1.9 On the temperature dependence of dissociative attachment in O_2

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Abstract

The temperature dependence of dissociative attachment of electrons on oxygen molecules is studied in the framework of the theory of Dubrovski, Janev and Ob'edkov for such processes. Using the recent experimental results of Henderson, Fite and Brackmann the real part of the complex potential curve of the quasistationary $^2\Pi_u$ state of O_2 ion is obtained. This curve is quite different in respect to that obtained by O'Malley, using another formulation of the dissociative attachment theory. The cross sections of the studied process are calculated for temperatures of 300 K, 1030 K and 1940 K. The agreement with the experimental data is good.

1.10 High resolution studies of electron excitation functions in helium

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A hemispherical electron energy monochromator has been used for the measurement of some excitation functions in helium in the vicinity of the threshold. An electron beam of variable energy spread, from 35 meV to 15 meV, and current $(5 - 1)\times10^{-8}$ A was directed through the gas at a pressure of 2×10^{-3} torr. The resultatnt radiation is viewed at right angles to the electron beam with a Hilger E612 Raman Spectrograph and is detected with an E. M. I. 6256S photomultiplier cooled to -30°C. A Victoreen P. I. P. 400 multi-channel analyser is used in the multi scale mode to collect the photomultiplier signal in the channel appropriate to the collision chamber potential and to drive the potential on the collision chamber.

In all the results presented the voltage step height is 10 mV and the energy range is either 1 or 2 eV. The duration of an experiment varies from fifteen hours to seventy two hours, the dwell time per channel being in most cases one second. As the duration of an experiment is considerable there was some concern over the stability of the energy scale; this was checked by monitoring a particular point on an excitation function at five minute intervals over a period of twenty four hours. The experiment could detect a drift of less than 2 mV in five minutes.

The accompanying figures show the 4^1S, 4^3S, 4^1D, 4^3D, 3^3D and 3^3S excitation functions in He uncorrected for polarization, on what we consider to be an absolute energy scale correct to ± 10 meV. The applied energy resolution is 20 meV and the beam current 2×10^{-8} A.

The 4^1S and 4^3S channels show complete correlation in their resonant structure, the energies of the feature marked 1—6 in 4^3S and 1—5 in 4^1S being computed from six separate runs of each function, the quoted error is the r. m. s. deviation. There is strong correlation between structure observed in the 4^1D, 4^3D and 3^3D channels, but much weaker correlation between D and S channels; the feature at 23.915 eV being common to all.

