THE CHESS SURVEY OF THE L1157-B1 BOW-SHOCK: DISSECTING THE WATER CONTENT

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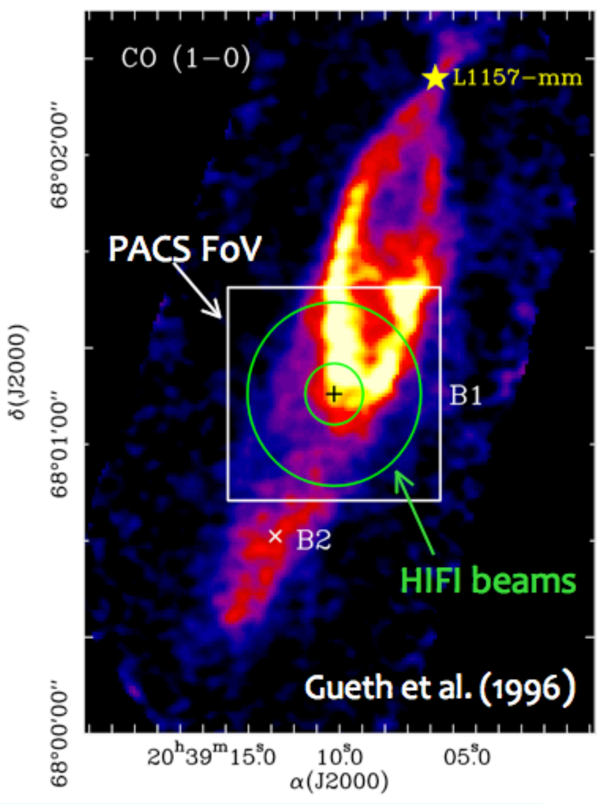
CONTEXT: Molecular outflows powered by young protostars strongly affect the kinematics and chemistry of the natal molecular cloud through strong shocks, resulting in an increase of the abundance of several species. In