

Excitation and fragmentation in high velocity C_nN^+ - He collisions

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Synopsis: We will present measurements and modeling for two aspects of the C_nN^+ - He collisions ($n=1-3$, $v=2.25$ a.u) : cross sections for electronic excitation processes and fragmentation branching ratios for the excited and ionized C_nN^{q+} molecules produced in the collision ($q=-1,0,1,2-5$).

The study of molecule-atom collisions is a difficult topic, both from the experimental and theoretical points of view. In the high velocity regime, mostly small molecular systems have been studied [1]. On the other hand, the so-called Independent Atom and Electron (IAE) model was applied recently with reasonable success to C_n^+ -He, Ar systems with state of the art CTMC and SCAOCC P(b) probabilities [2]. We will test this approach again in this work.

Fragmentation of the excited molecular system is another topic of interest. In high velocity collisions ($\tau_{\text{coll}} \sim 10^{-16}$ s) it occurs well after the excitation and can be treated separately. The MMMC approach and its new more general version M3C [3] is dedicated to treatment of statistical fragmentation. The systems studied here belong typically to this class of fragmentation [4]. We will ultimately compare our experimental fragmentation branching ratios (BR) to predictions of this statistical approach.

Experiments have been performed at the Tandem accelerator in Orsay with beams of C_nN^+ molecular ions ($n=1-3$) of constant velocity $v=2.25$ a.u colliding with helium atoms. The setup is identical to the one described in [5] (see also Jallat et al, this conference). Briefly the setup allows to reconstruct, from fragments complete collection and identification in charge and mass, the charge q of the projectile after the collision, signature of the process. An example is given in Table 1 for the case of double electron capture ($q=-1$) in the C_2N^+ - He collision where contribution of various channels to the $\{C_2N\}$ production is reported.

We will present two types of results. First experimental cross sections for various electronic processes will be presented and compared to predictions of the IAE + CTMC calculations. These calculations will use structure calculations for C_nN^+ systems that we performed. Second, fragmentation BR for C_nN^{q+} species with $q=-1,0,1,2,3-5$ will be presented. In addition to the fundamental aspects discussed before, these BR are also of interest in astrochemistry as already pointed out [6]. Note that C_nN species, in their neutral and anionic forms, have been detected in interstellar medium [7] and planetary atmospheres [8].

Table 1 Measured fragmentation BR of $\{C_2N\}$ species produced by double electron capture in the collision C_2N^+ - He ($v=2.25$ a.u).

| Channel | Exp. BR | Error |
|---------------|-------------|-------|
| C_2N^- | 0.40 | 0.04 |
| $CN^- + C$ | 0.51 | 0.06 |
| $C^- + CN$ | 0.07 | 0.02 |
| $C_2^- + N$ | ≤ 0.01 | |
| $C^- + C + N$ | 0.020 | 0.012 |

References

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