ASTROCHEMISTRY AT WORK IN THE L1157-B1 BOW-SHOCK: FORMATION OF ACETALDEHYDE AND DEUTERATED MOLECULES.

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Introduction: The formation of complex organic molecules (COMs) in protostellar environments is a hotly debated topic. In particular, the relative importance of the gas phase processes as compared to a direct formation of COMs on the dust grain surfaces is so far unknown.

L1157 is a prototypical chemically active outflow driven by a low-mass class-0 protostar, and B1 is its brightest bow shock [1]. Towards L1157-B1, several emission lines of COMs and deuterated molecules have been detected by our team for the first time. We show evidence that both species were formed on grain mantles, and then released into the gas phase by the passage of the shock. In fact, observations obtained at high angular resolution with the Plateau de Bure Interferometer of L1157-B1 ([2], [3]) indicate that the emission of both molecules perfectly delineates the region of the interface between the fast jet and the slower ambient material (Fig. 1).

Astrochemical modelling indicates that gas phase reactions can produce the observed quantity of acetaldehyde only if a large fraction of carbon [3], of the order of 0.1%, is locked into iced hydrocarbons. Moreover, our study represents the first clear evidence ever found of the common formation of complex molecules and deuterated molecules on the ices covering the dust grains during the cold pre-protostellar phase [2].

References: [1] Bachiller et al. (2001) *A&A, 372,* 899. [2] Fontani F. et al. (2014) *ApJ, 788,* L43. [3] Codella C. et al. (2014) *arXiv:1412.8318*.

Fig. 1:

Integrated emission of HDCO (black contours) superimposed on the acetaldehyde emission (grey scale) towards the bow-shock L1157-B1. The red arrow indicates the direction of the jet impacting the ambient material. Clearly, the emission of both molecules arise from the interface between the jet and the ambient cloud. The big circle represents the field of view of the PdB Interferometer. The grey ellipses in the top- and bottom-left corners correspond to the synthesized beam of the acetaldehyde and HDCO observations, respectively.