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# The Formation of $N_2O^+(\tilde{A}\ ^2\Sigma^+(0,0,0))$ by Photoionization of $N_2O$

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H. Hertz, H. W. Jochims, and W. Sroka
*Institut für Angewandte Physik, Universität Hamburg*
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# The Formation of $N_2O^+(\tilde{A}\ ^2\Sigma^+(0,0,0))$ by Photoionization of $N_2O$ ‡

H. Hertz, H.W. Jochims, and W. Sroka

Institut für Angewandte Physik, Universität Hamburg, Hamburg, Germany

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*The relative cross section for the process $N_2O(\tilde{X}\ ^1\Sigma^+(0,0,0))+h\nu \rightarrow N_2O^+(\tilde{A}\ ^2\Sigma^+(0,0,0))+e^-$ has been measured in dependence on the incident photon energy between 16.4 eV and 20.3 eV via the fluorescent radiation of the transition $N_2O^+(\tilde{A}\ ^2\Sigma^+(0,0,0) \rightarrow \tilde{X}\ ^2\Pi_i(0,0,0))$. It is strongly influenced by Tanaka's apparent emission series R IX and the Rydberg series R VI and R VII.*

The $\tilde{A}\ ^2\Sigma^+$ state of $N_2O^+$ has been the subject of various investigations (for example Cook et al. 1968, Bahr et al. 1972, Fink and Welge 1968, Eland 1973). The aim of this paper was to study the influence of molecular Rydberg states on the photoionization cross section which can only be done by means of an intense continuous light source like a synchrotron. In an earlier paper (Sroka and Zietz 1973) the fluorescence spectrum of $N_2O$ was measured with a synchrotron as a primary light source. Furthermore a first attempt was made to determine the energy dependence of the cross section for the above mentioned transition.

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In this work the synchrotron radiation was dispered by a 1m-scanning monochromator in a modified Wadsworth mounting at a resolution of about 2 Å (Reinke et al. 1973). The reaction chamber was located immediately behind the exit slit. Within this cell the pressure could be varied up to 2.5 x $10^{-2}$ Torr. The excited ions were detected by measuring the fluorescence radiation perpendicular to the incident beam and parallel to the polarization plane with a secondary monochromator (0.5 m Ebert mounting) at a resolution of 20 Å and a cooled multiplier (EMI 6256S). The signal was normalized to the primary photon intensity by means of a reference multiplier. Pulse counting technique was used for the fluorescence signal as well as the reference signal.

The process of ionization and deexcitation can be written as follows:

$$N_2O(\tilde{X}\ ^1\Sigma^+(0,0,0))+h\nu_p \rightarrow N_2O^+(\tilde{A}\ ^2\Sigma^+(0,0,0)) + e^- \rightarrow N_2O^+(\tilde{X}\ ^2\Pi_i(0,0,0))+h\nu_s$$

It leads to a fluorescence at about 3550 Å. Figure 1 shows the excitation function. It was obtained at a pressure of $2.5\times10^{-2}$ Torr. Below about 690 Å the measurement was performed with a lower statistical error than at higher wavelengths, as indicated by the error bars in Fig. 1.

The shape of the excitation function did not change when the measurement was repeated at a pressure of $5\times10^{-3}$ Torr at different characteristic wavelengths. Collisional deexcitation of the $\tilde{A}\ ^2\Sigma^+$ state should not exceed few per cent at a pressure of $2.5\times10^{-2}$ Torr (Alderson et al. 1973, Fink and Welge 1968, Sieck and Gordon 1973). Furthermore the state $\tilde{A}\ ^2\Sigma^+(0,0,0)$ does not predissociate (Eland 1973).

The ground state electron configuration of $N_2O$ is $1\sigma^2 \ldots 6\sigma^2 1\pi^4 7\sigma^2 2\pi^4 \tilde{X}\ ^1\Sigma^+$. The ion states $\tilde{X}\ ^2\Pi_i$ and $\tilde{A}\ ^2\Sigma^+$ are formed by the ejection of a $2\pi$ and a $7\sigma$ electron respectively. The apparent emission series R IX (Tanaka et al. 1960) corresponds to the transition $6\sigma \rightarrow np\pi$ (N = 3,4,...) (Lindholm 1969) and the window resonances found here result from the interference of these molecular states with the continuum of the $\tilde{A}\ ^2\Sigma^+$ state. In a similar way the Rydberg series R VI and R VII - classified as $6\sigma \rightarrow nd\sigma$ and $6\sigma \rightarrow nd\pi$ (N = 3,4,...) transitions (Lindholm 1969) - lead to the observed maxima in the cross section. Two unidentified maxima are found at 687 Å and 693 Å. A striking fact is the fall in the cross section between about 705 Å and 685 Å on which the strong window resonance at 698 Å is superimposed. The formation of $N_2O^+(\tilde{B}\ ^2\pi)$ has an onset energy of about 17.7 eV ( Brundle and Turner 1969). It may be that the cross section for the formation of $N_2O^+$ in the $\tilde{B}$ state increases at the expense of the $\tilde{A}\ ^2\Sigma^+$ state (Bahr et al. 1972). We did not find any significant structure at 706.3 Å (R VIII-3) and 657 Å (R VIII-4) contrary to the observation of Cook et al. (1968). Therefore this apparent emission series seems to have no influence on the formation of $N_2O^+(\tilde{A}\ ^2\Sigma^+(0,0,0))$.

