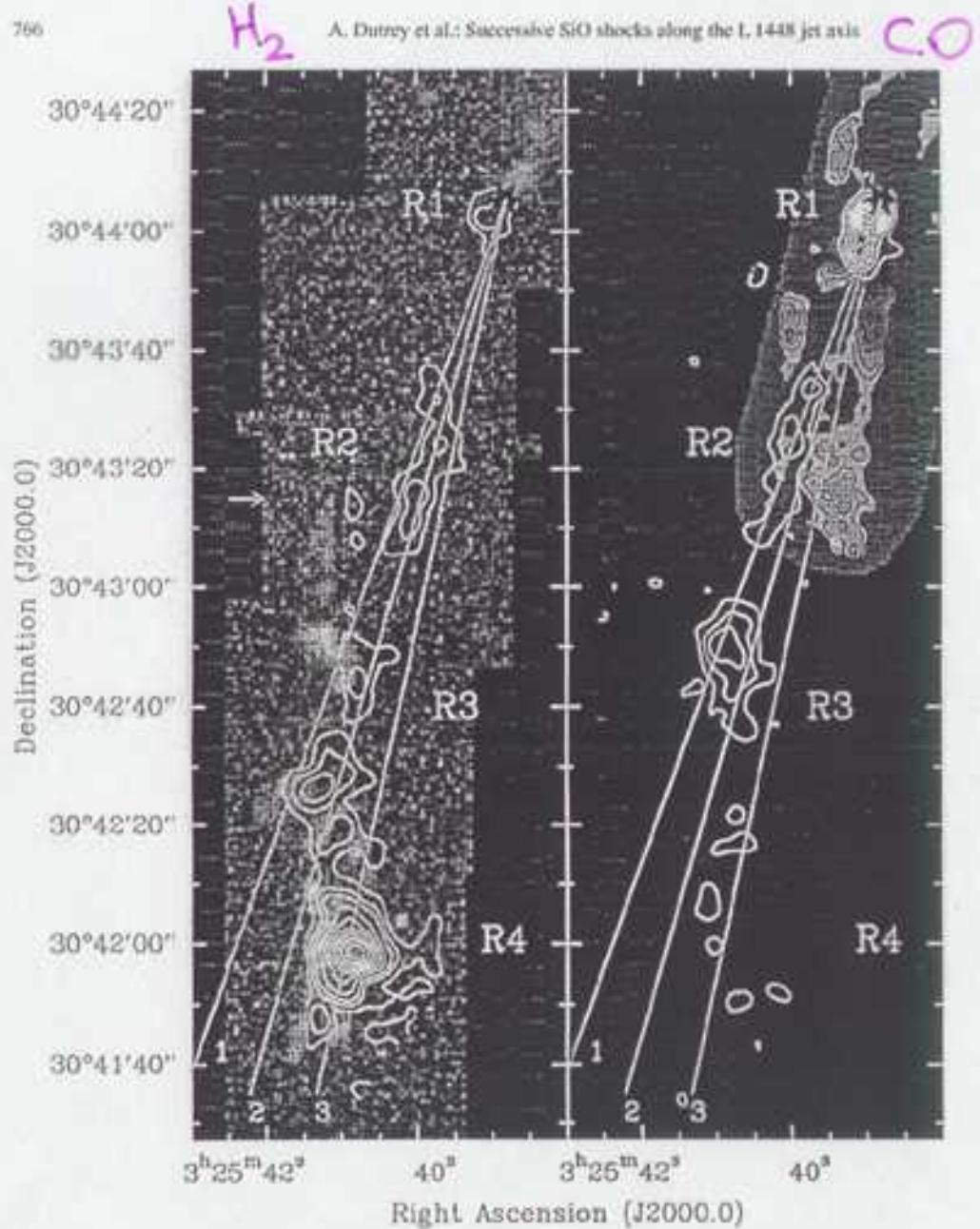


Fig. 8. SiO contour maps overlaid on the H_2 emission (left), and CO $J=1-0$ integrated intensity (right). The arrow shows the global shift ($6''$) of the H_2 emission from the nominal position given by Bally et al. (1993), who mentioned positional errors of $5''$. The area covered by the CO image (Bischiller et al. 1995) is indicated by the purple colour.

Dutrey et al A&A 325, 758 (1997)

