4. Experimental Study on Electron Impact Excitation and Subshell Ionization for Argon and Krypton*

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This thesis is composed of two parts.

1. Excitation Cross Sections and Oscillator Strengths for Ar and Kr

Absolute differential cross sections for Ar $3p^6\ ^1S_0$-$3p^5(^2P_{1/2,3/2})4s$ excitation and for Kr $4p^6\ ^1S_0$-$4p^5(^2P_{1/2,3/2})5s$ excitation have been measured at impact energies of 300, 400 and 500 eV and at scattering angles of 1.5-10 deg., by the electron energy loss spectroscopy (EELS)[1]. The experimental apparatus mainly consists of an electron selector, an interaction region and an electron analyzer, as schematically shown in Fig.1. Integated cross sections and generalized oscillator strengths (GOS) have also been determined at the above mentioned energies. The GOS for Ar and Kr are presented in Fig.2. Optical oscillator strengths have been determined by extrapolating the GOS to zero momentum transfer[2]. Comparisons are made between the present results and the results by other groups. It is believed that the present results are more reliable than other previous measurements. The integrated cross sections for Kr are firstly reported.

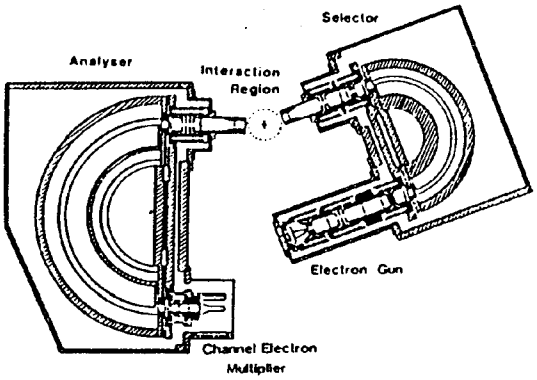

FIG.1. Schematic drawing of the experiaental apparatus. The target beam in the interaction region is perpendicular to the paper surface.

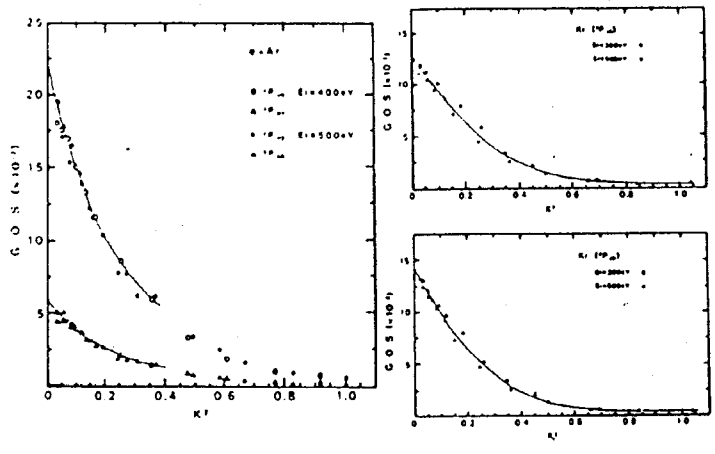

FIG.2. GOS vs the squared momentum transfer K^2. The solid lines are obtained with the method of the least squares. The intercepts on longitudinal axis are the optical oscillator strengths.

2. Cross Sections for s-Subshell Ionization in Ar and Kr

Subshell ionization cross sections for the 3s-electrons in Ar and for

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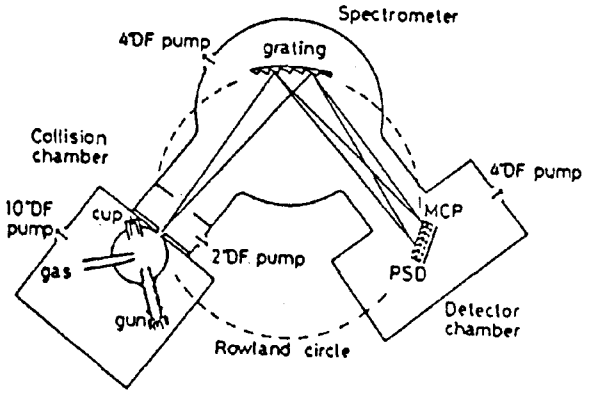

FIG.3. Schematic drawing of the apparatus. The angle between the electron beam direction and the optical axis is 54.7 deg., while the angle between the scattering plane and the entrance slit of the spectrometer is 45 deg. Both the entrance slit and the center of the detector are on the Rowland circle.

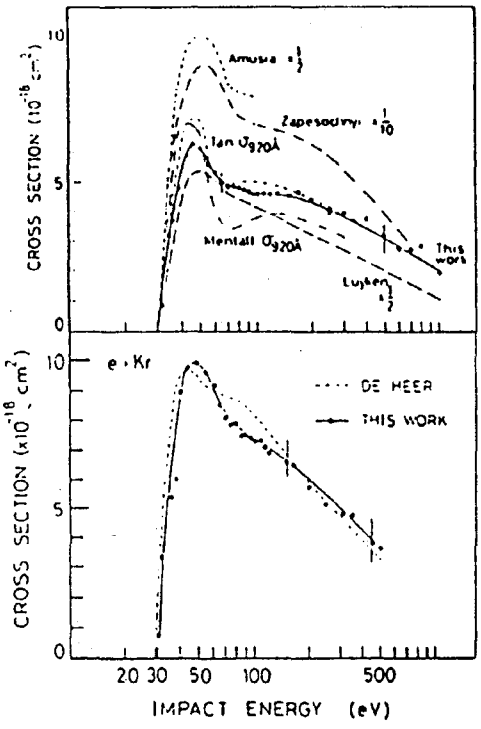

FIG.4. Absolute cross sections for the s-subshell ionization in Ar and Kr. Several results by other groups are also drawn for comparison.

the 4s-electrons in Kr have been determined for impact energies between the thresholds and 1 keV, by observing the vacuum ultraviolet emission lines originating from the $nsnp^6\ ^2S_{1/2}$-$ns^2np^5\ ^2P_{1/2,3/2}$ transitions of Ar^+ (n=3) and Kr^+ (n=4). Figure 3 shows the experimental apparatus which consists of a collision assembly, a Seya-Namioka type spectrometer and a position sensitive detection system. The cross sections for Ar 1067Å and that for Kr 1236Å resonance lines, obtained by the EELS as mentioned in Sec.1, are utilized as the normalization standards. Results of this work are shown in Fig.4. A common double peaked structure are demonstrated very clearly in the impact energy dependence of the ionization cross sections[3], and the causes leading to discrepancies in the absolute values are also analyzed. The errors in the cross sections are estimated to be 21%, including the errors in the normalization standards. Comparisons of the present results are made with previous measurements and with theoretical results.

REFERENCES

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2) K.Klump and E.Lassettre, J. Chem. Phys. 68 (1978) 886.

3) J.Mentall and H.Morgan, Phys. Rev. A 14 (1976) 954.