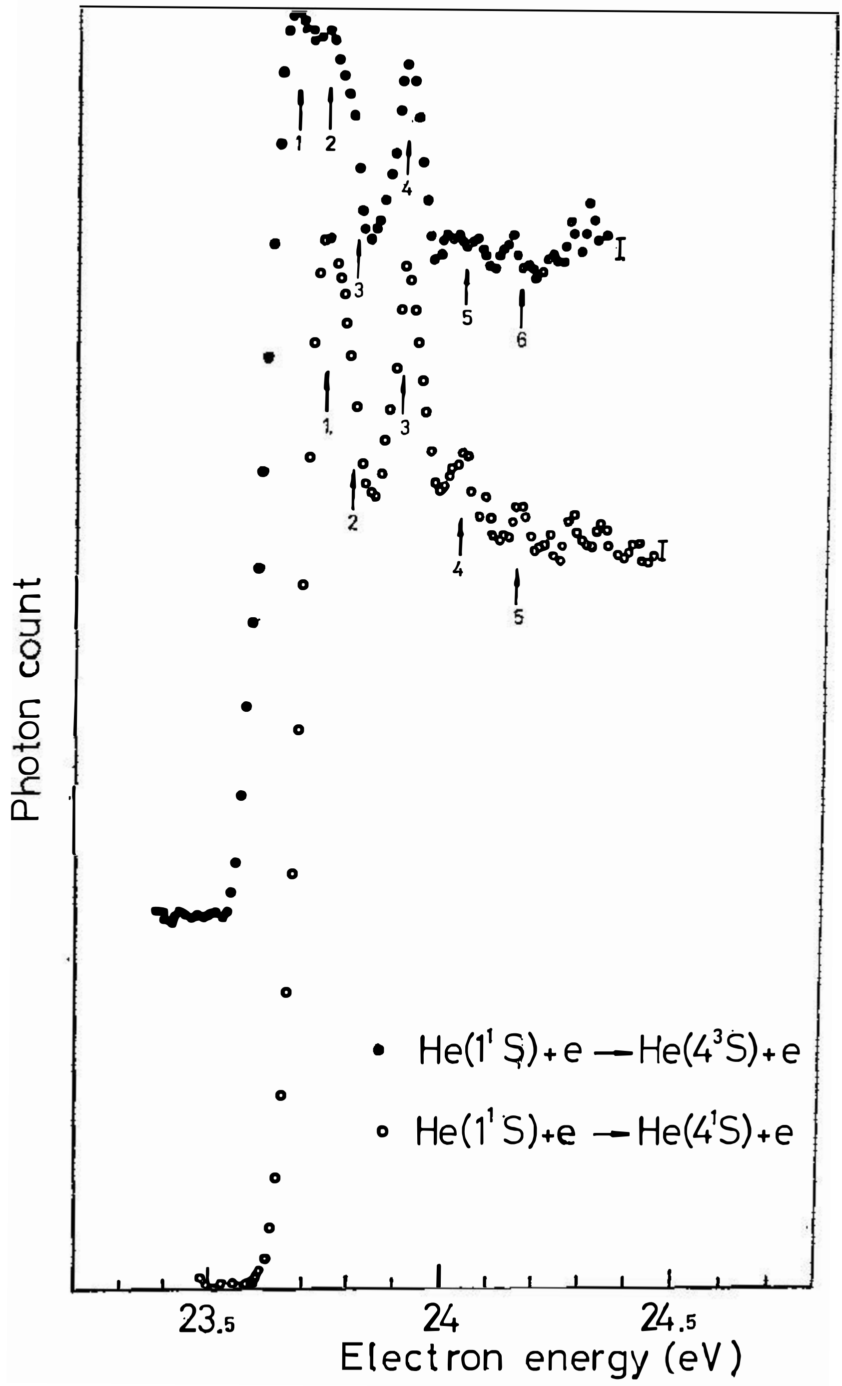

Fig. 1 Excitation of the He (1^1S — 4^1D) and He (1^1S — 4^3D).