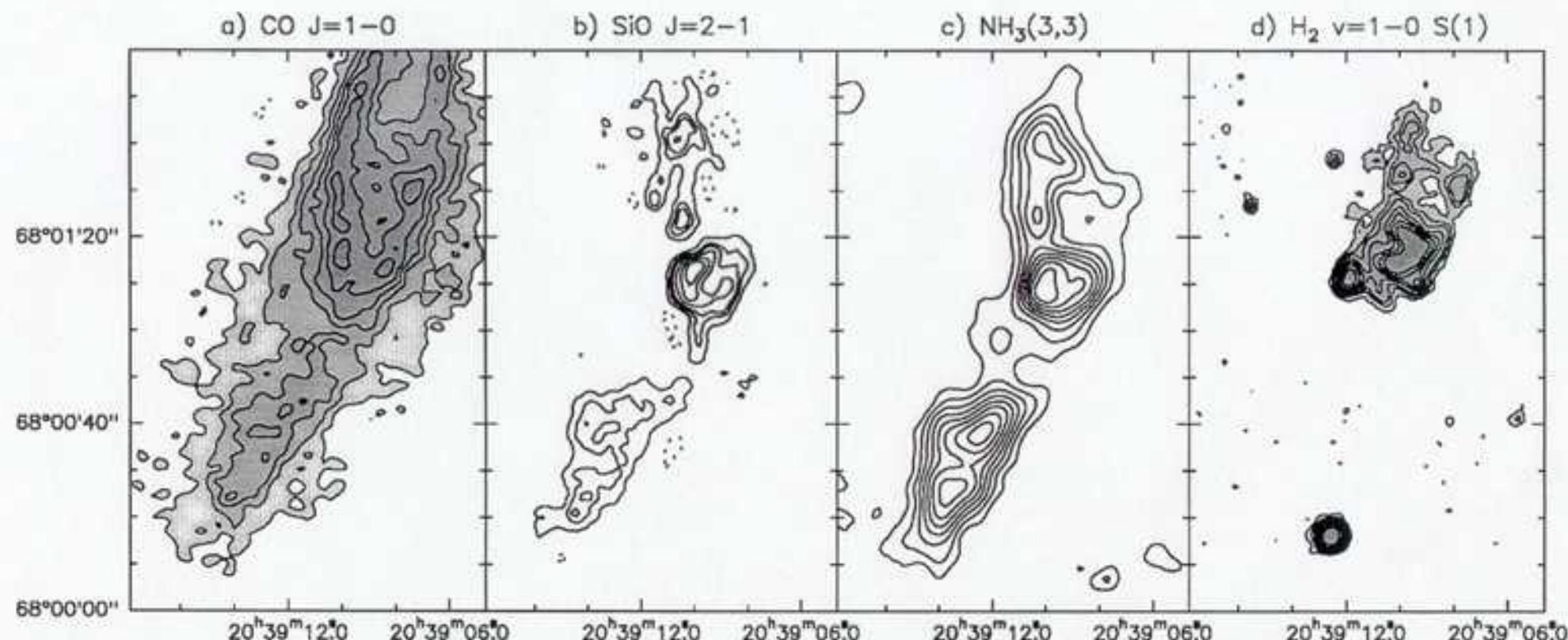
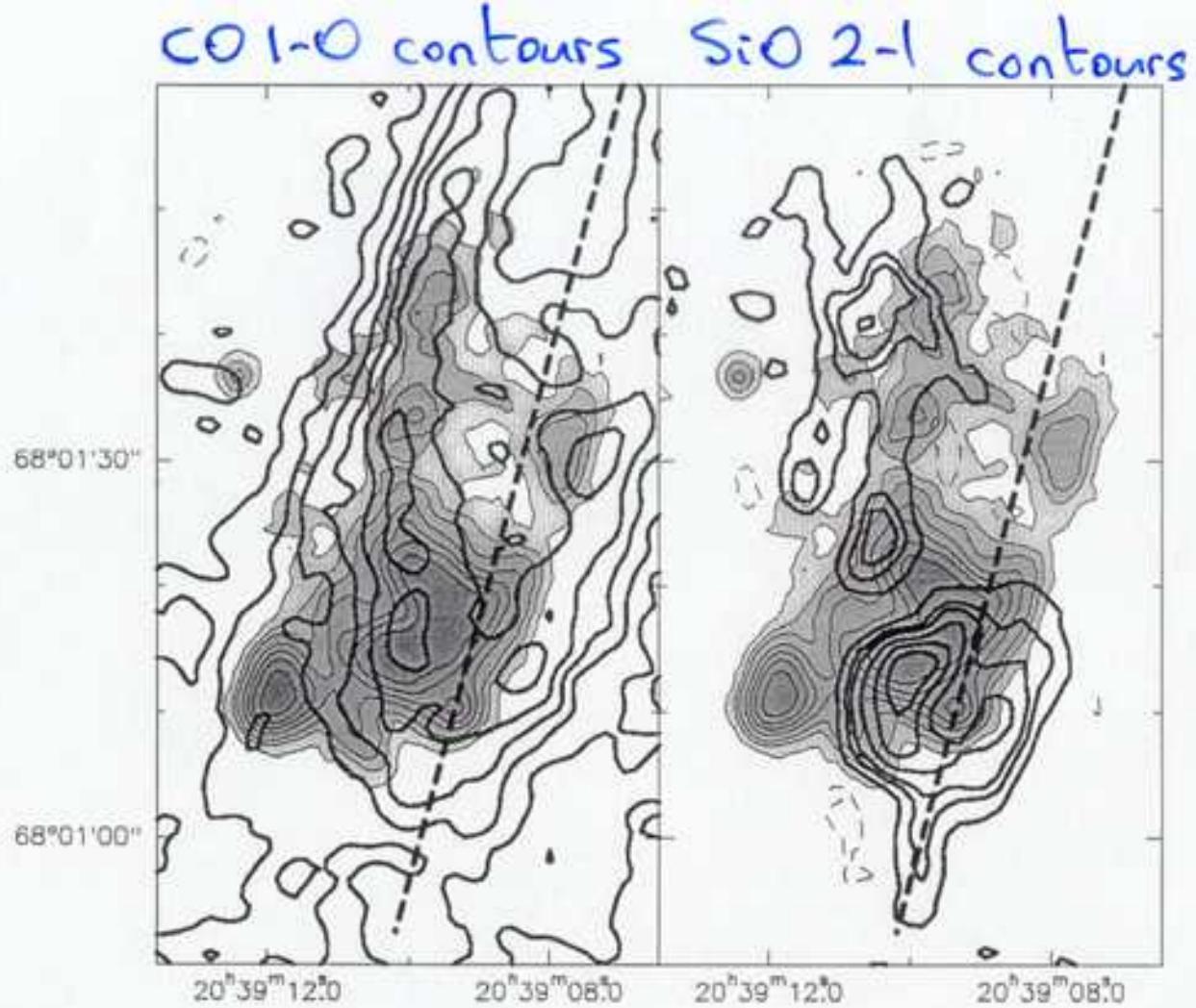


Fig. 5. High-resolution images of the molecular emission through the blueshifted lobe of the L 1157 molecular outflow. **a** Integrated CO $J = 1 \rightarrow 0$ emission (see Fig. 1 and 4). Resolution is $3.6'' \times 3''$. **b** Integrated SiO $J = 2 \rightarrow 1$ emission (see Fig. 4). Resolution is $2.8'' \times 2.2''$. **c** Integrated NH₃(3,3) emission (from Tafalla & Bachiller 1995). Resolution is $5.8'' \times 5.1''$. **d** H₂ $v=1-0$ S(1) + continuum emission (from Davis & Eislöffel 1995). Resolution is around $1.5''$. The strong point-like emission at the southern edge of the map is a field star.



greyscale = $H_2 + cont.$
@ 2 μm

Fig. 6. Overlay of the $H_2 v=1-0 S(1) +$ continuum emission in greyscale (from Davis & Eislöffel 1995) and the CO $J = 1 \rightarrow 0$ (left) and SiO $J = 2 \rightarrow 1$ (right) integrated emission in the S2/S3 region. The dashed line is the axis of the C2 cavity indicated in Fig. 4.

