CO is the most abundant molecule after H₂ and it is commonly used as a kinematical tracer of interstellar gas. Because CO is virtually always optically thick, less abundant optically thin CO isotopologues (e.g. C₁₈O) are commonly used to probe the denser and colder regions of molecular clouds. However, in this environment, where densities are ≳ 10⁶ cm⁻³ and the temperature is ≳ 20 K, the effects of CO-depletion can alter the amount of C₁₈O in the gas phase and thus its usefulness as a kinematical tracer. We present a study of the depletion of C₁₈O in the IRDC G351.77-0.51 (G351). A key parameter is the radius within which the C₁₈O is depleted (R_dep). To derive a map of the depletion across the cloud, we used the dust continuum emission (Herschel Hi-Gal), combined with APEX C₁₈O and CO(2-1) line observations. We built a simple 1D-model to investigate the size of the CO-depleted regions in G351. The model suggests that R_dep is the radius within which the C₁₈O (e.g. C₁₈O is the most abundant molecule after H₂) profiles are obtained by the product of the other two.

1. Introduction

The problem of CO-depletion in massive clumps:
- Infrared Dark Clouds (IRDCs) are recognized as some of the nurseries of massive stars [1]; CO is the most abundant molecule after H₂; it is used to trace the ISM kinematics;
- continuum v.s. molecular line emission from the same clump: discrepancy between the locations at which the two emissions peak. The explanation is the so-called CO-depletion [2];
- How much CO is depleted onto the surface of the dust grain is described by the depletion factor, f_D: its timescale, τdep, mainly depends on the volume density of H₂:

\[ f_D = \frac{X_{CO}}{X_{CO}} \text{ with } \tau_{dep} = \frac{10^9}{5n(H_2)} \text{[yr]} \]

where: – X_CO and X_CO are the ‘expected’ and observed abundance of CO with respect to H₂, respectively;– S is sticking coefficient, (here 1);– n is the volume density of H₂;
- In different samples of young HMXB (Fig. 1), f_D varies between 1 and a few tens (beam- and los-averaged quantities);
- Depletion radius (R_{dep}): radius within which most CO is locked onto dust grains;
- The real size of the R_{dep} (un-observable) gives us the spatial scales on which:
  ❑ different chemical processes operate in HMXR;
  ❑ the estimate of H₂ from CO and/or the study of the gas-kinematics using CO lines could be misleading.

The source:
- Is the most massive, closest filament in the ATLASGAL survey (Fig. 2);
- Early evolutionary stage, lots of cold and chemically young material, dark in the MIR [4];
- Mass: ≳ 2000 M_☉;
- Distance: < 1 kpc (~ 7.8 kpc from Galactic Centre);
- The presence of numerous star-formation regions, its filamentary structure and its proximity, make this source the perfect choice to study the variation of the depletion factor, even in regions where the gas is more diffuse.

Observations:
- Herschel (Hi-Gal) and LABOCA dust continuum data (160, 250, 350, 500 and 870 μm); dust temperature, T_dust and H₁ column density, N(H₁) [5];
- APEX C₁₈O and C₁₈O(2-1); observed N(C₁₈O) corrected for opacity effects;
- Profiles have radial symmetry with respect to the center of the ridge, i.e. the “spine”;
- We changed the relative abundance C₁₈O/H₂, to simulate different depletion conditions (Fig. 5):

\[ R < R_{dep} \hspace{1cm} f_D = \frac{(10, \infty)}{n_{H_2}} = \frac{n_{H_2}}{n_{H_2}} \hspace{1cm} \frac{(10, \infty)}{n_{H_2}} = \tau_{dep} \]

\[ \frac{X_{CO}}{X_{CO}} = \frac{X_{CO}}{X_{CO}} \]

Profiles are smoothed to the beam size.Temperature is expressed in K, VLSR in km s⁻¹, the gas-to-dust ratio in M_☉/M_☉.
- Profiles are smoothed to the beam size.
- Temperature is expressed in K, VLSR in km s⁻¹, the gas-to-dust ratio in M_☉/M_☉.
- Extraction of the best-fit lines (Fig. 6);
- Extraction of the best-fit power law function for R_{dep}, as a function of f_D;

\[ f_D \text{ changes from the best-fitting model applied (see the example of the clump-5 in Fig. 6d)}\]

REFERENCES: