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ABSORPTION EFFECTS IN ELASTIC ELECTRON SCATTERING BY ARGON ATOM

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1. INTRODUCTION

Coupling between elastic and inelastic channels, described as an absorption potential in the electron atom scattering theory, causes a decreasing of the elastic scattering amplitude. Experimentally, the coupling effect results in loosing of electron flux for the elastic channel, more significantly if relative contribution of excitation (q_{exc}) and ionization cross sections (q_i) to the total cross section (Q_t) is larger.

In electron-argon scattering, the fall in the integral elastic cross section ($q_t(E_\circ)$) around 25 eV incident electron energy ($E_\circ$) is more rapid then at neighbouring energies. In order to obtain more sensitive test whether a structure in $q_t(E_\circ)$ exsists or not, we performed a more convincing check, as followes. Quantum mechanical considaration of binary electron-atom scattering includes dimensionless quantity, kd, where k is the wave number of the incident electron (reciprocal of the incident electron de Broglie wavelength), and d is the corresponding "range" of the interaction [1]. Rather than approximate the "strength" of interaction with an atomic potential [2], we have used realistic, experimentally determined $q_t(E_\circ)$, and introduce dimensionless quantity

$$D_\lambda = 2k\pi^{-1/2}(q_t(E_\circ))^{1/2}, \tag{1}$$

termed as the "reduced effective atomic diameter". In this way (1) represents how, from the electron "view point", d changes with respect to k, i.e. how D_λ changes vs. the energy.

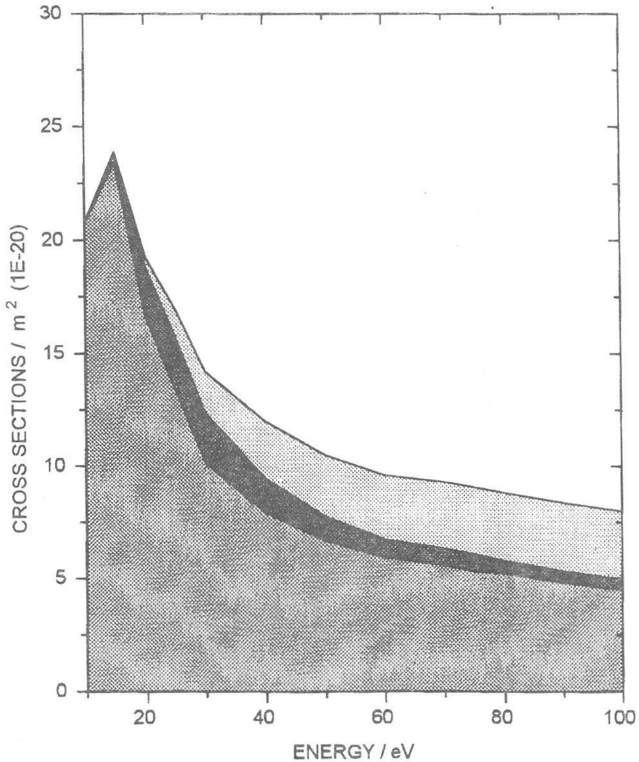

Figure 1.a. Partitioning scheme for electron scattering by argon. From the bottom to the top: present integral elastic (q_t) and excitation (q_{exc}) cross sections, and ionization (q_i) cross section by Straub et al. [5].

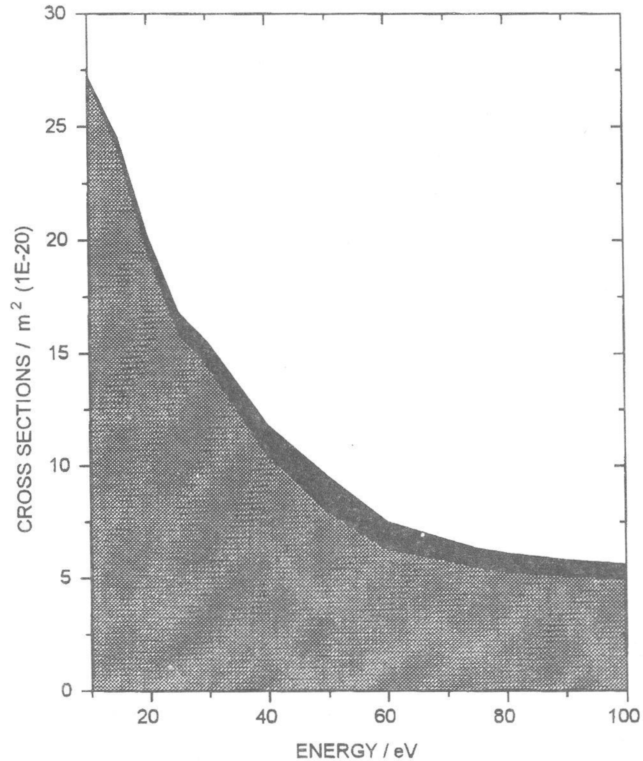

Figure 1.b. Partitioning scheme for electron scattering by argon. From the bottom to the top: integral elastic (q_t) and absorption cross sections by Bartschat [7].

2. EXPERIMENTAL

In this work we measured angular distributions of both elastically and inelastically (excitation) scattered electrons by argon atom using crossed beams technique. The electron spectrometer used is described earlier [3]. Breafly, E_o were between 10 and 100 eV, with 40 meV typical energy resolution; the scattering angle was changed between -30° to 150°, with ±2° angular resolution. Separately, the elastic-to-reference-inelastic (4s'$[1/2]_1$ state) intensity ratios, $k = q_t/q_{exc}$, were determined for all of 12 different E_o. The partitionig sheme (figure 1.) includes Q_t [4] and q_i [5]. Simple formulas $Q_t - q_i = q_t + q_{exc}$ and $k = q_t/q_{exc}$ were applied for normalization our $q_t(E_o)$ on the base of the partitioning sheme. The total q_t error in such normalization procedure is examined to be less then 10%. In addition, the test (1), proposed in this work, gives D_λ error within 5%, what is very convenient for evidence wether the structure around E_o =25 eV exsists.

It is important to note that there is no such structure in $q_t(E_o)$ for E_o=10 to 100 eV in theoretical results available, but the structure reproduces in the experiments with good energy and angular resolution [6]. The possible explanation of this systematic disagreement between experimental and theoretical results one can found in the partitioning shemes. For example, the results of a slightly modified "Optical Potential with 10 States" model, by Bartschat [7], is in excellent agreement with our experimental results in respect to DCS minima positions vs. the energy, but the structure in D_λ plot does not exsist in [7].

Additional possible effect responsible for the structure in electron argon D_λ plot would be the existence of at list two critical points [8] in the (E_o, θ) range of interest.

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