Gutti et al (1998)

SO/SO_2

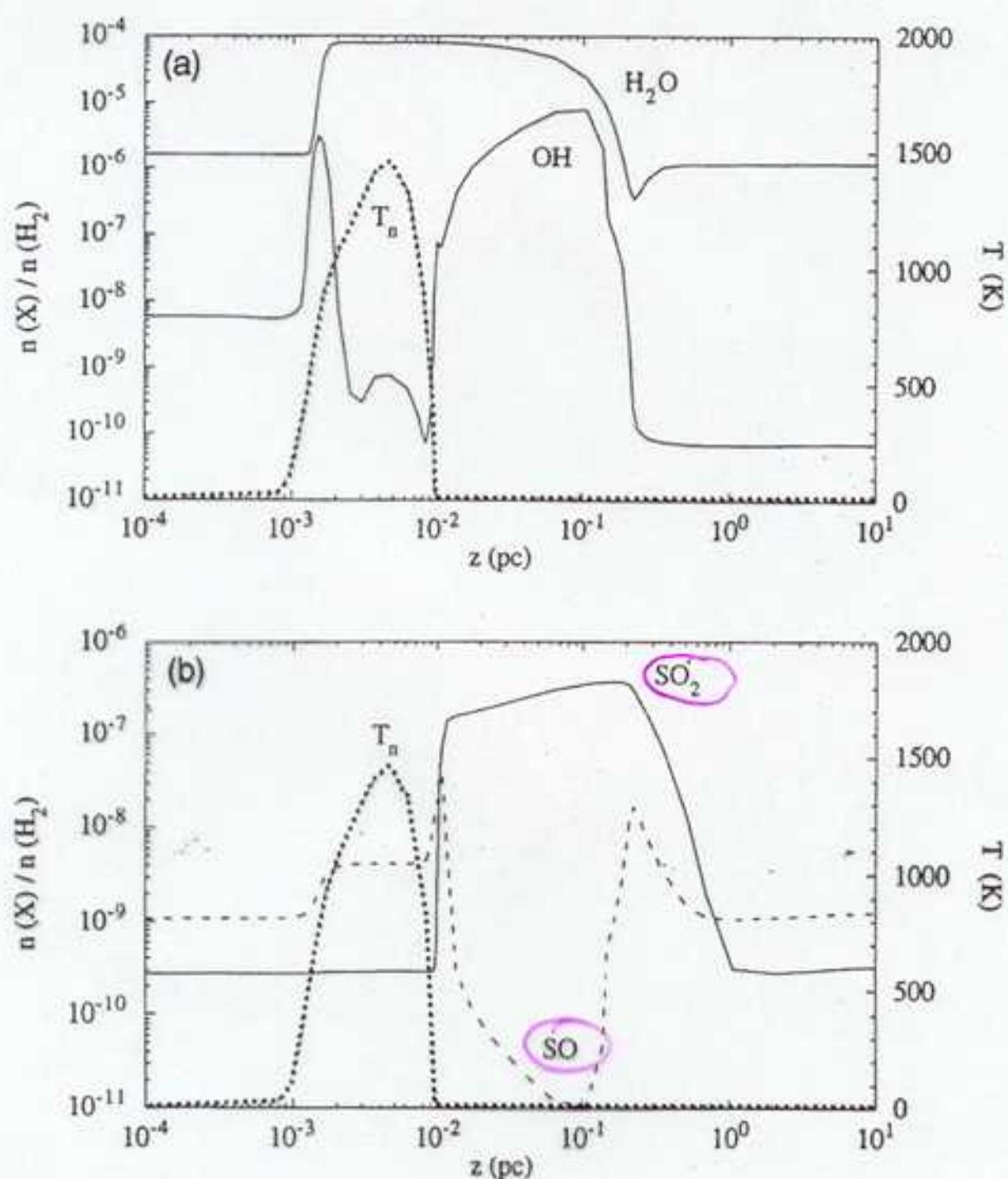


Figure 3. Fractional abundances of OH , H_2O , SO and SO_2 for the reference model, whose neutral temperature profile is also given.

Pineau des Forets et al 1993
MNRAS 262, 915

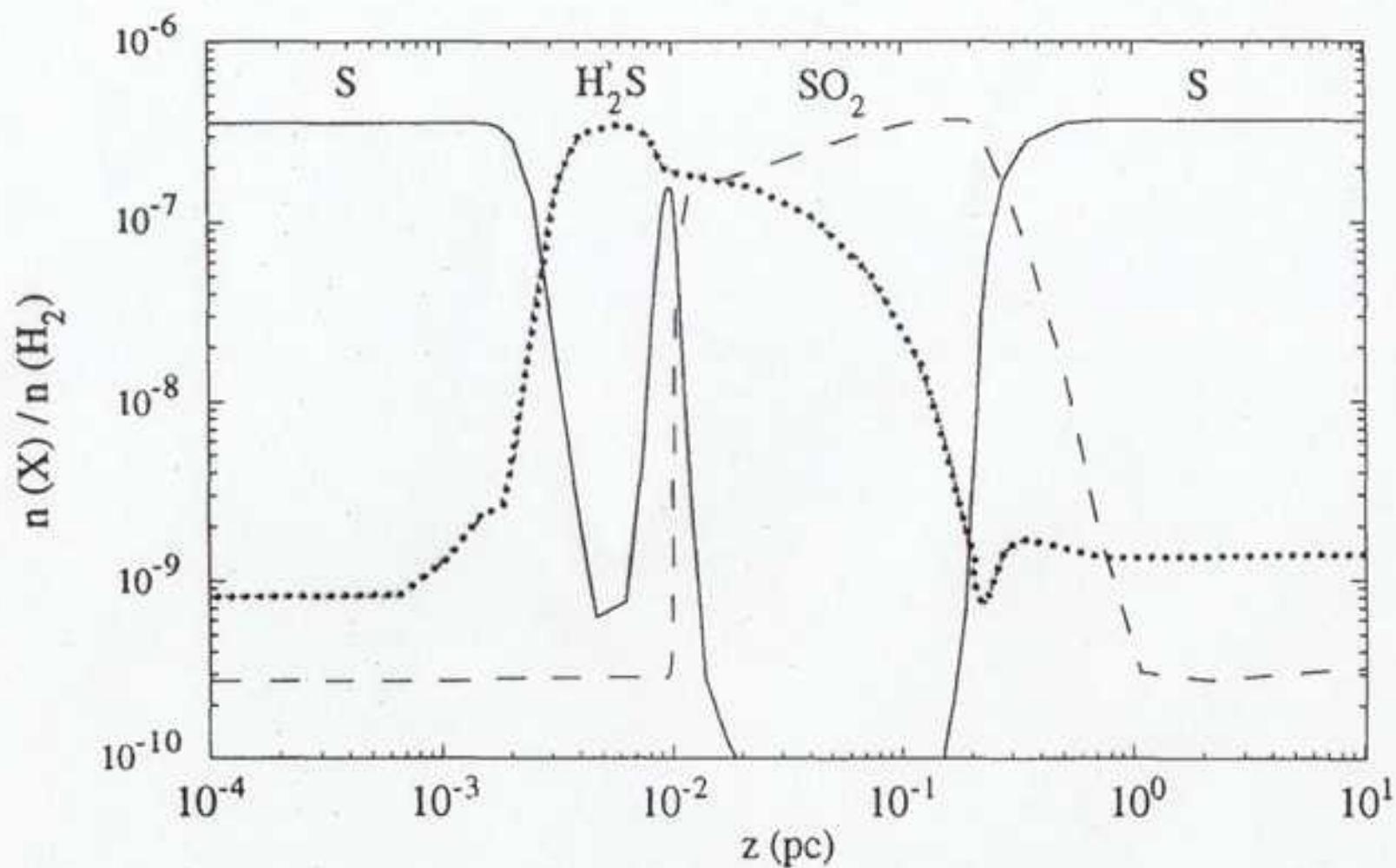
