Protostellar outflow shocked regions: astrochemical laboratories at our disposal - The case of L1157

J. Robuschi[1], A. López-Sepulcre[1,2], and C. Ceccarelli[1]

[1] *Univ. Grenoble Alpes, CNRS, IPAG, Grenoble, France*
[2] *Institut de Radio-Astronomie Millimétrique, 38400 Saint-Martin d'Hères, France*

Chemical compounds, and in particular organic molecules, have been observed and are thought to form at all stages of star formation. Among the $\geq$330 species detected in the interstellar medium to date, we are notably interested in the so-called interstellar complex organic molecules (iCOMs), which are molecules containing $\geq$6 atoms, including carbon and at least one other heavy element. It is currently thought that iCOMs can form in two main ways: on the surface of dust grains or via gas-phase processes. The two pathways are thought to be involved in the formation of different iCOMs; however, which process is predominant for each species remains a hotly debated topic.

A powerful way to discriminate between and constrain the two routes is to observe iCOMs along protostellar outflow-shocked regions, where dust material is released into the gas, provided their ages and physical conditions are well constrained. In this way, the evolution of gas-phase chemistry over time can be probed.

A perfect study-case for such works is the southern outflow of the protostellar source L1157, known for its richness in iCOMs, and which hosts three shocked regions of different post-shock ages, comprised between 900 yr and 2500 yr. Several studies targeting this region were able to bring constrains on the formation pathways of several iCOMs, including formamide (NH_2CHO), acetaldehyde (CH_3CHO) and glycolaldehyde (CH_2OHCHO). However, the studies also showed that the density and temperature have not yet been well constrained in all the shocked regions along this outflow.

The goal of this work is thus to constrain these two physical parameters along the outflow, by using high angular resolution ($\sim 4''$) observations of the southern outflow of L1157 conducted with the IRAM-NOEMA interferometer. To this aim we detected and analysed eight methyl cyanide (CH_3CN) lines and three methanol (CH_3OH) lines, allowing us to perform a non-LTE (Local Thermodynamic Equilibrium) radiative transfer analysis via our in-house GRELVG code. We obtained the temperature of the gas, density and column density for each shocked region. This provides us with new, better constrained physical parameters that can notably be used as inputs for the codes employed to model the time-evolution of gas-phase chemistry.