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processes in the interstellar medium 1.3.1 Gas-phase chemistry -- 1.3.2 Type of reactions -- 1.4 Isotopic fractionation in the context of star formation -- 1.4.1 The evolution of chemical complexity during star formation -- 1.4.2 The heritage of the Solar system -- 1.4.3 Deuterium enrichment during star formation -- 1.4.4 Nitrogen fractionation in the ISM -- 1.5 Thesis project -- 2 Nitrogen and hydrogen fractionation in high-mass star-forming regions -- 2.1 Introduction -- 2.2 Observations and data reduction -- 2.3 Results: column densities and isotopic ratios -- 2.3.1 HNC, HN¹³C, HCN, and H¹³CN -- 2.3.2 DNC -- 2.4 Isotopic fractionation -- 2.4.1 ¹⁵N-fractionation as a function of evolutionary stages -- 2.4.2 D-fractionation -- 2.4.3 Comparison between D/H and ¹⁴N/¹⁵N -- 2.5 The HCN/HNC ratio -- 2.6 Conclusions -- 3 Nitrogen fractionation across the Galaxy -- 3.1 Introduction -- 3.2 Sample and observations -- 3.2.1 Description of the sample -- 3.2.2 Observations -- 3.3 Results -- 3.3.1 Line detection -- 3.3.2 Fitting procedure and column density calculation 3.3.3 ¹⁴N/¹⁵N ratios -- 3.4 The Galactocentric behaviour -- 3.4.1 Linear analysis -- 3.4.2 Parabolic analysis -- 3.5 Discussion and Conclusions -- 4 Enhanced nitrogen fractionation at core scales -- 4.1 Introduction -- 4.2 Source and observations -- 4.3 Results -- 4.3.1 Continuum map -- 4.3.2 Morphology of NH and ¹⁵N-isotopologues emission 4.3.3 Fitting procedure and column density calculation 4.3.4 ¹⁴N/¹⁵N ratios -- 4.4 Discussion of the results -- 4.4.1 Comparison between line and continuum emission maps 4.4.2 Is N-fractionation a core-scale effect? -- 4.4.3 ¹⁵NNH vs N¹⁵NH⁺ -- 4.4.4 ¹⁴N/¹⁵N ratios in diffuse regions -- 4.5 Conclusions -- 5 Carbon isotopic fractionation: a new detailed chemical study -- 5.1 Introduction -- 5.2 Model -- 5.2.1 Chemical model -- 5.2.2 Introduction of ¹³C-fractionation in the chemical model 5.2.3 Isotopic exchange reactions -- 5.3 Results and Discussion -- 5.3.1 The fiducial model -- 5.3.2 The importance of Cs isotopic-exchange reaction 5.3.3 Parameter space exploration -- 5.4 Conclusions -- 6 Summary and Main Conclusions -- A Appendix: Spectra simulation tests -- A.1 ¹⁵N-isotopologues at lower spectral resolution -- A.2 NH at higher spectral resolution -- A.3 The effect of a possible N₂H⁺ line saturation -- Bibliography -- Ringraziamenti -- Acknowledgments.

Sommario/riassunto

One of the most important tools to investigate the chemical history of our Galaxy and our own Solar System is to measure the isotopic fractionation of chemical elements. In the present study new astronomical observations devoted to the study of hydrogen and nitrogen fractionation (D/H and ¹⁴N/¹⁵N ratios) of molecules, towards massive star-forming regions in different evolutionary phases, have been presented. Moreover, a new detailed theoretical study of carbon fractionation, ¹²C/¹³C ratios, has been done. One of the main results was the confirmation that the ¹⁴N/¹⁵N ratio increases with the galactocentric distance, as predicted by stellar nucleosynthesis Galactic chemical evolution models. This work gives new important inputs on the understanding of local chemical processes that favor the production of molecules with different isotopes in star-forming regions.

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