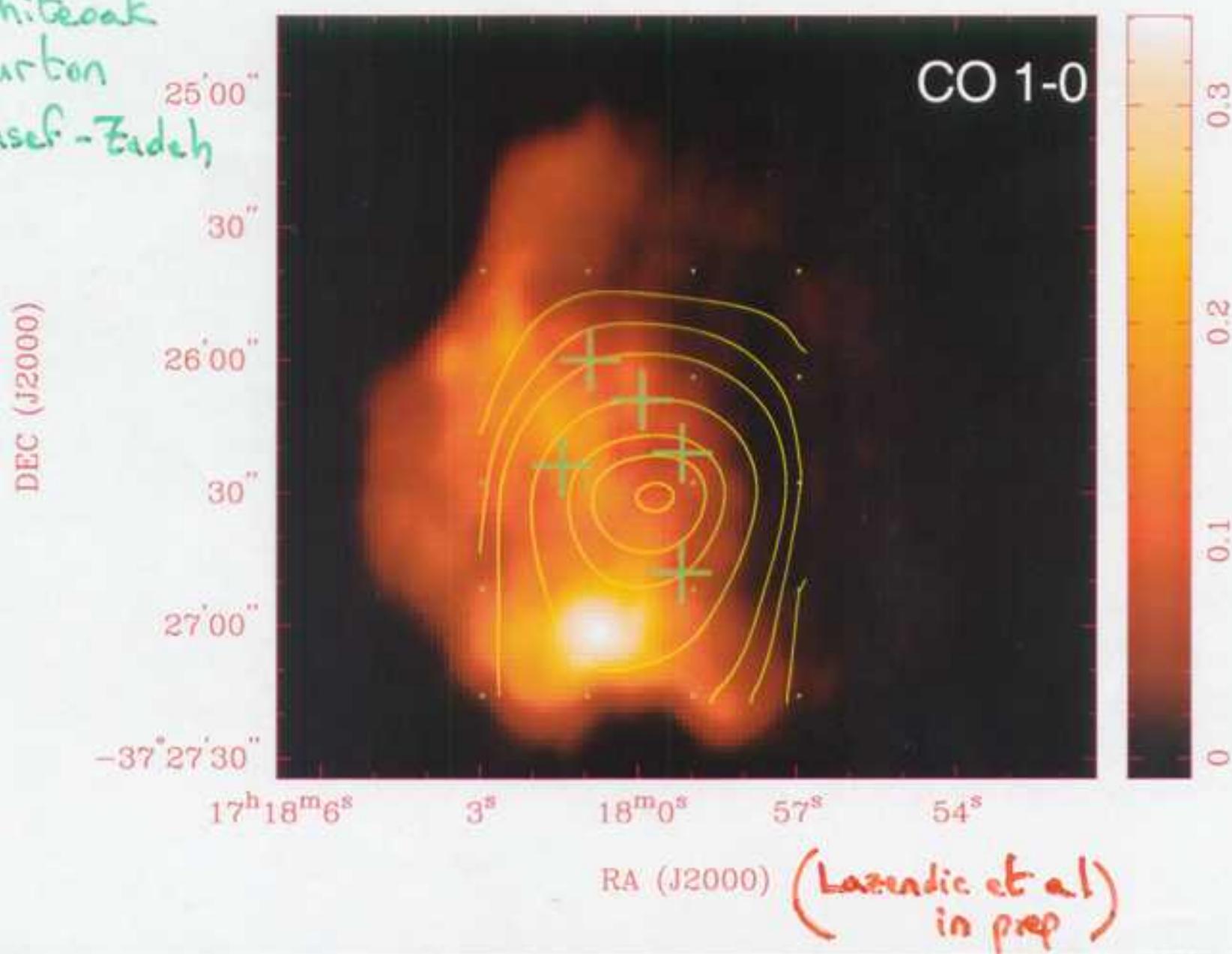
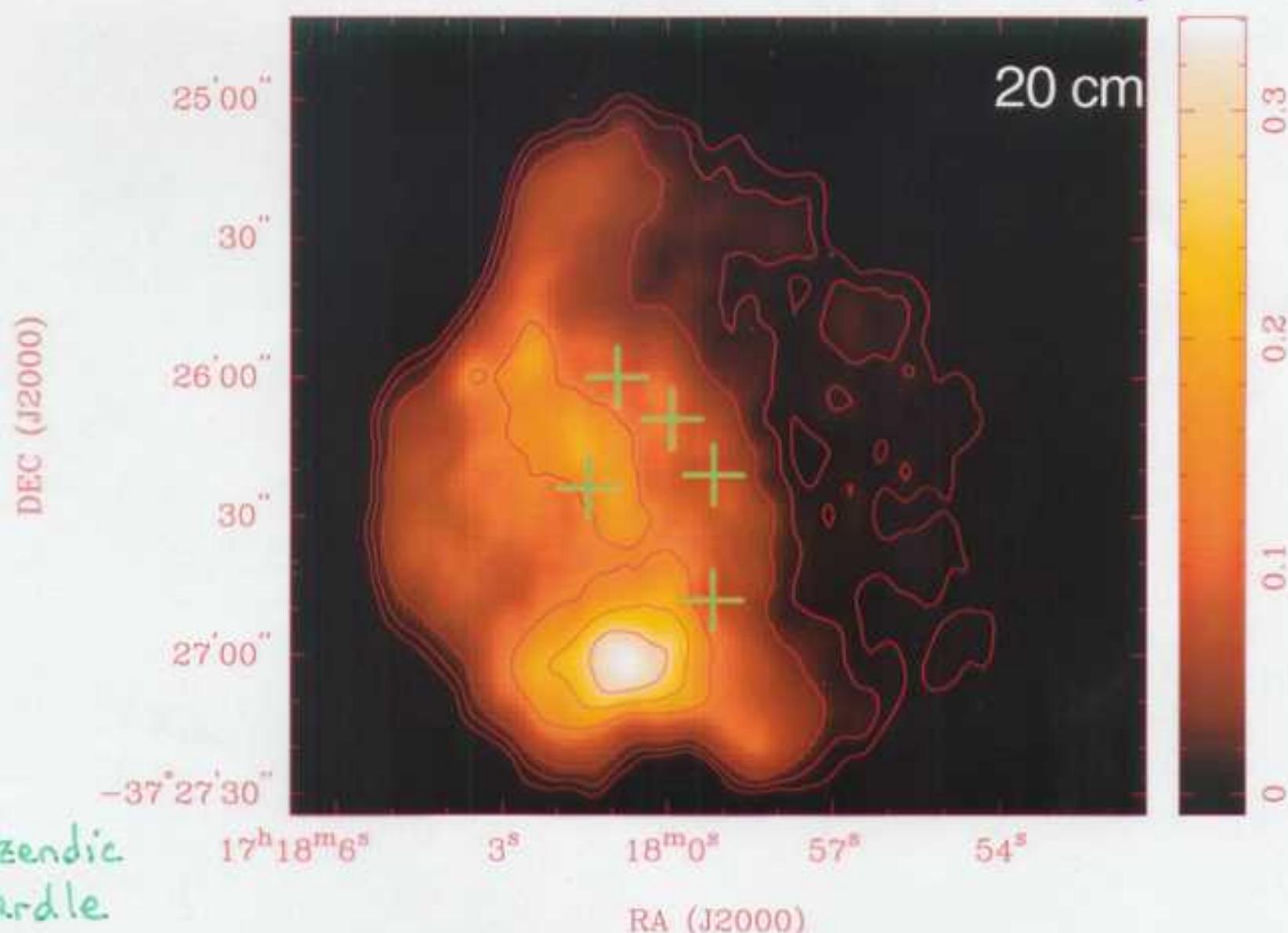
