IONIZATION AND ATTACHMENT IN WATER VAPOUR AND AMMONIA

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A.V. Risbud and M.S. Naidu*.

Indian Institute of Science, Bangalore, India.
*Presently with Eindhoven University of Technology, EEg, Group EHO, Eindhoven, The Netherlands.

Introduction. Electron attachment in water vapour has not been extensively studied as in other gases, such as, oxygen and its compounds, There are discrepancies between the existing data (1-5). The results of Parr and Moruzzi (5) are higher than those of Kuffel (1) and Ryzko (4) but are lower than those of Prasad and Craggs (2). Regarding the process of attachment, while Kuffel (1) observed it to be a three-body process at low E/N. Moruzzi and Phelps (6) did not see any attachment for E/N $\geq$ 33 Td. Like wise, $\frac{\alpha}{N}$ of Prasad and Craggs (2) and Ryzko (4) also differ.

Ammonia has not been investigated for over a long time. In view of the recent interest in it (7,8), Parr and Moruzzi (5) investigated attachment processes. Only other studies made in this gas were of Bailey and Duncanson (9) and Bradbury (10). Parr and Moruzzi's η/N are 20% higher than those of Bailey and Duncanson, while those of Bradbury are ten times lower; while these discrepancies exist in η/N, there appears to be no data on the measurements of α/N.

In view of these, measurements were made in both these gases and α/N and η/N were accurately evaluated over the range E/N = 70 to 150 Td (for η/N) and 70 to 2400 Td ($\frac{\alpha}{N}$) over the pressure range 5 to 20 Torr (20°C) (N = 16.5×10^{16} to $66 \times 10^{16} cm^{-3}$).

Experimental technique: The experimental apparatus used was of a usual form for the measurements of prebreakdown currents by the Townsend method using high vacuum techniques. Details were given by Maller and Naidu (11). Before the commencement of measurements, the ionization chamber was evacuated to 3μ Torr, the pumps were isolated and gas was leaked in (see below). The gas pressures were measured to ± 1% using a silicone oil manometer (D.C.705). The ionization currents were read to ± 1% (Keithley Electrometer, type 640) and the applied voltages were measured to ± 0.5% (DM 752, Electronics Corporation of India). Under these conditions, the estimated errors in $\frac{\alpha}{N}$ and η/N were about ± 2%.

Extreme care was taken in purification and drying of the gas samples as suggested by earlier workers (5). Water vapour used was from specially prepared triply distilled deionized water, while ammonia used was purified by fractional distillation and dried using sodium. The gases were further dried before entering the ionization chamber. Care was also taken to see that the density of water vapour inside the chamber was always maintained much below its saturated vapour density at room temperature to avoid possibilities of error in pressure measurement.

Results in Water Vapour. Current growth (log I-d) plots became increasingly linear for E/N > 152 Td indicating that η/N becomes negligible over this region. α/N and η/N obtained from these measurements are shown in figures 1 (η/N) and 2 (α/N). Fig. 1 shwos that the present data of η/N are in good agreement only with those of Crompton et al (3) and differ from the data of others (1,2,4,5). α/N shown in fig. 2 agree with the data of Prasad and Craggs (2) and Ryzko (4) only to within ± 3% over the entire range of E/N studied. η/N were found to be independent of gas pressures suggesting that attachment arises in this gas through dissociative attachment process represented as $e + H2O \rightarrow H^- + OH$.

Results in Ammonia. Coefficients $\frac{(\eta-\alpha)}{N}$ and α/N measured are shown in fig. 3 and 2 respectively. The present $(\eta-\alpha)/N$ values are lower than those of Moruzzl and Parr (5) and Bailey (9) and are higher than those of Bradbury (10) (figure 3). Fig. 2 shows only the present data on α/N as no other data appears to be available for comparison. As was observed in water vapour, no pressure dependence of η/N was observed in this gas also indicating that attachment arises mainly through dissociative processes.

