21st Summer School and International Symposium on the Physics of Ionized Gases

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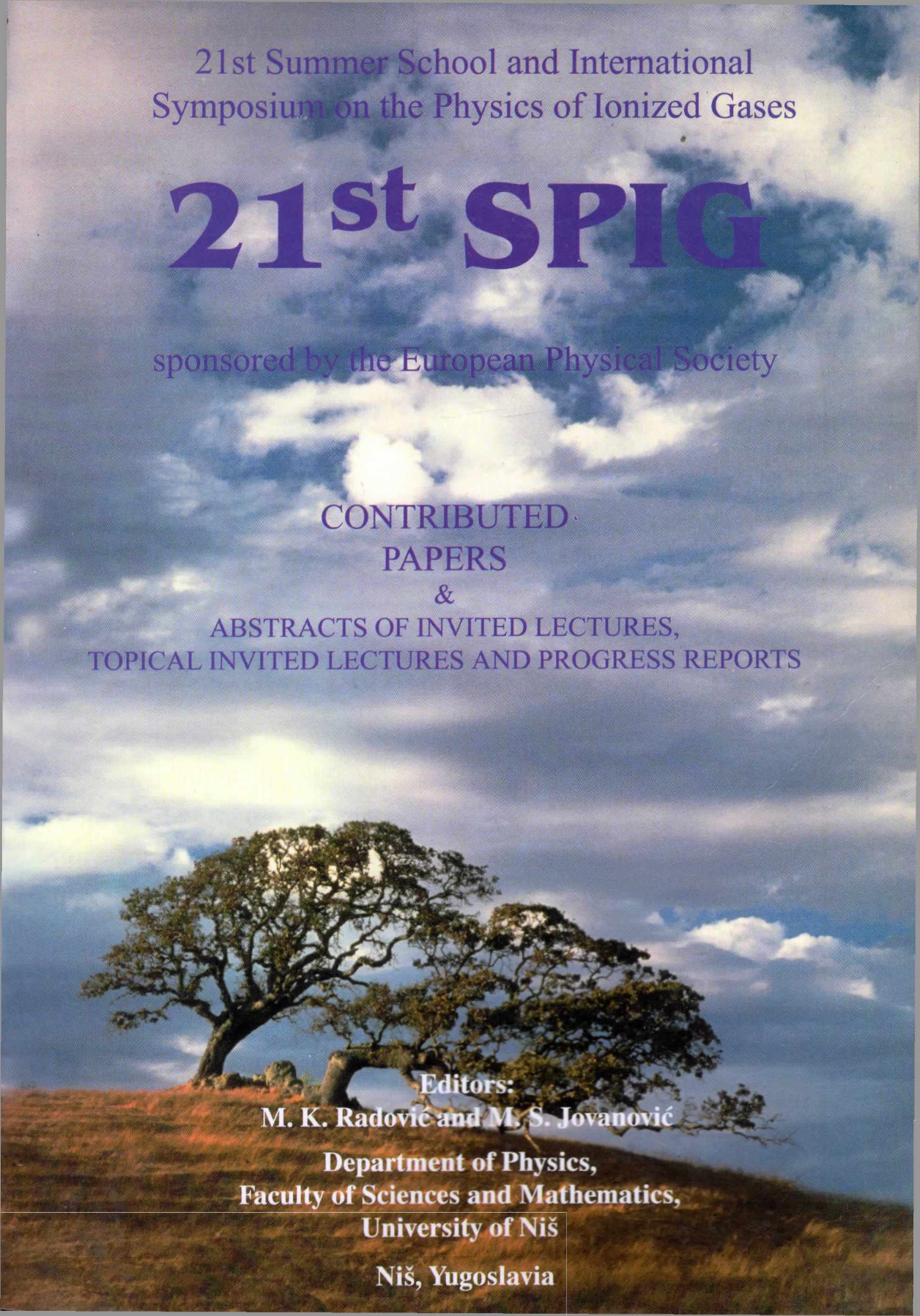
ABSTRACTS OF INVITED LECTURES, TOPICAL INVITED LECTURES AND PROGRESS REPORTS