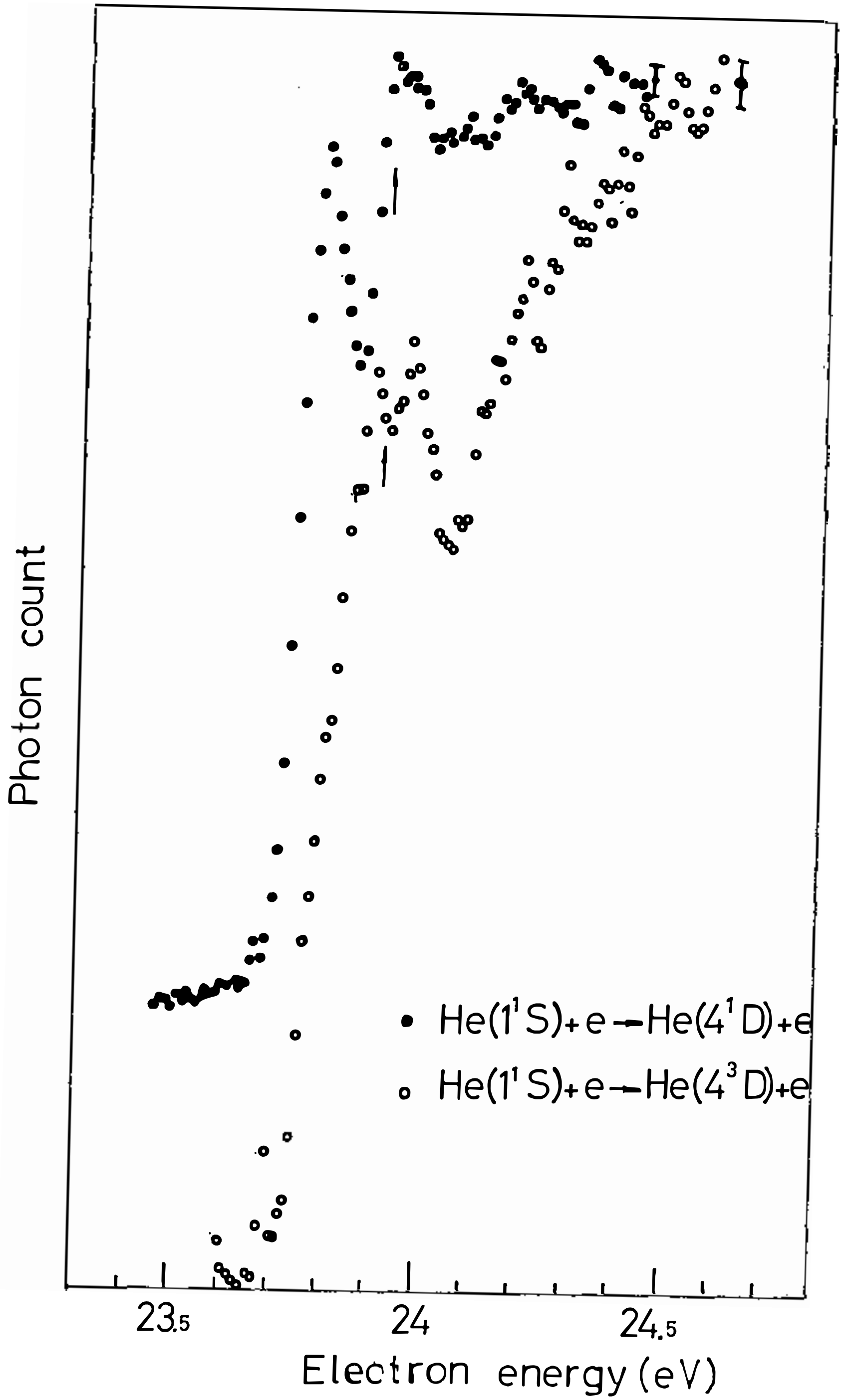

Fig. 2 Excitation of the He (1¹ S — 4³ S) and He (1¹ S — 4¹ S).

Apart from ourselves[1,2], only Zapesochny[3] has carried out high resolution studies in any of these channels. There is general agreement with his work, the main difference being attributable to our higher energy resolution. The energy loss technique[4] has been used to observe states of $n=2$ in the energy region of interest to us, and some correlation is found. Considerable theoretical work has been done by Fano[5] and Burke[6] in interpreting these resonances in terms of