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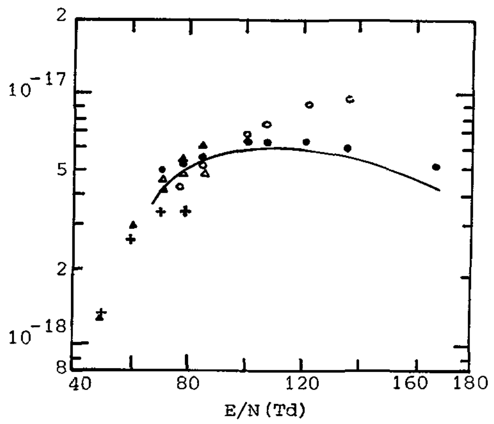

Fig. 1. Attachment coefficiënt (η/N) in water vapour. - present values, ▲ Parr et al (5), Δ Ryzko (4), • Crompton et al (3), o Prasad et al (2) and + Kuffel (1).

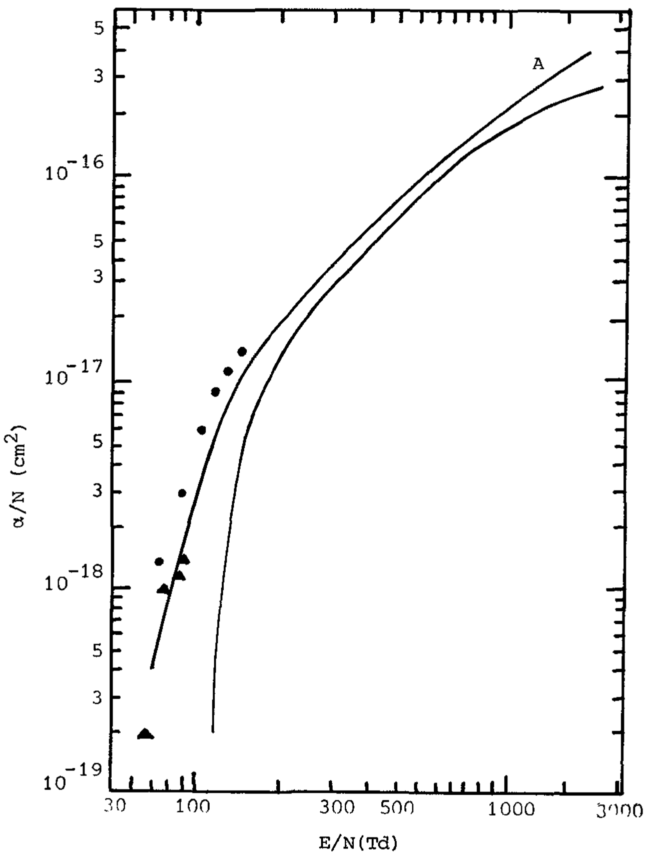

Fig. 2. Values α/N as a function of E/N in water vapour and ammonia. A present data in water vapour, B present data in ammonia, ▲ Ryzko (4) and • Prasad et al (2) both in water vapour.

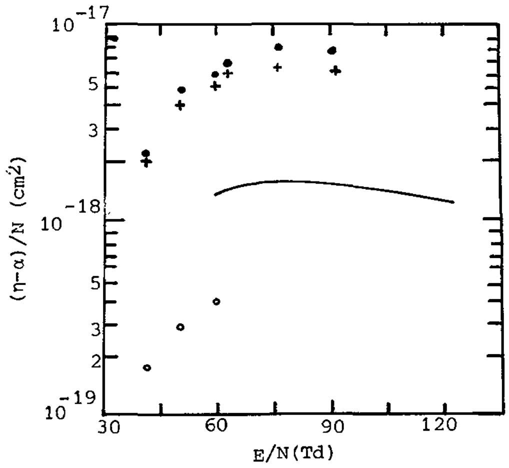

Fig. 3. Values of (η-α)/N as a function of E/N in ammonia. - Present data, • Parr et al (5) o Bradbury (10) and + Bailey et al (9)