DISSOCIATIVE RECOMBINATION OF CH_5^+: TOTAL CROSS SECTIONS AND BRANCHING FRACTIONS

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CH_5^+ is formed in dense interstellar clouds by the radiative association process $CH_3^+ + H_2 \rightarrow CH_5^+ + h\upsilon$ when the electron abundance is small enough to prevent dissociative recombination (DR) of CH_3^+ from being effective. DR of CH_5^+ can occur by as many as nine paths, but below 0.2 eV collision energy, only five are energetically possible.

Branching Path		Branching Fraction	
CH_5^++e	$\rightarrow CH_4 + H$	(α)	0.09
	$\rightarrow CH_3 + H_2$	(β)	0.06
	$\rightarrow CH_4 + 2H$	(γ)	0.67
	$\rightarrow CH_2 + H_2 + H$	(δ)	0.16
	$\rightarrow CH + 2H_2$	(ε)	0.02

The branching ratios are important since they could have a significant effect on the abundances of CH_2, CH_3 and CH_4.

We have used the CRYRING heavy-ion storage ring at the Manne Siegbahn Laboratory at Stockholm University in Sweden to measure total cross sections and branching in CH_5^+. The CH_5^+ is injected into the ring accelerated to an energy of 5.6 MeV. In one leg of the ring, the ion beam is merged with a collinear electron beam which acts as a "cooler" and as an electron target. The beam is stored to permit vibrational relaxation. The relative energy is varied from <0.001 to 40 eV. Neutral (DR) products exit the ring and are recorded on a surface barrier detector as a 5-6 MeV pulse. The total DR cross sections are shown in Fig. 1. The partial cross sections are determined by inserting a perforated absorbing sheet (50-μ-thick, 50-μ-holes -30% transparent) in front of the detector[1]. The DR fragments have independent probabilities of passing through a hole in the barrier and the signal is broken up into a series of pulse heights depending on how many hydrogen atoms have passed through holes in coincidence with a carbon atom (Fig. 2). Analysis of these spectra yields the branching ratios indicated in the table above. These results are contrary to the expectations of Bates and Herbst[2] who anticipated the major contributions from paths δ and β, but not from α and with Fox and Yelle[3] who expected the dominant mechanism would be α with some contribution from channel δ.

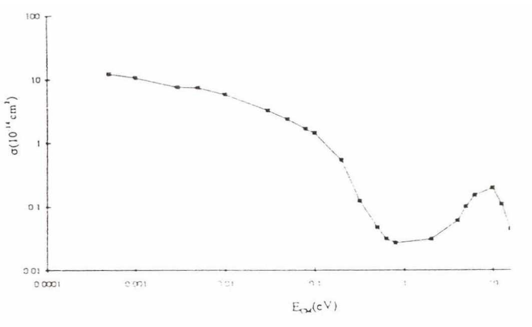

Fig. 1. Values (preliminary) of total DR cross section CH_5^+ versus collision energy.

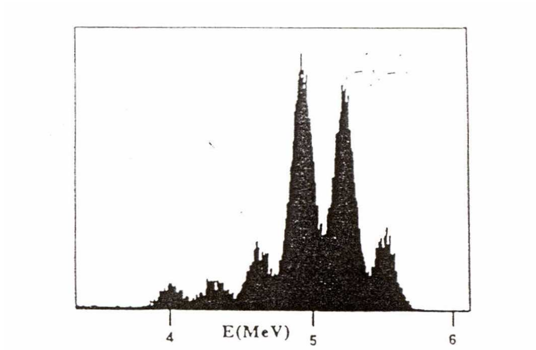

Fig. 2. Pulse height spectrum for DR of CH_5^+ after passing through the screen. From right to left, the peaks represent $C(H_5)$, $C(H_4)$, $C(H_3)$, $C(H_2)$, C(H) and C. The spectrum is taken at 1 meV relative energy and the last peak is not energetically possible in DR, it arises from collisions with rest gas.

1. S. Datz et al Phys. Rev. A 52, 1 (1995).
2. D.R. Bates and E. Herbst, "Rate Coefficients in Astrochemistry", 1988
3. J.L Fox and R.V. Yelle Proc Am. Astro. Soc. 23, 53 (1991).

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