particular, water is a powerful tracer of shocked material due to its sensitivity to both physical conditions and chemical processes.

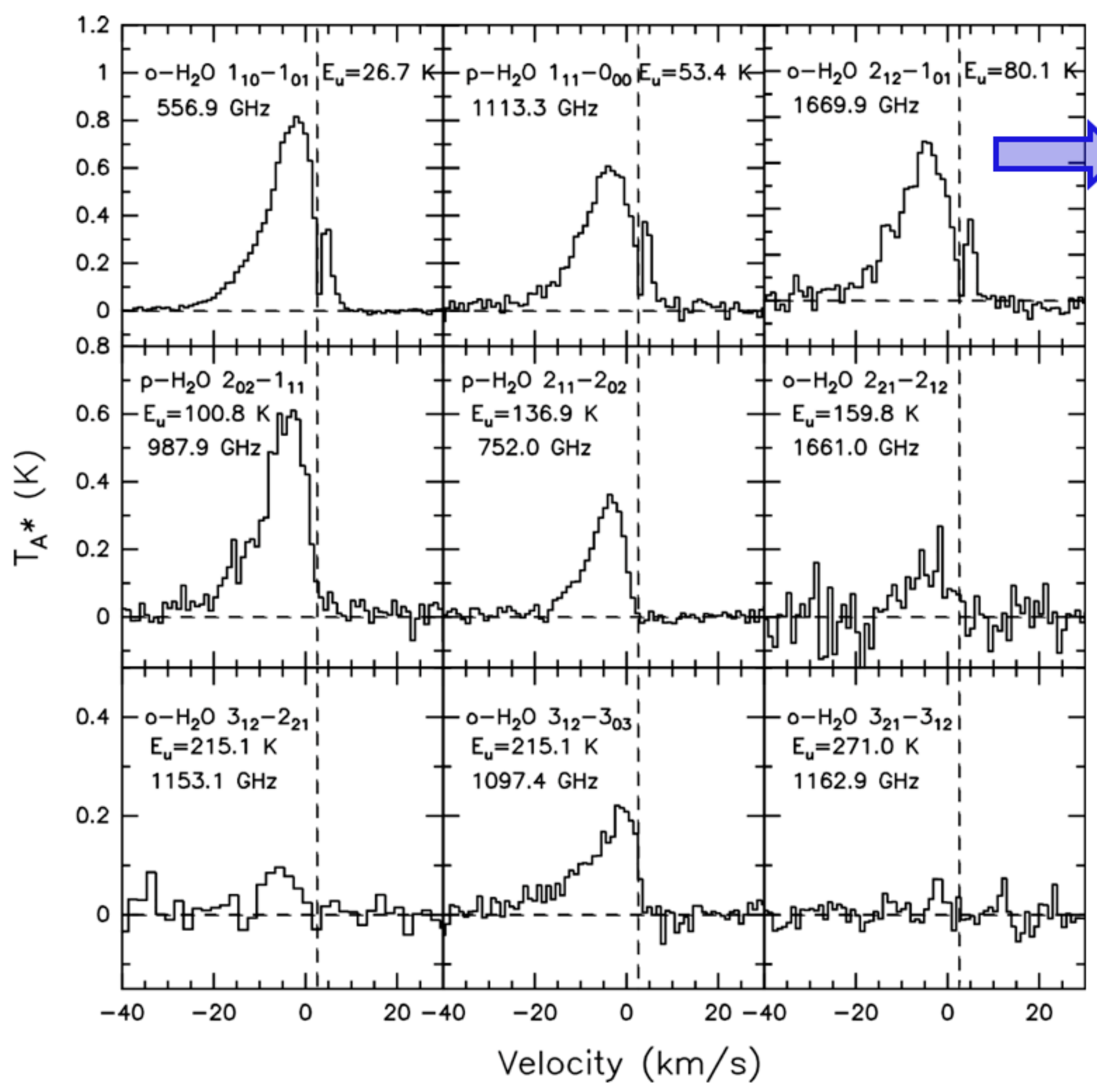
AIMS: As part of the "Chemical Herschel Survey of Star-forming regions" (CHESS) key program, we aim at investigating the physical and chemical conditions of H_2O in the brightest shock region B1 of the L1157 molecular outflow.

