Experimental investigation of collisional processes at low temperatures for astrochemistry

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The CRESU (Cinétique de Réaction en Ecoulement Supersonique Uniforme, or Reaction Kinetics in Uniform Supersonic Flow) technique, combined with laser photochemical methods, has been applied with great success to gas-phase chemical kinetics at low temperatures, of particular interest for astrochemistry and cold planetary atmospheres [1]. However, while many neutral-neutral reactions have a number of potential product channels, measurements have concentrated to date almost exclusively on the overall rate constants. There are virtually no experimental measurements of product branching ratios below 50 K, and only very limited information below room temperature.

A new combination of the revolutionary chirped pulse broadband rotational spectroscopy technique, invented by Brooks Pate and co-workers [2], with the CRESU technique has been developed in a collaboration with the groups of Arthur Suits (U. Missouri) and Bob Field (MIT) which we have called Chirped Pulse in Uniform Flow (CPUF) [3]. Rotational cooling by frequent collisions with cold buffer gas in the CRESU flow at ca. 20 K drastically increases the sensitivity, making broadband rotational spectroscopy suitable for detecting a wide range of transient species, such as photodissociation or reaction products.

In Rennes we have constructed two high-power chirped pulse spectrometers operating in the E-band (60-90 GHz) [4] and Ka band (26.5-40 GHz) [5] and made further experimental developments to increase the sensitivity of the CPUF technique. We have observed the products of reactions of the CN radical with C_2H, C_2H_4, C_2H_6 and C_3H_6 at temperatures from 10—50 K and these results will be presented along recent results using this new technique on the collisional excitation of the astrophysically important HCN molecule and its unstable isomer HNC [6].

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