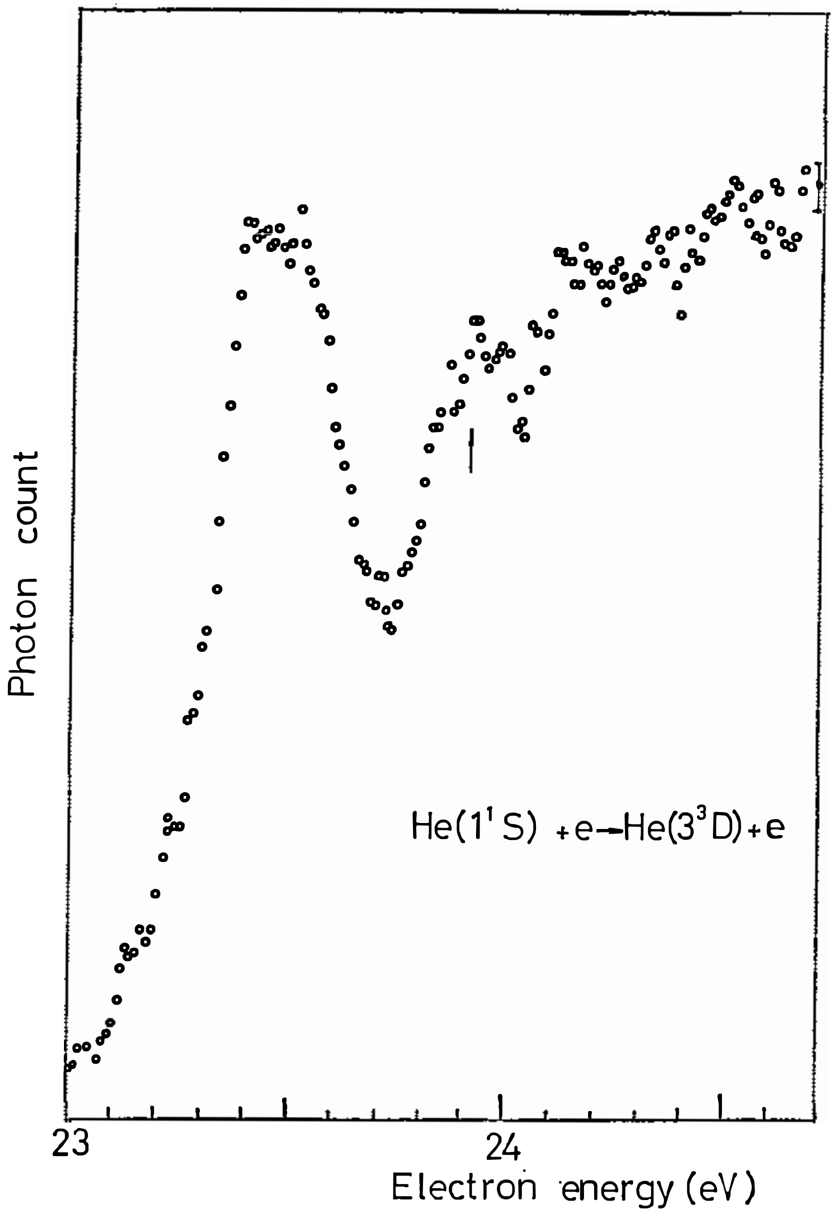

Fig. 3 Excitation of the He (1^1S — 3^3D) transition near threshold.

temporary negative ion states and in calculating their expected energies. Calculations have not yet been possible above the $n=2$ states except to give a general guide to the resonance width of the ^2S, ^2P, ^2D, etc. configurations.