OBSERVATIONS

PACS and **HIFI** instruments on board of ***Herschel*** have been used to observe several o-H_2O and p-H_2O transitions providing a detailed picture of the kinematics and spatial distribution of the gas. We have detected **13 H_2O lines** with E_u=26.7-319.5 K



LINE PROFILES FROM HIFI



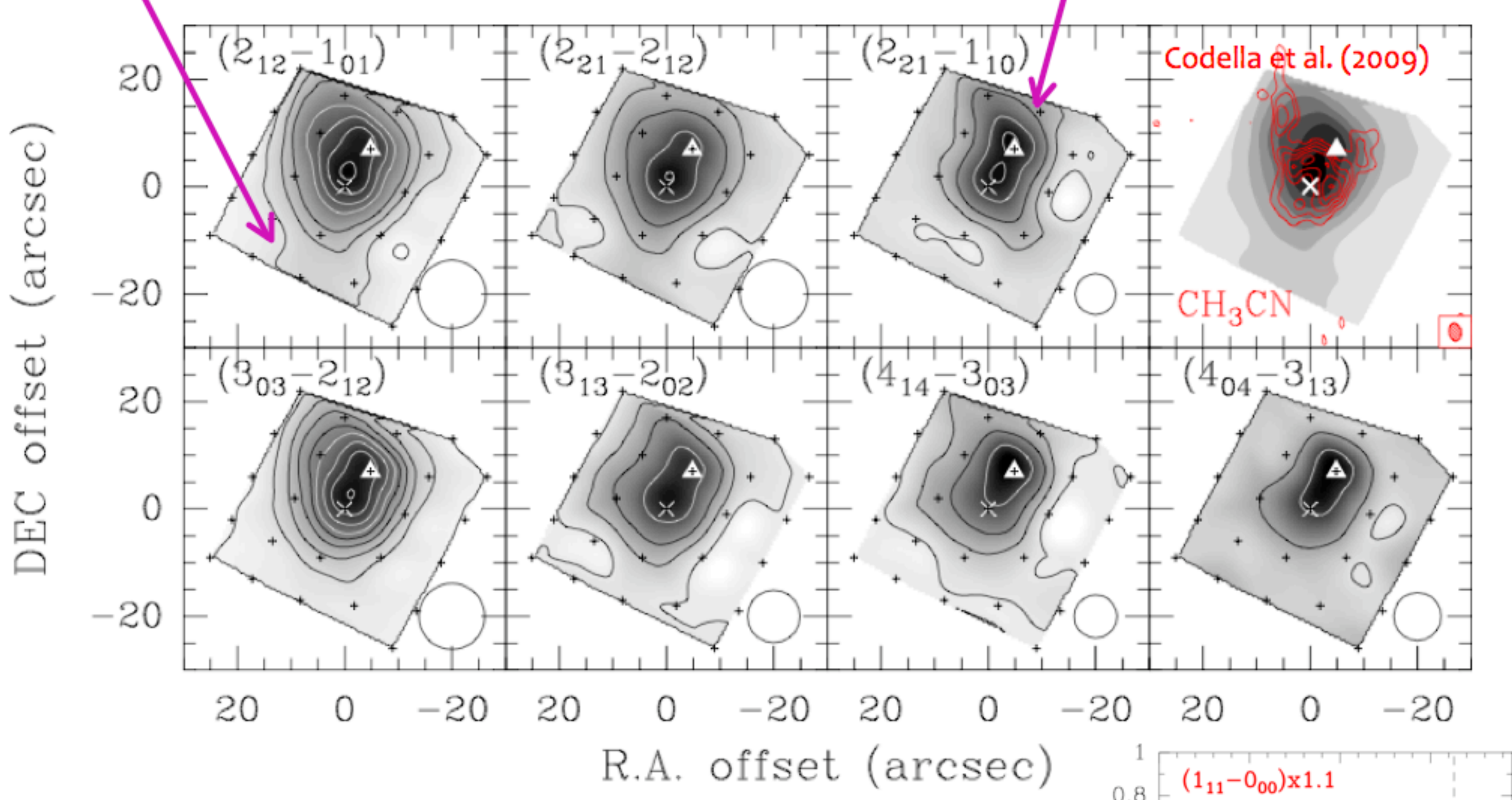
Narrow dip at the cloud velocity in the 3 transitions that connect with the ground state level. The **absorption** arises from a **water-rich layer at the surface of the cloud** formed as result of **water ice photodesorption** driven by the **external UV illumination**

SPATIAL DISTRIBUTION FROM PACS

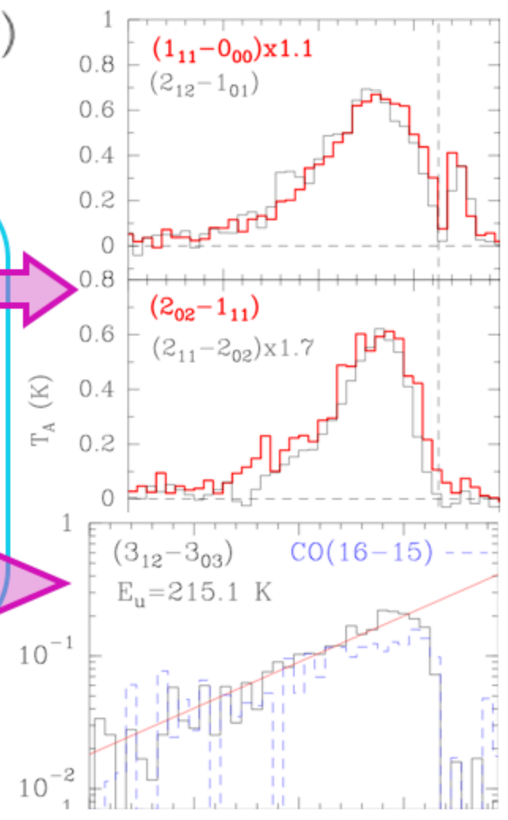
Two regions appear to contribute to the PACS water emission:

a) Extended plateau of low H_2O brightness downstream of B1 related to the outflow emission

