18th SPIG

18th Summer School and International
Symposium on the Physics of Ionized Gases

September 2nd - 6th, 1996, Kotor, Yugoslavia

CONTRIBUTED PAPERS
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ABSTRACTS OF INVITED LECTURES AND PROGRESS REPORTS

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RESONANCES IN ELASTIC e^- / Ar SCATTERING ABOVE IONIZATION LIMIT

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Most investigations of structures in elastic electron- argon scattering have been taken considering low-lying structures in the resonance spectra [1][2]. These states could be more easily distinguished and classified than those above the first ionization potential [3] (15.755 eV) where the presence of structures that originate from the excitation of neutral autoionizing states highly complicates the work [2]. Identification of states in such kind of spectra is possible only if the right coupling scheme is applied. In noble-gas atoms the most significant for this matter is a spin orbit interaction. Unfortunately, it is not a universal for all noble gases, especially not for He [2] (in He atom spin-orbit interaction is weak), which has been investigated the most.

Sanche and Schulz [4] performed an experiment where the broad energy region from 24eV to 32eV allowed to observe features with energy loss above the value of the first ionization limit. They measured the total cross-section for the electron scattering on argon atoms by collecting unscattered electrons. There were three structures that they identified as resonances: the first at 26.84...26.90eV, the second at 27.87...27.95eV and the third at 28.82...28.98eV. This conclusion was supported by the fact that no autoionizing states have the same energy as these structures. The other try to investigate these structures was made by Roy and Carette [5] (Fig.1). They observed resonances in the excitation function of the $3p^5 4s$ (^1P) state of argon in the energy region from 24 to 32eV, in the forward direction. They did not give any designation for the resonances above 27eV, although they observed several features in that energy region. Many different structures could be found in the work of Dassen et al. [6] (Fig.1) who measured the metastable yield of argon atoms in the similar energy region (from 24 to 33eV). Among the other structures they identified in the obtained spectrum, they suggested a classification for the resonances observed by Sanche and Schulz [4]: for the

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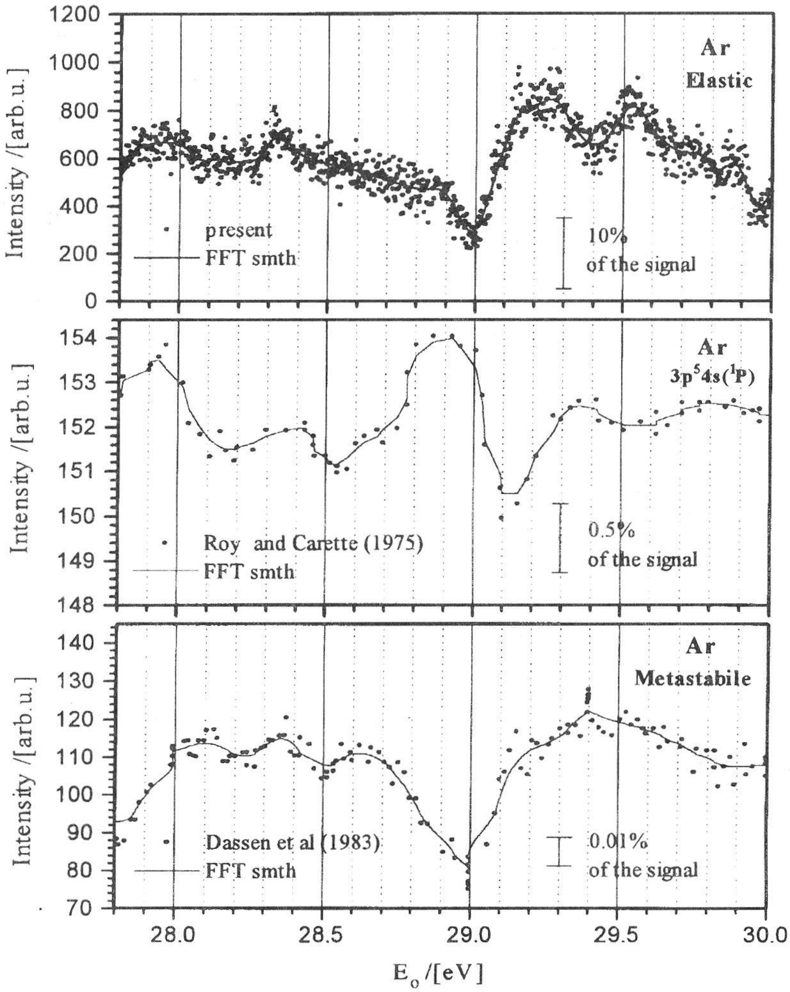

Fig.1 This figure represents our result for the elastic e^-/Ar scattering at $\theta=10^\circ$, the result of Roy and Carette [5] for the excitation of the ^1P state (11.83eV), in the forward direction, and the result of Dassen et al [6] for the metastable yield in Ar. FFT (Fast Fourier smoothing) has been applied to all three results in order to show existing structures.

one at 27eV $[3s^2\ 3p^4](^3P)\ 4s^24p$, for the other at 27.88eV $[3s\ 3p^6](^2S)5s5p(^2P)$ and for the most prominent, at 28.98eV, $[3s^2\ 3p^4](^1D)4s^24p$. Except for the second resonance, for which the P-symmetry is suggested, for two of these resonances there is not a suggestion, nor the data of the behavior at different angles in the elastic channel. Buckman and Clark [7] concluded that resonances in the autoionizing region could be equally associated with the parent states with cores $nsnp^6\ (^2S)$ and $ns^2np^4\ (^1S,^1D,^3P)$. For Ar, the ^3P-^1D and ^1D-^1S splitting is 1.7 and 2.4eV, respectively.

In our experiment we tried to see resonances in the elastic channel, at $\theta=10°$, in the energy region from 27.8 to 30eV (Fig.1). Our main objective was to determine position and width of the most prominent structure (at 29eV) in order to calibrate the incident electron energy (experimental apparatus and measuring procedure is described elsewhere [8]). This structure has been chosen for such a purpose because it is closer to the energy region where we were searching critical positions in elastic differential cross section [9] than resonances at 11.08eV and 11.27eV. Because of the similar reasons [1] we did not use the well known 2 ^2S He resonance for the energy calibration. For determination of the position and width of this resonance we used a fitting method applied before on He [10], Hg [11] and Cd [12]. The background was supposed to be of the quadratic form and it has been subtracted. We obtained that the energy is 29.03eV and width 130meV. Energy resolution was less then 70meV. In comparison (Fig.1) with the results of Roy and Carette [5] and Dassen et al. [6], it could be noticed that one structure at 28.3eV coincides with the structure classified as $[3s^23p^4]$ $(^3P)\ 4s4p^2$ [6]. There is about 100meV difference between the position of this structure and the similar on the excitation function [5]. Unfortunately, we could not say with certainty what are the other visible features in our elastic spectra (the one at 27.9eV is rather broad). This should be a subject to much thorough investigation in the future.

ACKNOWLEDGMENT

We make special thanks to our colleague Mr. Milan Minić for giving us the program for fitting the resonance parameters. This work is financed by the Ministry for Science and Technology of the Republic of Serbia (project N° 01E02).

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