§12. The Influence of Screening Effect on the Energies of Coster-Kronig Electrons Produced during the Autoionizing Decay of $1s^2 2p9\ell$ Rydberg States of Sulfur Ions

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Recently Coster-Kronig electrons from the autoionizing $1s^2 2p9l$ Rydberg states of sulfur ions S^{12+} have been observed in high energy beam experiments [1]. Here we have focused our attention on the theoretical calculation of energies of the ejected Rydberg electrons.

The observed spectra of electron energy emitted from $1s^2 2p9l$ autoionizing states of S^{12+} ions have been presented in Fig.1[1)] and the electron energies were calculated to assign the peaks in the spectra. Neglecting the term splitting and spin-orbit splitting, the energy of the ejected Rydberg electron due to the Coster-Kronig transition $1s^2 2pnl$ -$1s^2 2s\varepsilon l'$ was calculated using the quantum defect theory

$$E_{nl}=\Delta E-Q^2 Ry/2(n-\mu_l)^2 , \qquad (1)$$

where ΔE is the energy difference between the initial and final orbits of the decaying electron, Q is the effective charge of the atomic core seen by the Rydberg electron and is given as $Q=Z-N_c$ where Z and N_c are the nuclear charge of ions and the number of core electrons, respectively, and μ_l is the quantum defect depending on the angular momentum l of the emitted electron[2)]. Their results are presented in Table I and in Fig.1[1)] (the arrows inside the frame of figure). As seen in Fig.1[1)], the agreement between the observed peak energies and the calculated energies is not good. Further check seems to be necessary.

In order to improve their calculation by taking into account the term splitting we have calculated the energy of the ejected Rydberg electron using the screening parameter σ

$$E_{nl}=\Delta E-(Z-\sigma)^2 Ry/2n^2 . \qquad (2)$$

This screening parameter has been calculated on the base of perturbation theory by $1/Z$[3)] and equals

$$\sigma=N_c-E_1/2E_0 \qquad (3)$$

where E_0 is the hydrogenic energy of Rydberg electron and E_1 is the the first order correction of nonrelativistic energy. The results of this calculation are presented in Table I and in Fig.1 (the arrows outside figure frame). Comparing these energies with experimental peak energies we can see that the present calculation taking into account the term splitting makes us enable to identify the spectra. The present results clearly indicate that the broad observed peaks can be due to the overlapping of many autoionizing states.

In order to understand the observed energy spectra of the ejected electron, the calculation of the emission probabilities for each state are under way.

Table I. Electron energies for autoionizing states of S^{12+}

Autoionizing state	Electron energy[1)] E(eV)	Present calculation		
		Term	Screening parameter σ	Electron energy E(eV)
$1s^2 2p9s$	0.628	^1P	2.849	0.639
		^3P	2.830	0.556
$1s^2 2p9p$	0.954	^1S	2.996	1.286
		^3S	2.909	0.904
		^1P	2.883	0.789
		^3P	2.929	0.992
		^1D	2.955	1.106
		^3D	2.893	0.836
$1s^2 2p9d$	1.227	^1P	3.031	1.438
		^3P	2.982	1.225
		^1D	2.945	1.063
		^3D	2.979	1.211
		^1F	3.036	1.460
$1s^2 2p9f$	1.297	^1D	3.013	1.360
		^3D	3.007	1.334
		^1F	2.983	1.229
		^3F	2.986	1.242

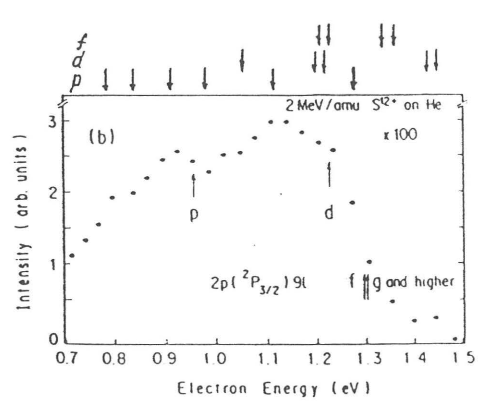

Fig.1 Electron energy spectrum for S^{12+} ions

References

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