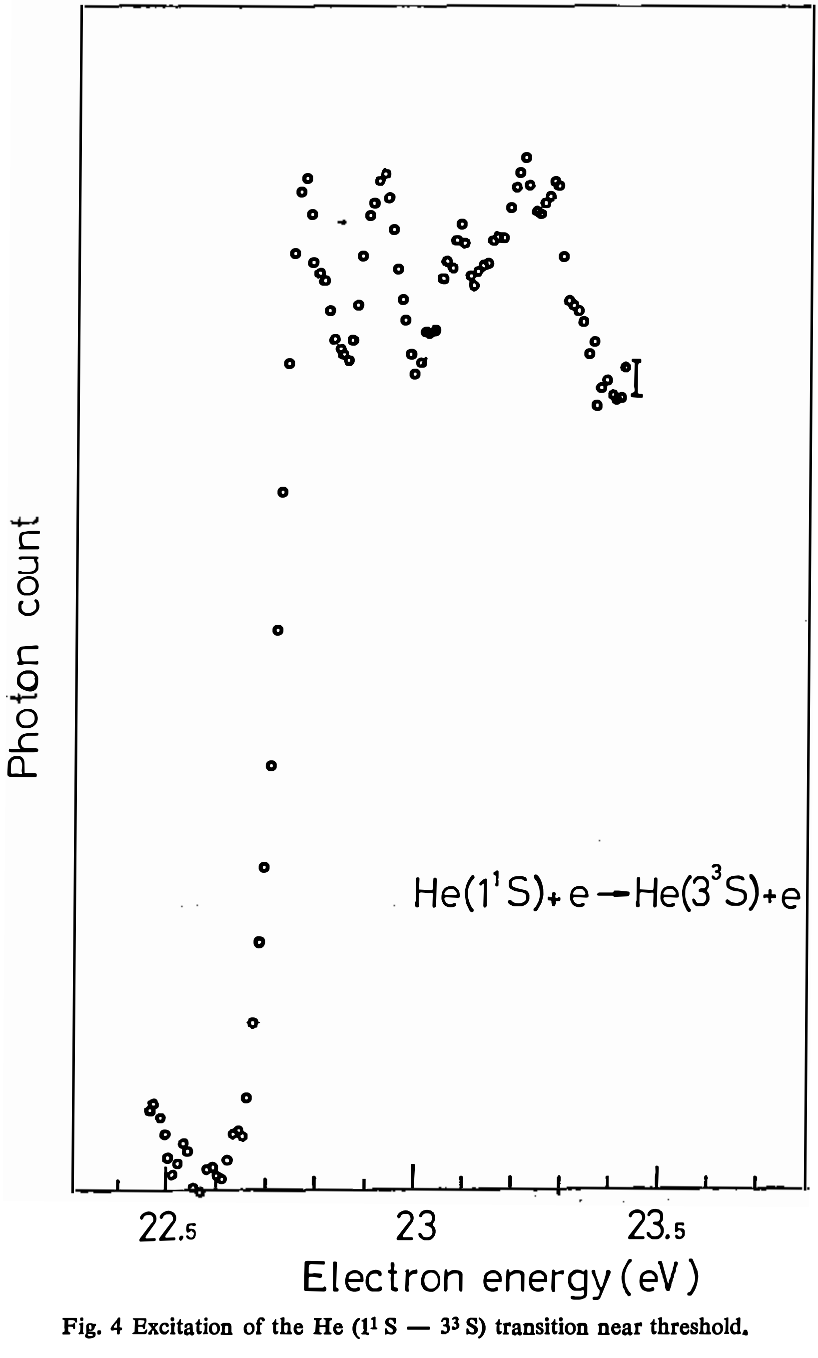

Fig. 4 Excitation of the He (1^1 S — 3^3 S) transition near threshold.

In the case of the 4^3D and 3^3D channels the Wigner[7] threshold law has been found to be valid over at least the first electronvolt above threshold. In the case of other channels studied the law does not seem to hold.

References

1) D. W. O. Heddle and R. G. Keesing, Proc. Phys. Soc., **91** (1967) 510;
2) D. W. O. Heddle and R. G. Keesing, I. U. P. A. C., Leningrad (1967);
3) I. P. Zapesochny and O. B. Phenik, J. E. T. P. **23** (1966) 592;
4) C. E. Kuyatt, J. A. Simpson and S. R. Mielczarek, Phys. Rev. **138** A (1965) 385;
5) U. Fano and J. W. Cooper, Phys. Rev. **138** A (1965) 400;
6) P. G. Burke, J. W. Cooper and S. Ormonde, Phys. Rev., **183** A (1969) 245;
7) G. Breit and U. Wigner, Phys. Rev. **51** (1937) 593.

1.11 Elastic and inelastic differential cross sections in ion — atom collisions

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We report a series of investigations on differential cross sections in ion-atom collisions. The starting point is the impact parameter eikonal approximation[1] which allows one to use standard impact parameter techniques to compute the differential cross section as a function of the angle. It will therefore be assumed throughout this work that if for a given impact parameter ϱ the probability amplitude of exciting state j is $b_j(\varrho)$, then the differential cross section $\sigma_j(\varrho)$ may be written as

$$\sigma_j(\theta) = 2\,\pi\mu^2 v^2 \left| \int_0^\infty b_j(\varrho)\, J_m\left(2\,\mu v \varrho \sin\frac{\theta}{2}\right) \varrho\, d\varrho \right|^2, \qquad (1)$$

where μ is the reduced mass of the colliding system, v is the velocity and m is the magnetic quantum number of state j.

Although (1) is a small-angle approximation, its range of validity covers the range of energy E and scattering angle θ studied experimentally by Helbig and Everhart[2] for H^+ — H collisions ($E \gtrsim 150$ eV, $\theta \lesssim 6°$).

In the energy range $E \lesssim 5$ keV, a molecular orbital expansion provides the most convinient representation of the wave function of the colliding system. For, since non-adiabatic effects are associated with the degeneracy of the $^2\Sigma_u$ and $^2\Pi_u$ electronic states of the molecule H^+ in the limit of small internuclear separations, it suffices to use the $^2\Sigma_u$, $^2\Pi_u$ and $^2\Sigma_g$ states as our basis set[3]. Using such a three-state molecular representation, we have computed the differential cross sections for elastic scattering, charge transfer and excitation (direct or exchange) of the 2p state of hydrogen.

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