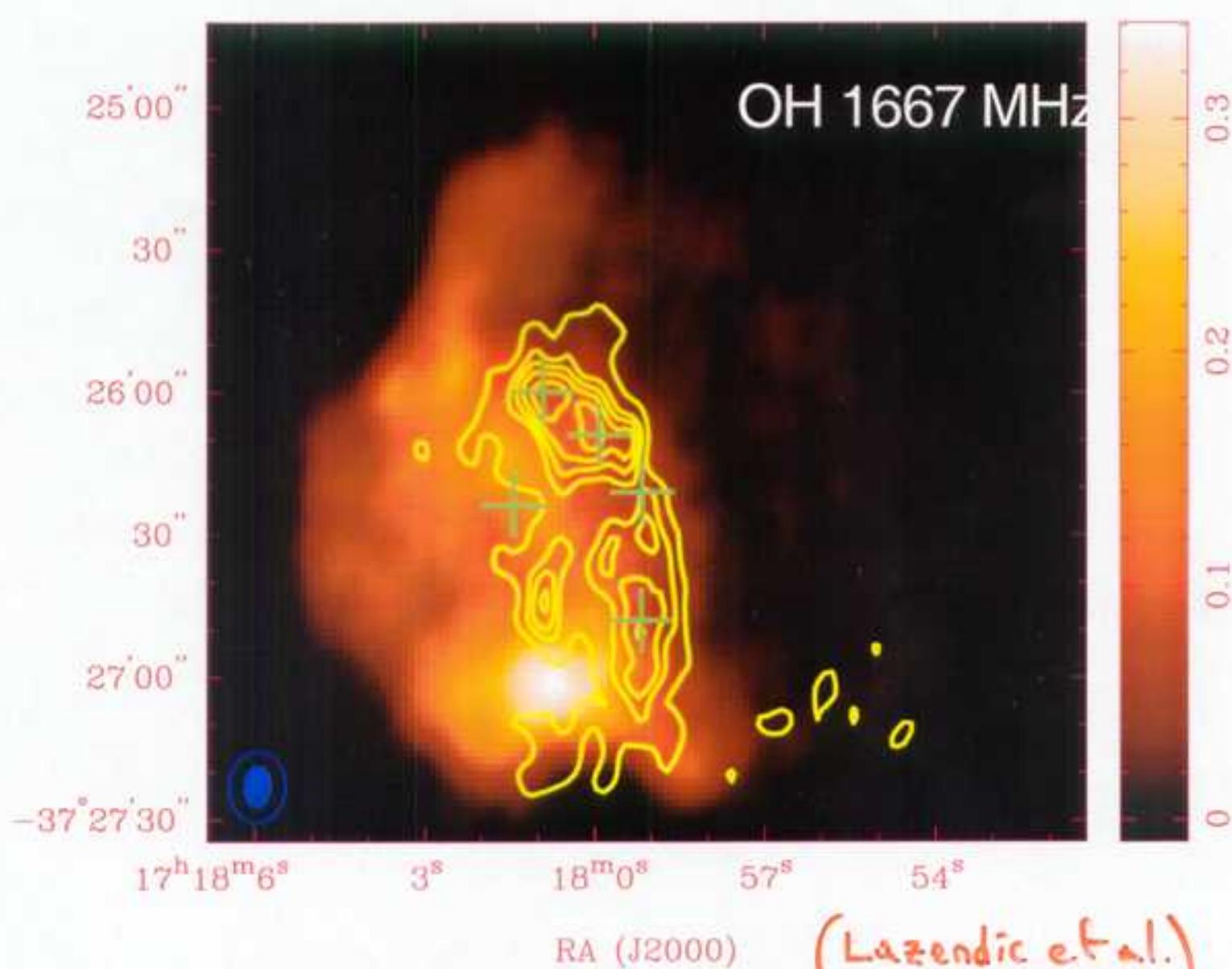
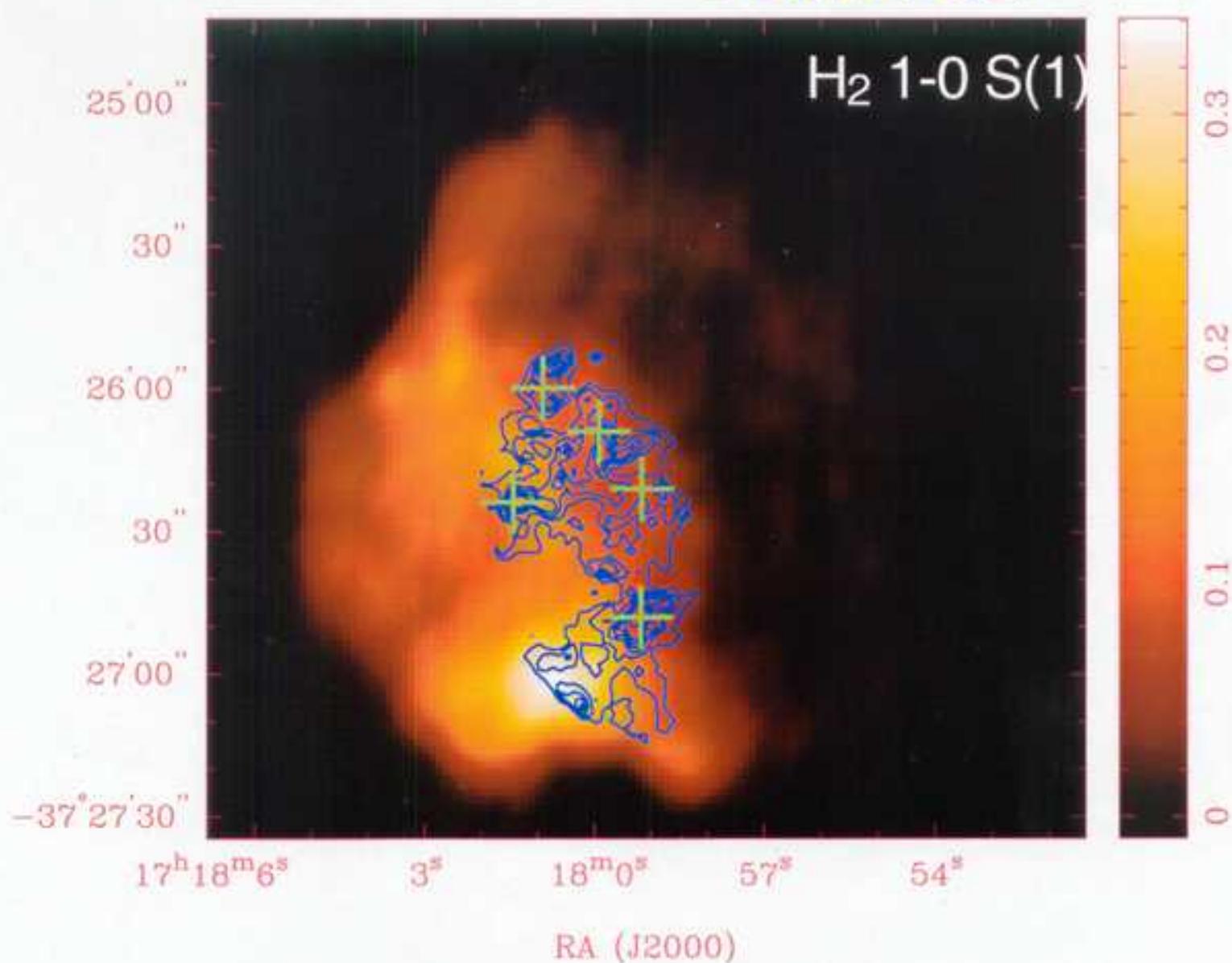


