Dense cavity walls traced by CS in the L1157-B1 protostellar shocked region

Arturo I. Gomez-Ruiz (INAF-OAA), C. Codella (INAF-OAA), B. Lefloch (IPAG), M. Benedettini (INAF-IAPS), G. Busquet (INAF-IAPS), B. Nisini (INAF-OAR), C. Ceccarelli (IPAG), S. Cabrit (LERMA), S. Viti (UCL)

The L1157 Protostellar Outflow

•L1157-mm: Class 0 source at 200-300 pc, with L ~ 3 $L_\odot$ (V_{sys}= +2.6 km/s), driving a precessing CO outflow of ~ 0.3 pc

•Peak of molecular emission at the B1 shock (age ~ 2000 yr) → **B1 key region to study shock chemistry**

•Temperature well constrained by previous studies (e.g. CO H_2, etc). But gas density not well constrained

•Carbon Sulfide (CS) is a well known gas density tracer

CHESS view of L1157-B1: CS emission

•Under the CHESS program (Ceccarelli et al. 2010, A&A, 521, L22), multiple CS transitions detected with Herschel and IRAM-30m single-dish telescopes

•18 CS transitions covering up to Eu ~ 180 K (1st time!)

•CS typical intensities of ~ 3 K for low-J (2-1 and 3-2), and ~ 0.05 K for high-J (HIFI lines)

•Highest blueshifted CS emission up to ~ 23 km/s w.r.t V_{sys} (low-J lines)

•Using the $C^{32}S/C^{34}S$ and $^{12}CS/^{13}CS$ ratios, τ ~ 0.05 at V_{LSR} of -7.5 km/s, τ ~ 1 at cloud V_{LSR}. Thus CS emission optically thin at outflow velocities

Spectral components

•CS line profiles can be decomposed into exponential components I(v) ~ exp(-v/v_0)

•Two components with coefficients v_0=4.4 km/s and v_0=2.5 km/s can fit the CS profiles

•Remarkably, the two components are similar to the exponential components, g2 and g3, found in CO (Lefloch et al. 2012, ApJ, 757, L25)

•The g2 and g3 components related to the cavity walls produced by the B1 and (older) B2 shocks, respectively

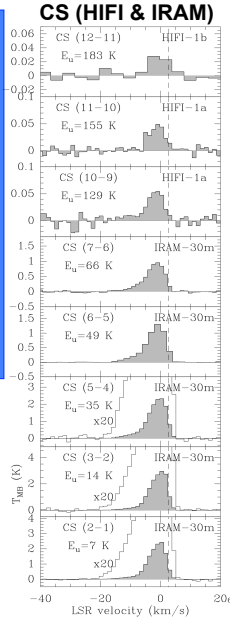
•Large velocity gradient (LVG) provides constrain of n ≥ $10^{4.5}$ cm^{-3}. In g2 case n ~ $10^{5.5}$ cm^{-3}

Molecular abundances

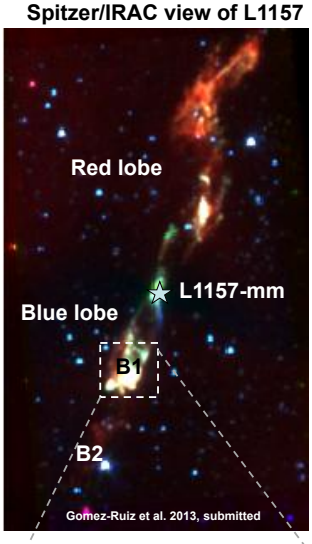
•Using N(CO), X(CS) ~ 9 x 10^{-8} for g2 and 6 x 10^{-8} for g3. Thus 30x lower than in jet-like outflows such as L1448 (Tafalla et al. 2010, A&A, 322, 91)

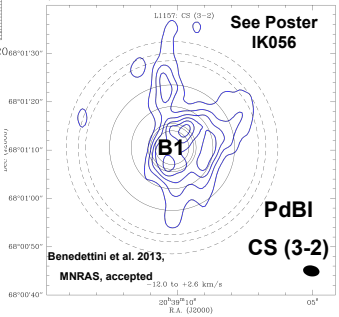
•Non detection of g1 (high-velocity dissociative shock) implies X(CS) < 10^{-8}, i.e. abundances lower than those of the g2 and g3 cavities

CS (HIFI & IRAM)

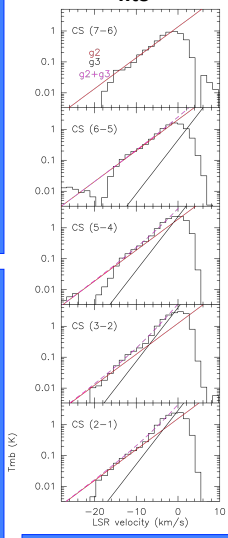


Spitzer/IRAC view of L1157

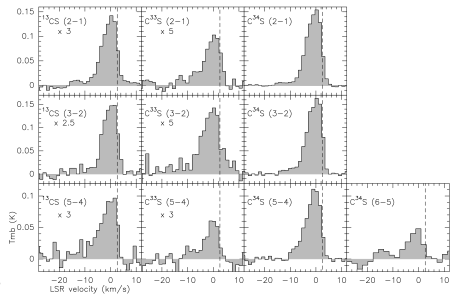




Exponential fits



Isotopologues



Conclusions & outlook

•CS line profiles consistent with the g2 and g3 exponential components found in CO

•We have constrained densities and probed that CS is a tracer of dense cavity walls

•Temperature and density estimations will be used to model the molecular emission in shocks (codes provided by the CHESS nodes at UCL-London and LERMA-Paris)

•Additional molecules such as SiO and SO will be included for spectral decomposition analysis

•Interferometric observations will map the different components