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Strong asymmetry of the angular distribution of Auger electrons from electron-impact excited autoionizing states of Rb

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Synopsis The asymmetry parameters of the angular distribution of Auger electrons for a number of electron-impact excited states were calculated in single configuration intermediate coupling approximation. Strong dependence on the energy of exciting electrons was obtained for the angular distribution of the emitted Auger electrons from the states with $J > 1/2$.

The investigation of the asymmetry of the angular distribution of Auger electrons from electron-impact excited atoms is important for the proper identification of a measured ejected-electron spectra [1, 2]. The expression for the cross section describing the angular distribution of Auger electrons from electron-impact excited non-polarized atoms with respect to the direction of impacting electrons is as follows [3]:

$$\frac{d\sigma(\alpha_0 J_0 \to \alpha_1 J_1 \to \alpha_2 J_2)}{d\theta} = \frac{\sigma}{4\pi} \times \left[1 + \sum_{K>0,\text{even}} \beta_K P_K(\cos\theta)\right].$$

Here $\alpha_0 J_0$, $\alpha_1 J_1$ and $\alpha_2 J_2$ are quantum numbers describing the initial and excited states of an atom and final state of an ion, respectively, σ is the total cross section for the excitation and following Auger decay of an atom, $P_K(\cos\theta)$ is the Legendre polynomial, θ is the angle between the directions of impacting and Auger electrons, and $\beta_K = A_K\ \alpha_K$ is the asymmetry parameter of the angular distribution of Auger electrons. A_K is energy dependent parameter of the alignment of the electron-impact excited atom, and α_K is the asymmetry parameter of the angular distribution of Auger electrons from the atom in the autoionizing state $\alpha_1 J_1$. For Rb, it is equal to constant value.

The calculations of the asymmetry parameter β_K were performed by using our own computer codes. The radial wave functions and the intermediate coupling expansion coefficients for the atoms in discrete states were obtained in Breit-Pauli approximation [4]. The calculated factors $C = [1 + \sum_{K>0,even} A_K \alpha_K P_K(\cos(75^o))]$ for the states $4p^5 nln'l'J$ excited by 27 eV energy of impacting electrons are listed in Table 1.

The calculated values of the asymmetry parameters β_K of the angular distribution of Auger electrons from the electron-impact excited $4p^5 nln'l'LSJ$ states have shown strong dependence on the energy of exciting electrons. Thus, the intensity of the lines from the states with $J > 1/2$ should strongly depend on the energy of exciting electrons. It could decrease up to 30% for some states with $J \geq 3/2$ (see factor C for the states 4d5s with $J = 5/2, 7/2$ and 5s5d with $J = 3/2$ in Table 1).

Table 1. Factor C for the states $4p^5 nln'l'J$ excited by 27 eV energy of impacting electrons.

$nln'l'$	J	C	$nln'l'$	J	C
$5s^2$	1/2	1.00	5s5d	1/2	1.00
$5s^2$	3/2	0.86	5s5d	3/2	0.71
4d5s	1/2	1.00	5s5d	5/2	0.77
4d5s	3/2	0.81	5s5d	7/2	0.77
4d5s	5/2	0.68	5s6p	1/2	1.00
4d5s	7/2	0.71	5s6p	3/2	1.06
5s5p	1/2	1.00	5s6p	5/2	1.10
5s5p	3/2	1.03	5s6s	1/2	1.00
5s5p	5/2	1.08	5s6s	3/2	0.88

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