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DIFFERENTIAL CROSS SECTIONS OF 200 AND 300 eV ELECTRONS ELASTICALLY SCATTERED BY KRYPTON ATOMS*

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Abstract: Cros sections of elastically scattered electrons at energies 200 and 300 eV on krypton atom are measured absolutely in the angular range between 10° and 25°. Measured values are displayed together with existing experimental and theoretical data. It is shown that the mutual agreement is within $\pm 20\%$

1. *Introduction*

Results for electron-krypton atom elastic scattering differential cross section are presented here as a part of our programme on electron-inert gas atoms absolute differential cross section measurements.

In the energy range of a few hundred electron volts only relative scattering intensities of Arnot[1], Webb[2] and Mehr[3] and absolute cross sections measured by Bromberg[4] and Lewis et al.[5] are available in the literature. We have measured the absolute cross sections for electron energies of 200 and 300 eV, in order to obtain more experimental results which could be used for normalization of relative scattering intensities and for comparison with theoretical calculations. The angular range between 10 and 25 degrees makes possible a comparison of curves at more than one point, giving thus more reliable results than normalization at one angle only.

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2. *Experimental*

The connection between the elastic differential cross section and the experimentally measurable quantities is given by

$$\sigma(\Theta) = K\,G\,\frac{I_s}{I_0\,p}.$$

The coefficient K includes the temperature of the gaseous target, the scattered and primary elctron beam collection efficiencies and other physical constants as well. We give a brief description of the experimental set up here (for details see Kurepa and Vušković[6]).

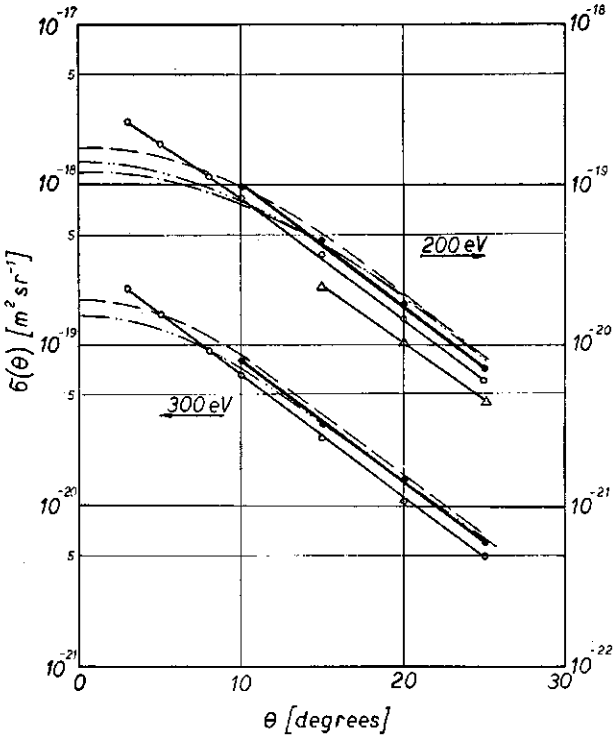

Fig. 1. Differential cross section values for elastic scattering of electrons by krypton atom: a) Experimental measurements: ● — Present work; ○ — Bromberg (1974); △ — Lewis et al. (1974), b) Theoretical calculations: — — - Lucas (Walkernon exch.) (1974); —·— — Lucas (Walker — exch.) (1974); —···— — Fink and Yates (1971).

Electrons from a Soa type electron gun[7] are accelerated by a three element electrostatic lens system (Heddle and Kurepa[8]) and the beam introduced into the interaction chamber through an aperture 2 mm in diameter. The interaction chamber is filled with the atoms under investigation in the form of a gaseous target at a pressure p. The incident electron beam intensity I_0 is continuously measured by collecting it by a Faraday cup. Elastically scattered electrons are separated from all inelastically scattered electrons by a retarding electric field analyzer, and the beam intensity I_s is then measured by collecting it by a second Faraday cup. The target gas pressure p was measured with an IEVT type* ionization gauge, calibrated in our laboratory by the constant gas flow method. The calibration procedure is described in detail by Kurepa, Čadež and Pejčev[9]. A target pressure of the order of 10^{-4} Torr was used in all measurements. The ion gauge calibration factor for krypton was found to be 1.78.

The geometrical factor G was determined from the measured geometry using the »sin ϑ approximation« which was found accurate enough for the angular range measured (Kalezić, Vušković and Kurepa[10]).