b) Compact (10") bright region elongated along the major outflow axis



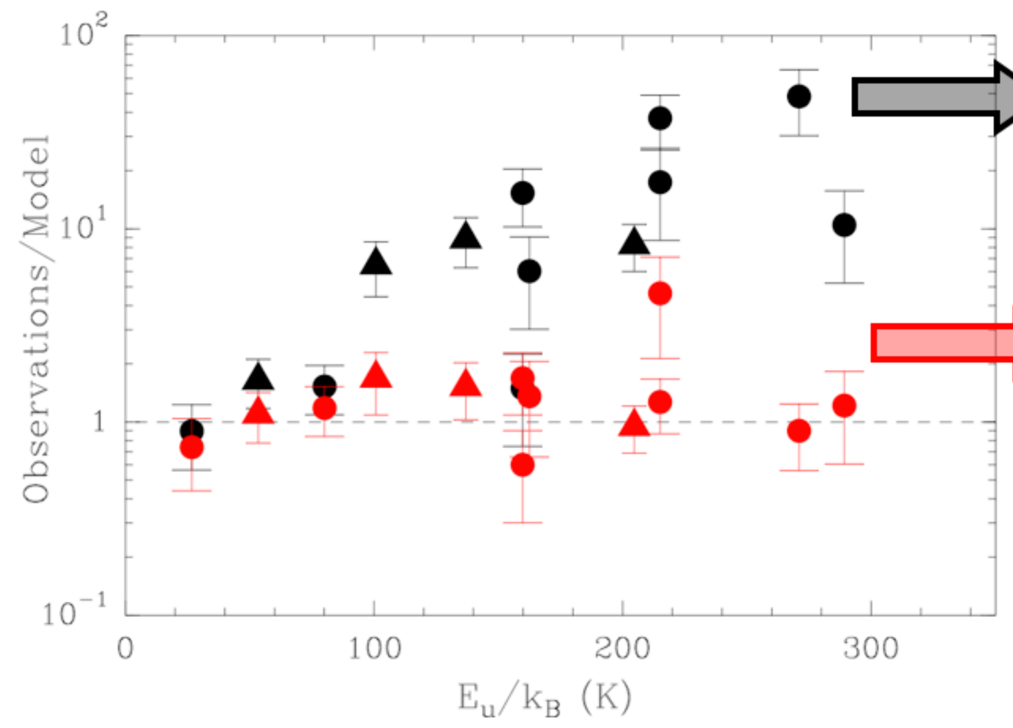
- Excellent match between 2_{11}-2_{01} and 2_{02}-1_{11} and between 1_{11}-0_{00} and 2_{12}-2_{02}, defining two groups of water lines, each of them following an specific pattern.
- o-H_2O (3_{12}-3_{03}) shows the same spectral signature, g1, of CO emission (Lefloch et al. 2012). The g1-shock component is characterized by gas at 250 K, and it is associated with the partly dissociative shock (Benedettini et al. 2012)



Excitation conditions of H_2O emission obtained using a **radiative transfer code under the LVG approximation** (Ceccarelli et al. 2003) and adopting slab geometry.

Comp.	T_{kin} [K]	$n(H_2)$ [cm-3]	$N(H_2O)$ [cm-3]	$X(H_2O)$	$L(H_2O)$ [L_{sun}]
Warm	250	10^6	2.7×10^{14}	2×10^{-6}	0.002
Hot	1000	2×10^4	9.1×10^{16}	3.6×10^{-4}	0.03

SHOCK EMISSION: A TWO TEMPERATURE MODEL



One single temperature component does not reproduce simultaneously all line in the HIFI and PACS range

