

# Low-temperature photochemical and spectroscopic studies of the cyanoacetylenes of astrophysical relevance.

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## Abstract

Here I present the results of spectroscopic and photochemical investigations on cyanoacetylenes (cyanopolyynes) – molecules belonging to the most important ones detected in the interstellar medium. The experiments, performed mostly in the environments of frozen noble gases, have resulted, inter alia, in the photochemical conversion of cyanoacetylene ( $\text{HC}_3\text{N}$ ) into longer cyanopolyynic chains:  $\text{C}_4\text{N}_2$ ,  $\text{HC}_5\text{N}$ ,  $\text{C}_6\text{N}_2$ ,  $\text{HC}_7\text{N}$  or  $\text{C}_8\text{N}_2$ . The identification of these nitriles and dinitriles was accomplished via the analysis of luminescence emitted from photolysed samples. Alternative method consisted in subjecting a gaseous mixture, containing the precursor and rare gas atoms, to electric discharges, prior to its solidification onto the cold substrate (*cold window radial discharge* technique, CWRD). Apart from above listed molecules, larger than the precursor species, I could witness the appearance of additional luminescing products, among them the  $\text{C}_3\text{N}^-$  anion. The investigations of electronic emission spectra have also been carried out for some selected pure substances, synthesized with preparative organic chemistry methods. Strong phosphorescence of  $\text{HC}_5\text{N}$  was discovered, and the analysis of (already known)  $\text{C}_4\text{N}_2$  emission has been substantially extended. Investigations directed toward the detection of  $\text{HC}_5\text{N}$  photolysis (or CWRD-treatment) products have led to the identification of  $\text{HC}_5\text{N}$  isomers and of the  $\text{C}_5\text{N}^-$  anion; this was possible following the isotope labeling experiments. Knowledge of  $\text{HC}_5\text{N}$  vibrational spectroscopy was broadened with Raman scattering measurements. The Dissertation contains also preliminary data regarding spectroscopy and photochemistry of  $\text{HC}_3\text{N}$  molecules isolated in solid parahydrogen matrices.

Throughout this Ph.D. project, the cooperation with French laboratories, in particular with the Laboratoire de Photophysique Moléculaire of the CNRS (Orsay) was of great importance, as it granted me the access to a range of scientific instruments and methods – complementary to those available at IPC PAS.