Figure 4. Fractional abundances of the principal sulphur-bearing species, for the reference model.

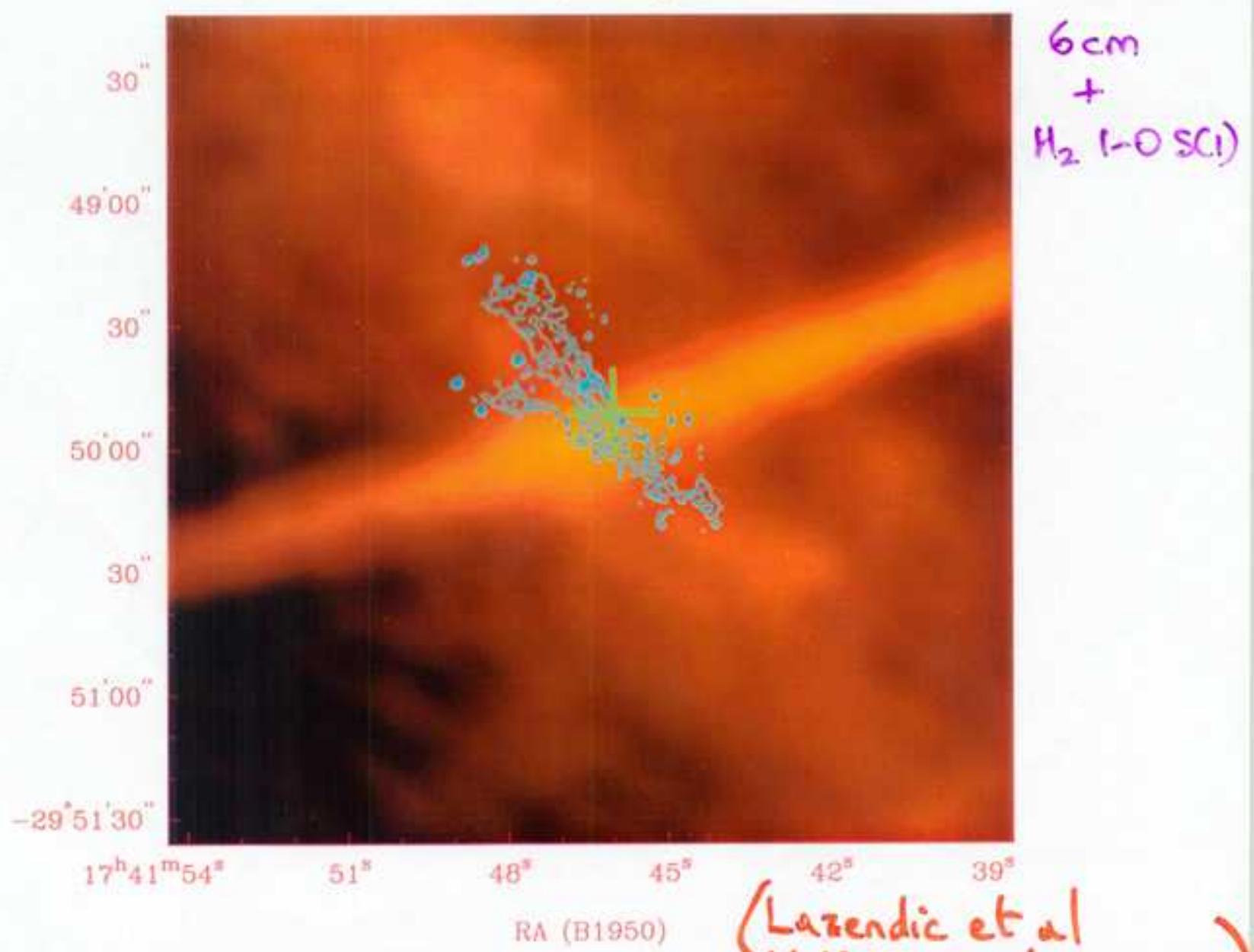
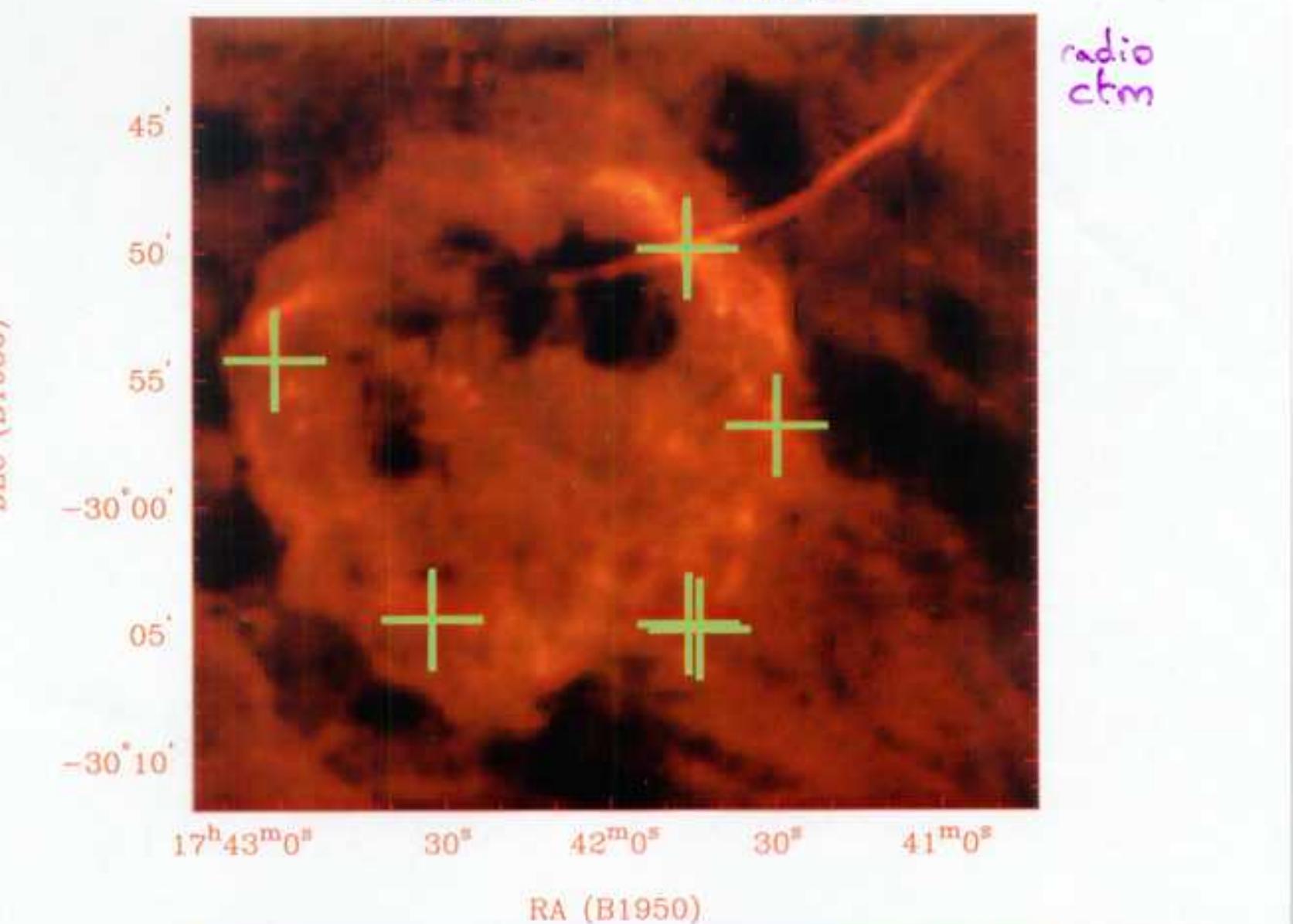
G349.7 + 0.2 "Candy"