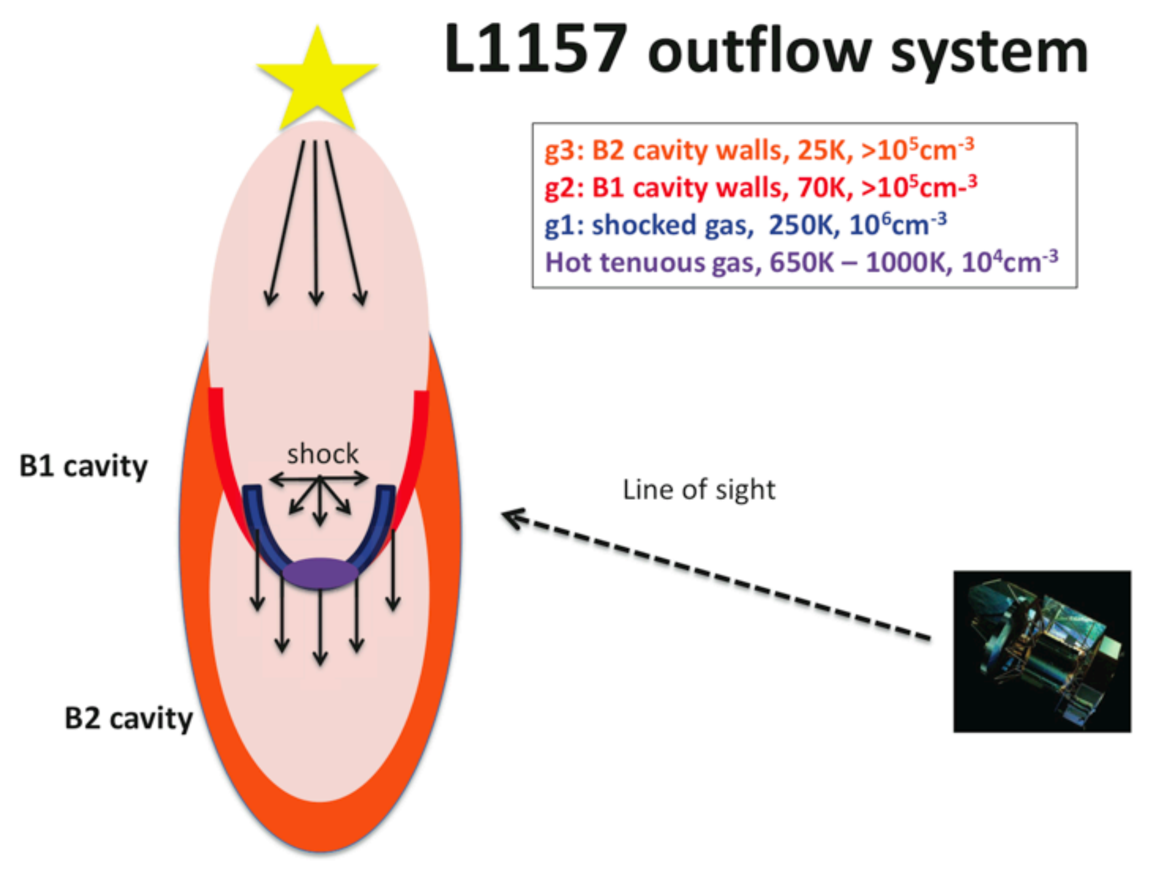
Second gas component at much higher temperature is needed to reproduce the flux of of higher E_u transitions

H_2O COOLING

Warm: 1.5×10^{-19} erg s^{-1} cm^{-3} → Consistent with the value predicted in the **molecular reformation zone for a J-type shock** (Flower & Pineau Des Forêts 2010)

Hot: 2×10^{-16} erg s^{-1} cm^{-3} → Several orders of magnitude higher than the predictions for a C-type (MHD) shock, **favoring a J-type shock origin**

3D RECONSTRUCTION



References: Benedettini, M., Busquet, G., Lefloch, B. et al. 2012, A&A 539, L3; Ceccarelli, C., Maret, S., Tielens, A.G.G., Castets, A., & Caux, E. 2003, A&A, 410, 587; Codella, C., Benedettini, M., Beltrán, M.T. et al. 2009, A&A 507, L25; Flower ,D. R. & Pineau Des Forêts, G. 2010, MNRAS, 406, 1745; Gueth, F., Guilloteau, S., & Bachiller, R. 1996, A&A 307 , 891; Lefloch, B., Cabrit, S., Busquet, G., et al. 2012, ApJ, 757, L25