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University of Niš

Niš, Yugoslavia

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DIFFERENTIAL CROSS SECTIONS FOR ELASTIC ELECTRON SCATTERING BY ARGON IN THE ENERGY RANGE OF THE THIRD CRITICAL MINIMUM

A. R. Milosavljević, D. Šević and B. P. Marinković

Institute of Physics, Belgrade, P. O. Box 57, 11001 Belgrade

Abstract. We present the preliminary obtained results of both angular and impact energy dependence of differential cross sections (DCS) for elastic electron scattering by argon in the angular range of 40-130 degrees and the energy range of 100-150 eV where the critical point in DCS should be expected. The results are compared with the available experimental data. Also, the positions of DCS minima as a function of impact electron energy were plotted and results were compared with the available experimental data and the recent theoretical data of Sienkiewicz *et al* [1].

1. INTRODUCTION

Elastic scattering of electrons on argon has been extensively studied and a large number of both experimental and theoretical data are available. Moreover, the determination of critical points where the DCS attains its smallest values has been of the greatest interest. These minima are important as a sensitive test of experimental-theoretical agreement and give good possibilities for testing the experimental procedures as well as theoretical models. The DCS minima have been measured most recently by Panajotović *et al* [2] and two critical points were found to be at 68.5 °, 41,30 eV and 143.5 °, 37.30 eV. These results are in very good agreement with the later theoretical calculations of Sienkiewicz *et al* However, by the experimentally obtained preliminary results of Kessler *et al* [3], the third critical point was also found to be at 120.9 °, 132,3 eV. This minimum was above the energy domain of Panajotović *et al* The essence of our effort was the measurement of relative DCSs in this energy region and with a good angle resolution in order to investigate positions of minima in the elastic electron-argon scattering.

2. EXPERIMENT

The results we present were obtained on the apparatus "UGRA", placed in the Laboratory of Atomic Collisions, Institute of Physics, Belgrade. It is an electron spectrometer and has three main sub-units: a) electron gun, b) electron (ion) energy analyzer and c) electron (ion) detector. Also, the primary electron beam collector can be added. The effusive molecular beam for the "cross-beam" experimental technique is obtained by passing target gas through a nonmagnetic, stainless steel needle placed perpendicularly to the incident electron beam. The electron gun produces nonmonoenergetic, collimated electron beam of up to 2 μA in the energy range from 20 to 500 eV. It is fixed on a turntable and can be rotated around the gas needle (i.e. interaction chamber axis) in the angular range from – 30 ° to + 130 °. All elements described above are placed in the vacuum chamber and turbo-molecular pump is used for achieving the background pressure of about 3×10^{-7} mbar. The double μ - metal shield reduces the Earth and other magnetic fields to less than 2×10^{-7} T.

The energy distribution of electrons (ions) leaving the interaction chamber is obtained by an analyzing system which consists of four-element electron lens and double cylindrical mirror analyzer (DCMA) with an energy resolution of $\Delta\varepsilon/\varepsilon = 0.03$. Electrons (ions) that pass the analyzer are detected by a channel electron multiplier in the single counting mode.

The DCS at each point (defined by concrete values of impact energy and scattering angle) was obtained by integration of count rates in the elastic energy loss spectrum normalized by the scanning time. Due to the high energies of scattered electrons and nonmonoenergetic incident electron beam the overall energy resolution of the system was about 1.5 eV. It was more than sufficient to separate elastically scattered electrons from the inelastic ones. The angular resolution was estimated by comparing our results with the Panajotović *et al* ones and it was found to be less than 2 °. The true zero scattering angle position was calibrated from signals of inelastically scattered electrons in the –25 ° to + 25 ° angular region. The correction was made for each measurement of DCS. We have not yet performed exact energy calibration of the system. However, the rough estimation can be done according to the linear dependence of DCMA voltage as a function of the selected electron energy. This function is defined by the design parameters of DCMA and was experimentally investigated by Čubrić [4].

