Product detection of C(^{3}P) reactions with small hydrocarbons using tunable vacuum ultraviolet synchrotron radiation coupled with time of flight mass spectrometry

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Atomic carbon is the third most abundant species in interstellar medium. It has been detected in various astronomical objects [1,2] as well as in chemical vapor deposition processes and plasmas [3]. Carbon atoms may contribute significantly to combustion chemistry by fast reactions with small hydrocarbons [4,5] initiating complex radical chemistry leading to the formation of larger molecules.

Table 1: H-atom product branching ratios for C(^{3}P) reaction with selected hydrocarbons

Reactant molecule	*H-product ratio*
C_2H_2	0.53
C_2H_4	0.92
C_3H_6	0.51
C_4H_8	0.33
C_6H_6	0.17

The aim of this work is to improve our understanding of the chemistry between carbon atoms with small hydrocarbons. One of the proposed exit channels used in chemical models is the loss of a hydrogen atom to form larger open-shell hydrocarbons. The overall reaction can be written as $C + C_nH_m \rightarrow C_{n+1}H_{n-1} + H$. Table 1 displays measurements of the H-atom branching ratios for C(^{3}P) reactions with unsaturated hydrocarbons [6,7]. In most cases, the H-loss accounts for half of the reaction product ratios. The accuracy of the models reproducing the chemistry of carbon-rich environments strongly depends on the identification of all the reaction products. Here we propose to detect the products of the ground state, C(^{3}P), reactions with various small hydrocarbons in order to refine our understanding of their reaction mechanisms.

The experiments were performed in a slow gas flow tube at 330 K and 4 torr. The C(^{3}P) radicals were generated by photolysis of a precursor (CBr_4 at 248 nm and C_3O_2 at 193 nm) using an excimer laser. Detection of the products in the flow was carried out by photoionization using tunable vacuum ultraviolet synchrotron radiation, coupled with a time of flight mass spectrometer [8]. Kinetic traces and photoionization spectra of the species were used to determine primary products of the reactions.

We present here first results obtained on the reaction products of C(^{3}P) atoms with C_2H_4, C_3H_6 and C_6H_6 that can all contribute to the formation of larger species in carbon rich environments.

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References

[1] Ingalls, J. G. et al. *Astrophys. J.*, *431*, L139 (1994)
[2] Van der Veen, W. et al. *Astrophys. J.*, *505*, 749 (1998)
[3] Benedikt, J. et al. *J. Appl. Phys.*, 94, 6932 (2003)
[4] Kaiser, R. I. et al. *Inter. Rev. Phys. Chem.*, 21, 307 (2002)
[5] Chastaing, D. et al. *Astron. Astrophys.*, 365, 241 (2001)
[6] Bergeat, A. et al. *Phys. Chem. Chem. Phys.*, 3, 2038 (2001)
[7] Loison, J. C. et al. *Phys. Chem. Chem. Phys.*, 6, 5396 (2004)
[8] Osborn, D. L. et al. *Review of Scientific Instruments*, 79 (2008)