## Cosmic-ray induced ionization of a molecular cloud shocked by the W28 supernova remnant

S.Vaupré<sup>1</sup>, C. Ceccarelli<sup>1</sup>, P. Hily-Blant<sup>1</sup>, Guillaume Dubus<sup>1</sup>, S.Gabici<sup>2</sup> and T.Montmerle<sup>3</sup>

<sup>1</sup> Univ. Grenoble Alpes/CNRS, IPAG, F-38000 Grenoble, France; e-mail: solenn.vaupre@obs.ujf-grenoble.fr

<sup>2</sup>APC, AstroParticule et Cosmologie, Université Paris Diderot, CNRS, CEA, Observatoire de Paris, Sorbonne Paris, France

<sup>3</sup> Institut d'Astrophysique de Paris, 98bis bd Arago, FR-75014 Paris, France

Cosmic rays are an essential ingredient in the evolution of the interstellar medium, as they dominate the ionization of the dense molecular gas, where stars and planets form. However, since they are efficiently scattered by the galactic magnetic fields, many questions remain open, such as where exactly they are accelerated, what is their original energy spectrum and how they propagate into molecular clouds. In this work, we present new observations and discuss in detail a method that allows us to measure the cosmic ray ionization rate towards the molecular clouds close to the W28 supernova remnant. To do so, we use CO, HCO+ and DCO+ millimeter line observations and compare them with the predictions of non-LTE radiative transfer and chemical models. The CO observations allow us to constrain the density, temperature and column density towards each observed position, while the DCO+/HCO+ abundance ratios provide us with constraints on the electron fraction and, consequently, on the cosmic ray ionization rate. Towards positions located close to the supernova remnant, we find cosmic ray ionization rates much larger (> 100) than that in standard galactic clouds. Conversely, towards one position situated at a larger distance, we derive a standard cosmic ray ionization rate. Overall, these observations support the hypothesis that the Y-rays observed in the region have an hadronic origin. In addition, based on CR diffusion estimates, we find that the ionization of the gas is likely due to 0.1 - 1 GeV cosmic rays. Finally, these observations are also in agreement with the global picture of cosmic ray diffusion, in which the low-energy tail of the cosmic ray population diffuses at smaller distances than the high-energy counterpart.

## Références (cambria 10 pt, gras, alignement gauche)

[1] S.Vaupré et al. (2014) A&A, accepted

[2] C.Ceccarelli et al. (2011) ApjL, 740