3. *Results*

The error in absolute differential cross sections was found to be 17.5% by adding all of the individual error estimates. The largest contribution to this error comes from the target gas pressure and temperature measurement uncertainties, being around 5% for each of them. Other sources of error are the geometrical factor G, the procedure for extrapolating to zero pressure and the beam current intensity measurements.

TABLE 1.
Elastic electron-krypton atom differenctial cross sections for impact energy of 200 eV. All values in units of 10^{-25} m^2/sr.

Θ (degrees	This work	Bromberg	Lucas (non-exch.	Lucas (exch.)	Fink and Yates	Lewis et al.
0	—	—	173.9	119.0	140.0	—
3	—	249.0	164.4	114.0	—	—
4	—		157.4	110.0	127.7	—
5	—	184.0	149.0	105.5		
8	—	111.0	117.9	88.0	97.2	—
10	99.0	81.5	101.3	74.5	80.0	—
12	—	—	74.9	60.8	63.6	—
15	45.2	37.0	48.8	42.5	—	21.8
16	—	—	41.7	37.2	36.9	—
20	18.3	14.8	21.1	20.2	19.6	10.2
22	—	—	14.6	14.4	13.9	—
25	7.26	5.97	8.43	8.38	—	4.47
26			7.07	6.98	6.92	—

Results of our measurements are shown graphically in Fig. 1 together with data of other authors. Numerical values of the cross sections for incident electron energies of 200 and 300 eV are given in Tables 1 and 2.

* Producer: IEVT, Ljubljana, Yugoslavia

The data of Bromberg[4] were determined by a set-up similar to ours. The »sin ϑ approximation« was used for the geometric factor, too. The target gas pressure was measured by a capacitance manometer with an error of 1.5%.

TABLE 2.

Elastic electron-krypton atom differential cross sections for impact energy of 300 eV. All values in units of 10^{-25} m^2/sr.

θ (degrees)	This work	Bromberg	Lucas (non-exchange)	Fink and Yates
0	—	—	195.0	156.2
3	—	218.2	180.1	—
4	—	—	169.5	136.7
5	—	155.5	158.5	—
8	—	92.0	114.0	93.7
10	80.4	66.2	86.5	72.5
12	—	—	63.0	53.9
15	32.6	26.4	37.2	—
16	—		31.0	27.9
20	13.1	10.8	14.9	14.0
22	—	—	10.7	10.1
25	5.90	4.93	6.90	—
26	—	—	6.09	5.76

Results of Lewis et al.[5] were obtained by a modulated gas beam apparatus giving relative scattering intensities and then normalized to calculation by the same authors based on the local central optical model of Furness and McCarthy[11].

Cross section calculations were made by Lucas* using a program of Walker[12] based on the exact numerical solution of the relativistic indepèndet particle model.

Fink and Yates[13,14] have calculated the cross sections by solving numerically the Dirac equation for central field potential scattering by partial wave methods. Exchange and polarization have not been taken into account.

The two sets of experimental data measured on an absolute basis, those by Bromberg[4] and ours have the same slope but differ in magnitude, the data of Bromberg being smaller by 18%.

Cross section data of Lewis et al.[5] are lower than our results by a variable percentage, being 52 at 10 degrees and 38 at 25 degrees. This proves that the slope of their curve is different from ours.

In the range of angles where our measurements have been made the shapes of the theoretically calculated curves differ from the experimentally determined ones, having a tendency to flatten at angles smaller than ten degrees. For angles larger than ten degrees, the calculated curves of Lucas and Fink and Yates[13,14] do not differ significantly in shape from the experimental curves, being mainly above our by less than 20%.

* C. B. Lucas, Private communication, 1974.

Acknowledgments

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DIFERENCIJALNI PRESECI ZA ELASTIČNO RASEJANJE ELEKTRONA ENERGIJE 200 I 300 eV NA ATOMIMA KRIPTONA

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Sadržaj

U radu su pokazani rezultati eksperimentalnog određivanja apsolutnih vrednosti diferencijalnog preseka elektrona energije 200 i 300 eV na atomima kriptona. Ugaoni domen merenja bio je 10° do 25°. Ukratko je prikazan eksperimentalni postupak i način izračunavanja preseka iz merenih fizičkih veličina.

Određeni preseci za elastičko rasejanje elektrona upoređeni su sa postojećim eksperimentalno merenim i teorijski proračunatim podacima drugih autora. Međusobno slaganje svih postojećih preseka je unutar $\pm$ 20%.