3. RESULTS

3.1. Angular dependence of DCS

We have measured angular distributions of electrons elastically scattered by argon in the angular range of 40°-130° at incident energies of 100, 105, 110, 115, 120, 125, 130, 135, 140 and 150 eV. We present the relative DCS at energies of 100 eV and 150 eV in Fig. 3.1. and Fig. 3.2. At these energies our results are compared with the previous obtained experimental data. A very good agreement was achieved, although the minimum of Williams *et al* [6] appeared to be rather deep.

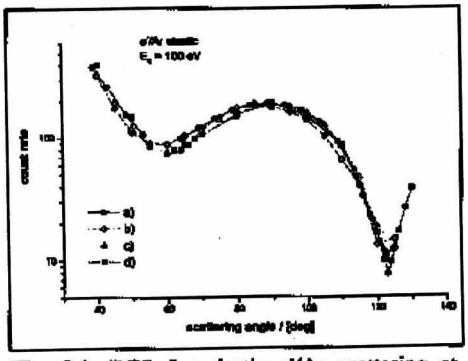
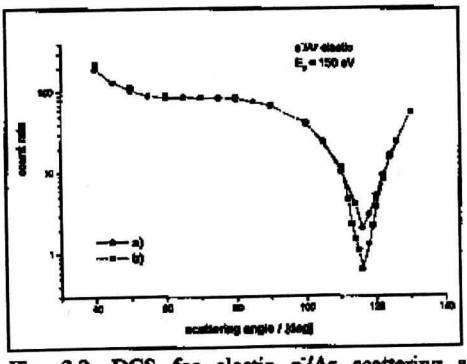


Fig. 3.1. DCS for elastic e⁻/Ar scattering at incident energy of 100 eV: a) our results; b) Panajotović *et al* [2]; c) DuBois *et al* [5]; d) Williams *et al* [6]. The results of b), c) and d) are normalized at our result at the maximum.



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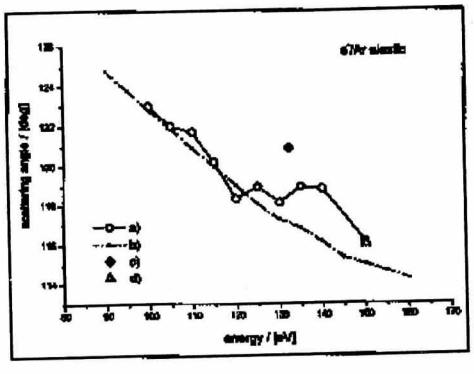

Fig. 3.3. Positions of high-angle DCS minimum versus incident electron energy in elastic e⁻/Ar scattering: a) our results; b) Sienkiewicz *et al* [1]; c) Kessler *et al* [3]; d) Williams *et al* [6].

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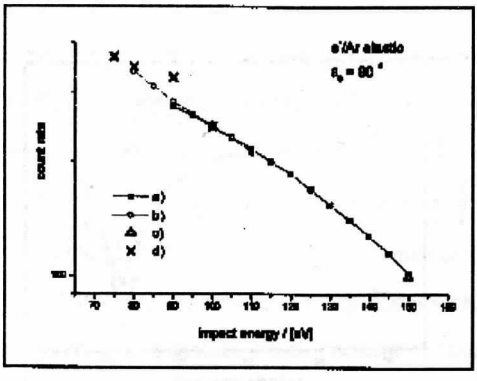
The measurements of energy dependence of DCS should be preceded by careful examination of both the incident electron beam and transmission of the energy analyzing system. We used the analyzer lens as a Faraday cup to monitor electron beam as a function of incident energy and it was found to be rather constant in the energy range of 100-150 eV. The examination of transmission of analyzer lens system by simulations in program SIMION is given in the following contribution on this SPIG conference. The obtained energy dependence of DCS for fixed scattering angle is given in Fig. 3.4.