G349.7+0.2

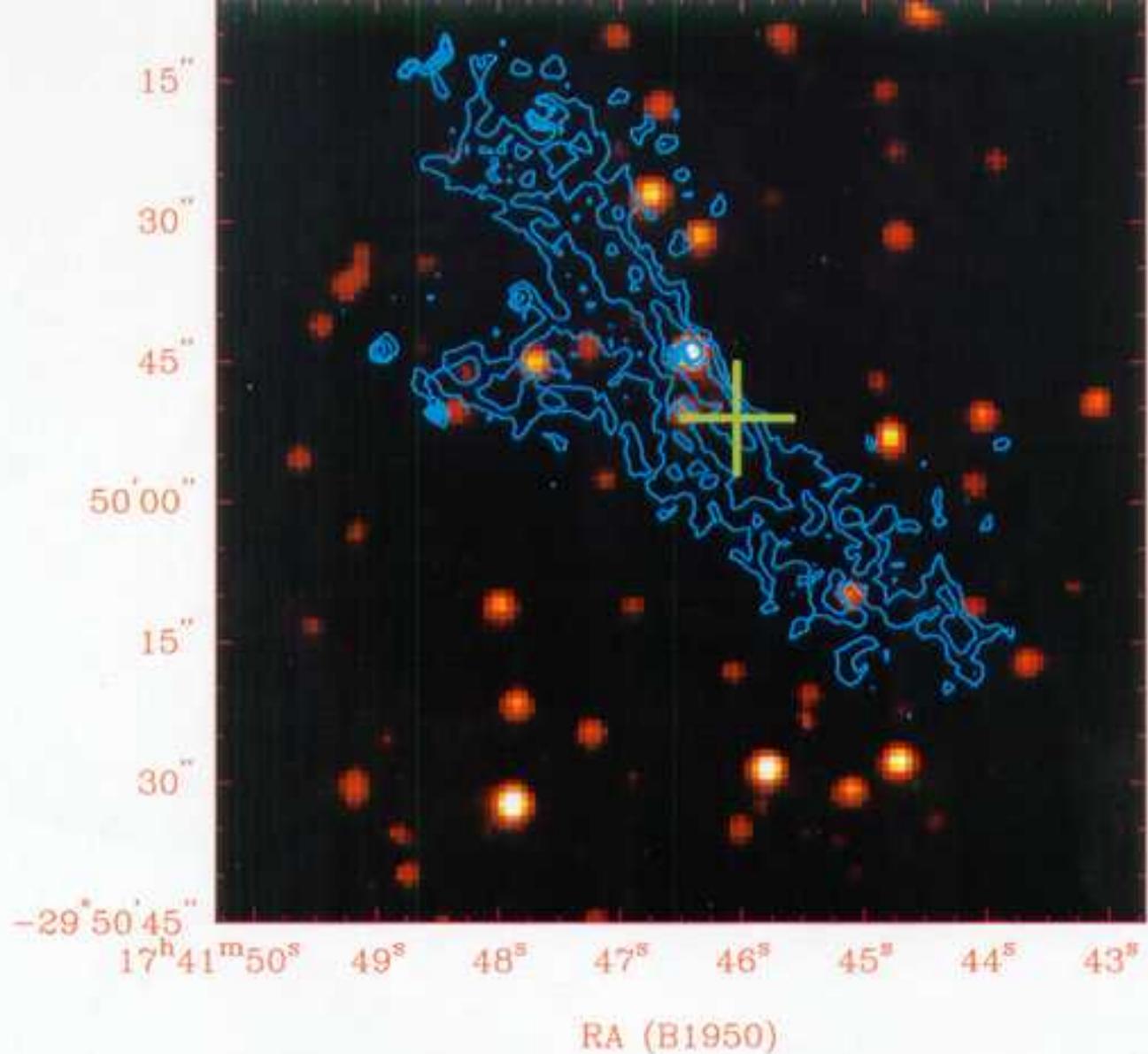


G359.1-0.5 + Snake

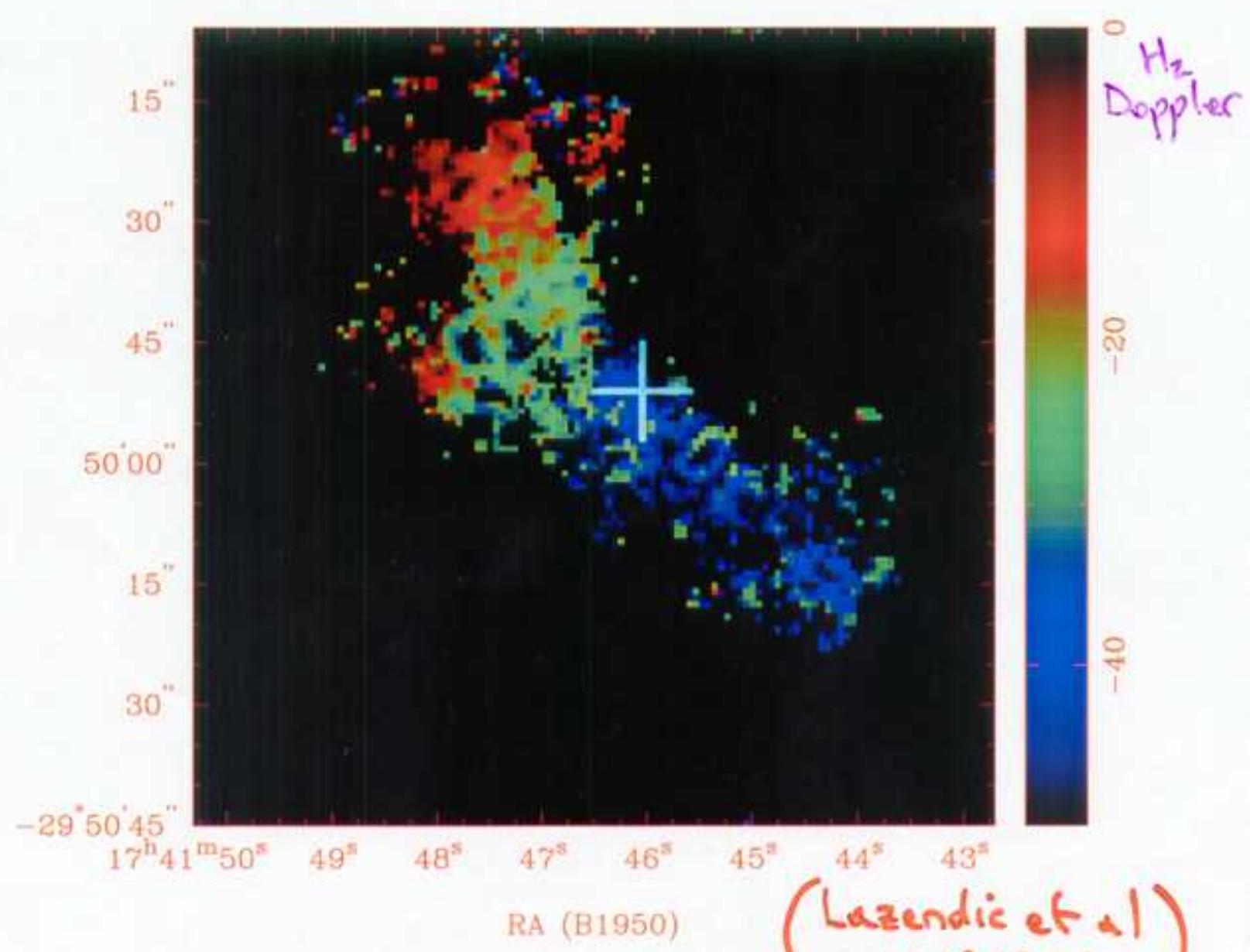


(Lazendic et al
MNRAS, nearly in press)

DEC (B1950)



DEC (B1950)



Summary

species	trans.	ν (GHz)	what I like about it
H ₂ O	6 ₁₆ -5 ₂₃	22	OH masers, water
SiO	2-1	86.8	sputtering of grains in stronger shocks
SO	3 ₂ -2 ₁	99.3	} sulphur chemistry,
SO ₂	3 ₁₃ -2 ₀₂	104	} X-ray induced dissociation
CS	2-1	98.0	$n \sim 10^6 \text{ cm}^{-3}$
HCO ⁺	1-0	89.2	ionisation level
HCN	1-0	88.6	$n \sim 10^5 \text{ cm}^{-3}$

* SNR-cloud interactions are good targets

- OH (1720 MHz) masers
- prelim det^{ns} CS HCO⁺ HCN SO OH
H₂
- many are distant \Rightarrow 30" field of view is ok

W28
Candy
Snake