ABSTRACTS of Contributed Papers

Amsterdam, 1985

Editors
V.E. de Vries and M.J. van der Wiel

PHOTON - ION COINCIDENCES IN LOW ENERGY ION REACTION

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INTRODUCTION

Many different methods are currently used to determine specific cross sections for reactive collision processes. The determination of the translational energy, being very universal, suffers on resolution. With respect to that, optical methods (e.g. the detection of chemiluminescent photons) are several orders of magnitude superior, but have also their drawbacks. Often, the luminescence constitutes only a minor reaction pathway, and unknown states, overlapping spectra of several channels and cascading transitions obscure the information.
In a modified guided beam apparatus, fluorescence detection has been combined with time of flight analysis of mass selected product ions. Results will be presented for collisions of Ar^{++} with N_2 and N^+ with CO.

EXPERIMENTAL

The guided beam machine is on the whole (storage ion source, quadrupole mass filter and detector) comparable to the apparatus described in earlier publications /1 and 2/. Reactive products, formed in the scattering cell (see fig. 1), are guided

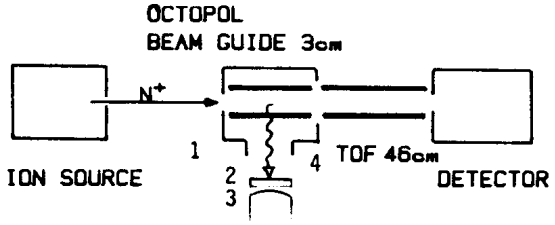

fig. 1 Scattering cell (1), filter (2), photomultiplier (3), octopole for TOF analysis (4)

in a short octopole towards a second long octopole for TOF analysis. A photomultiplier allows the detection of luminescent processes, different wavelength regions can be selected by filters.
Two modes of operation are possible: 1. pulsed ion source, TOF distribution of all products of a given mass or 2. continous ion beam and TOF distributions of ions, correlated to a photon. (see fig. 2). The high sensitivity of the apparatus allows the detection of very weak luminescent channels even in the presence of much stronger bands of other products. Measuring simultaneously kinetic and photon energy, cascading transitions can be identified.

RESULTS AND DISCUSSION

In collisions of Ar^{++} with N_2 (collision energy .1 - 10eV) single charge transfer is the dominant channel leading to highly excited N_2^+ ions. While from translational distributions an excitation energy of 7 - 8 eV has been deduced, emission from the several electronvolts lower lying B and the D state has been reported /3/. Using the coincidence technique it has been proven, that these states are not populated directly in the collision process.

The reaction of low energy N^+ ions with CO has been studied by several groups. Integral cross section measurements have been reported in ref. /4/. At very low energies (20 meV) the charge tranfer cross section reaches almost the Langevin limit /2/, falls off steeply proportional to $E^{-1.2}$ and increases again above 2 eV. The structure in our TOF distributions of all CO^+ ions (fig. 2) points to an internal excitation of either the $CO^+(A)$ or the $N(^2D)$. The absolute values of our cross sections for total luminescence, being in resonable agreement with the results of Neuschäfer et al /5/, show, that below 4 eV only a minor part of the total CO^+ production is due to the $CO^+(A)$ channel. The photon - ion coincidence technique (see fig. 2) corroborates this fact and proves the dominant role of the $N(^2D)$ channel.

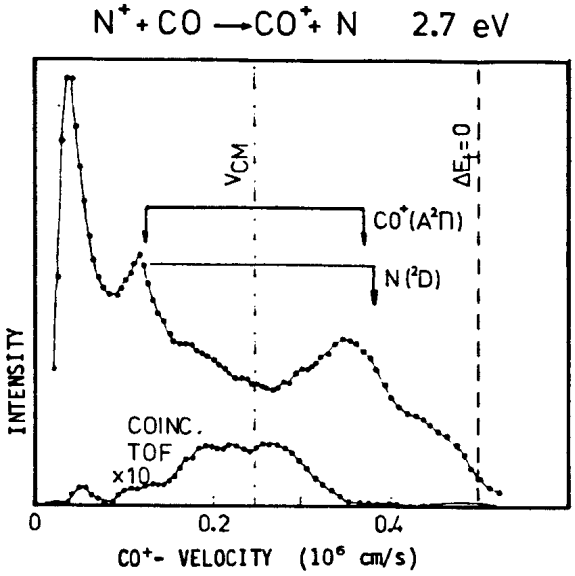

Fig. 2 Velocity distributions of CO^+ product ions.

From the variety of the other possible emitters, also the CN^+ molecule could be identified as a luminescent product using the coincidence between photon and mass selected ion. The luminescent cross section rises steeply above the threshold (5.3 eV kinetic energy) and reaches a maximum of .08 $Å^2$ at 9 eV. By filters the emission spectrum was found to be located at wavelengths above 500 nm.

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