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4. CONCLUSION

For the first time angular distribution of elastically scattered electrons was measured with good energy and angular resolution in the energy range between 100 and 150 eV where the third critical point of DCS should be expected. For the angular dependence of DCSs at 100 and 150 eV and energy dependence of DCSs at 90 and 120 degrees, a very good agreement with the previous experimental data was achieved. Also, the positions of DCS minima as a function of the incident energy were plotted and results were compared with the recent theoretical and experimental data.

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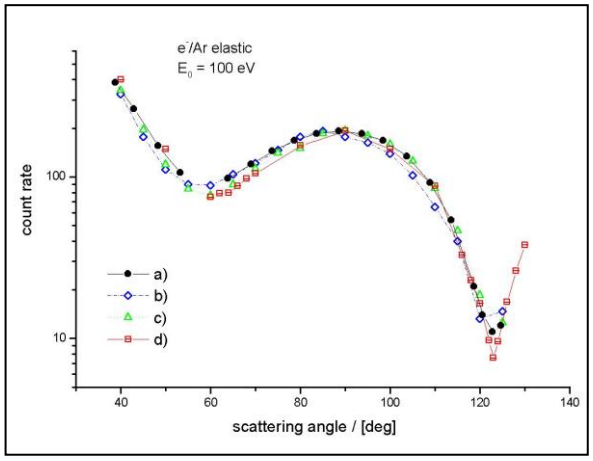

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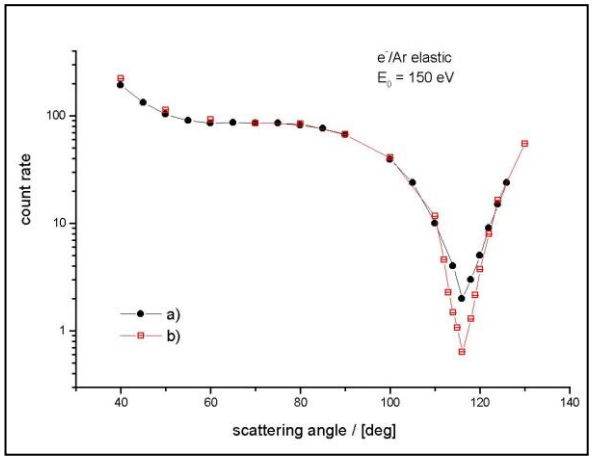

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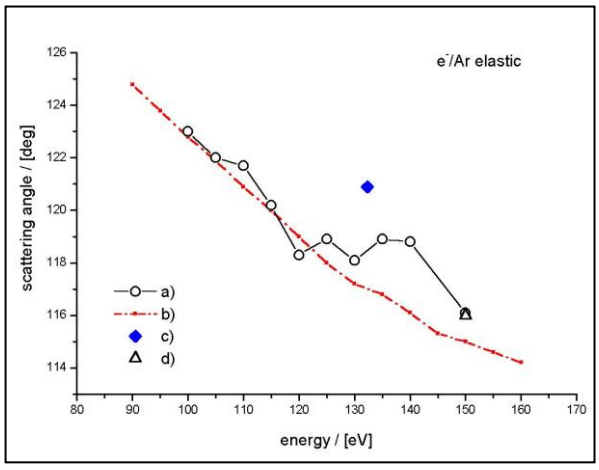

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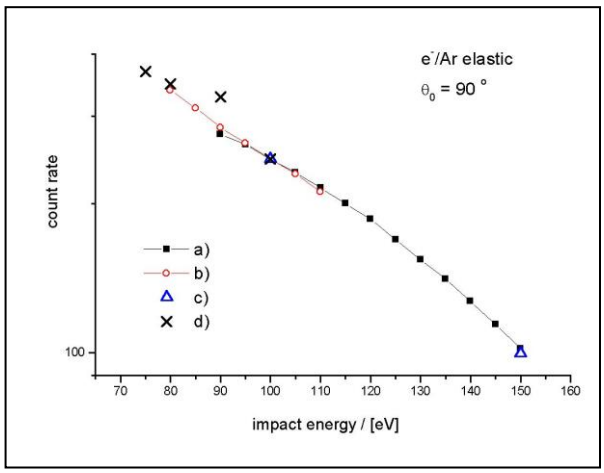

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