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Abstract. The electron impact excitation function of the 1048·2 Å and 1066·7 Å lines resulting from the decay of the first excited state in argon have been measured from threshold to 180 eV. The data are compared with the plane and distorted wave Born approximations.

Recent calculations on electron energy distributions in swarm experiments in argon have indicated the need for an excitation function for the first excited state in argon (Fletcher and Burch 1971). The lack of experimental data is also apparent in a recent distorted wave calculation of this cross section by Sawada *et al* (1971). This letter reports the measurement of the excitation function at incident electron energies between threshold and 180 eV.

A well focused beam of electrons passed into a region containing argon atoms at a constant pressure. The electron beam was collected in a Faraday cup, which was held at earth potential. The Faraday cup was designed so that the possibility of secondary electrons passing back through the interaction region was minimized. This was accomplished by constructing the tube out of 0·2 mm sheet. The solid angle subtended by the entrance at the back of the collector was $2{\cdot}5\times10^{-3}$ sr. An outer collector surrounded the central collector. This outer collector was used to establish the fact that the beam was well focused and that all of the incident electrons were collected. Under operating conditions the beam was focused so that better than 99·5% of the incident beam was collected on the central collector.

The electron gun was a multistage gun which had a sufficient number of independent parameters so that it was possible to maintain a well focused beam with a constant current of 1 μA over the whole energy range of the incident beam.

A set of Helmholtz coils surrounded the interaction region and ensured that the magnetic field in this region was less than 0·1 G. All surfaces bounding the interaction region were coated with aquadag and were kept at earth potential.

The radiation which resulted from the decay of the first excited state, that is, the states with configuration ($3p^54S$) to the ground state was detected with a Channeltron electron multiplier (S3029-x). This radiation occurs in two lines, one at 1066·7 Å and the other at 1048·2 Å. However at energies greater than 14·2 electron volts it was possible to excite the states with configuration ($3p^53d$). These states can decay directly to the ground state by the emission of radiation with wavelengths 894 Å and 876 Å. Since the quantum efficiency of the Channeltron was substantially greater at these wavelengths than for the former case (Johnson 1969), it was essential to eliminate the shorter wavelengths. This was achieved by placing a lithium fluoride crystal in front of the Channeltron. The transmission of lithium fluoride is zero for wavelengths less than 1040 Å. A high transparency grid was positioned between the crystal and the interaction region to prevent any electric fields which may have built up on the crystal from entering the interaction region.

The radiation was observed at 90° to the incident beam direction. Thus our data depend somewhat on the polarization of the radiation. The relationship between our data, Q_{90}, and the actual cross section, Q_T, is given by

$$Q_{90} = Q_T \frac{3-P}{3}$$

where P is the polarization of the electric dipole radiation and is defined by

$$P = \frac{I_{11} - I_1}{I_{11} - I_1}$$

and I_{11} is the intensity of the electric vector which is parallel to the incident beam direction and I_1 intensity with electric vector perpendicular to the incident beam direction.

Pulses from the Channeltron were amplified and recorded in a scaler. The counting time for each data point was chosen so that the statistical uncertainty for the lowest counting rates was of the order of 1%.

The operating current and the pressure of the argon in the interaction region were chosen so that they lay on the linear parts of the counts versus pressure and counts versus incident beam current curves.

The experimental data are shown as points in figure 1. No attempt has been made to correct for the effects on the excitation function by cascade from the higher excited states to the first excited state. It is unlikely that either of metastable states in the first excited state have contributed to our data as none were observed when a time of flight investigation was carried out. It would therefore appear that the quenching of the metastable states by collision with the lithium fluoride crystal does not proceed via the emission of a photon in the vacuum ultra violet. The metastable argon atoms have on the other hand been detected with the crystal removed (Lloyd *et al* 1971).

It has not been possible to obtain an absolute excitation function in the present case due to the uncertainty in the transmission of the lithium fluoride at wavelengths so close to cut off. The absolute quantum efficiency of the Channeltron is also not well known. We have therefore normalized our data to the Born approximation at an incident energy of 160 eV.

Significant departures from the Born approximation occur at energies below 100 eV. In general the Born approximation does not predict the shape of the cross section.

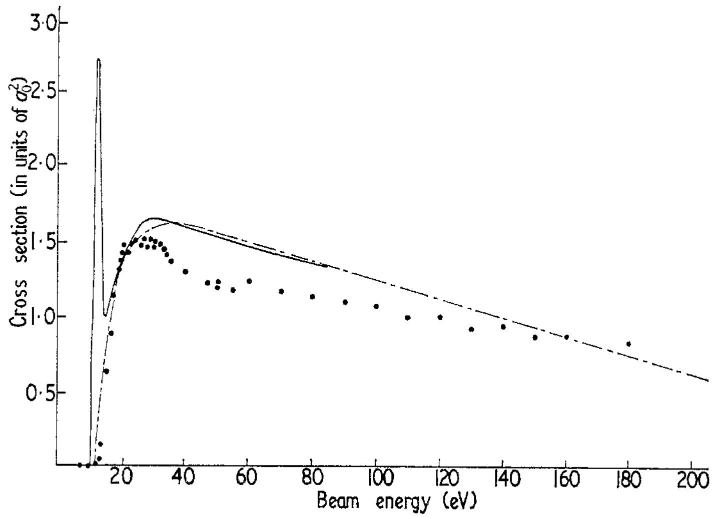

Figure 1. The electron impact excitation function plotted against beam energy. ● experimental data; ——— distorted wave approximation; —— — —— Born approximation.

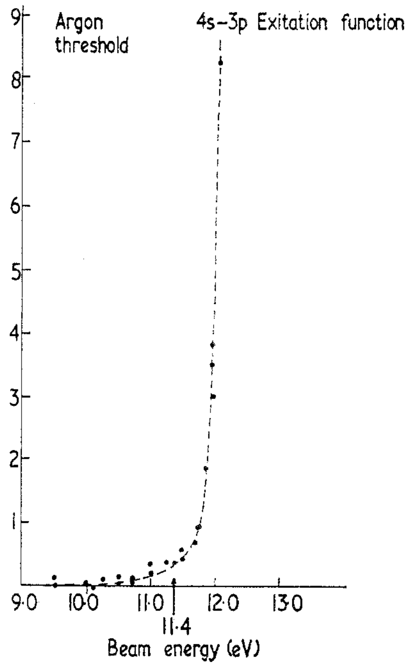

Figure 2. The threshold behaviour of the excitation function.

The threshold behaviour of the excitation function is shown in figure 2. No evidence was found for the sharp resonance which is predicted by the distorted wave calculation when both the direct and exchange terms are included.

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