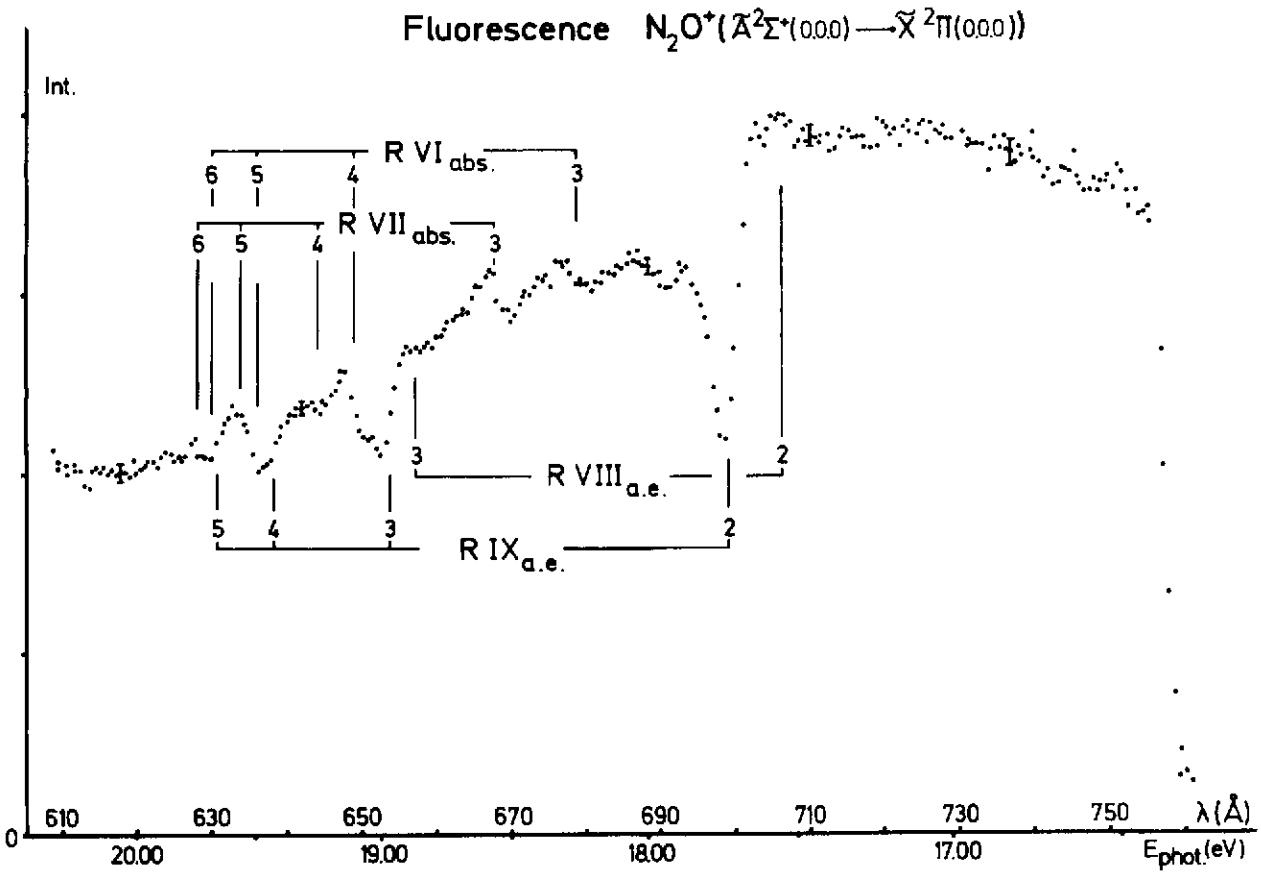
Fluorescence $N_2O^+(\tilde{A}^2\Sigma^+(0,0,0) \longrightarrow \tilde{X}^2\Pi(0,0,0))$
Int.
R VI abs.
6 5 4 3
R VII abs.
6 5 4 3
3
R VIII a.e.
2
5 4 3
R IX a.e.
2
0
610 630 650 670 690 710 730 750 λ(Å)
20.00 19.00 18.00 17.00 $E_{phot.}$(eV)

Figure Caption

Fig. 1 Fluorescence intensity at 3550 Å versus incident photon energy.

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