Išsklaidytų elektronų sužadinant Rb autojonizacines būsenas kampinis pasiskirstymas

Angular distribution of scattered electrons in excitation of autoionizing states in Rb atoms

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The ejected-electron and photoabsorption spectroscopies are powerful methods for the investigation of the autoionizing states of atoms [1, 2]. Concerning quasimetastable and metastable states, their direct observation in the excitation channel is enabled only by the energy-loss spectroscopy.

The main purpose of the present work was to calculate the angular distribution of scattered electrons from the excitation of the autoionizing states of Rb atom by electron-impact. The obtained regularities of the angular distribution are planned to be used for the analysis of energy-loss spectra measured in our group.

For the excitation of Rb atom from the state J_0 to the state J_1 by an electron moving with the momentum p_1 can be written as follows [3]:

$$\frac{d\sigma(J_0 \rightarrow J_1 p_2)}{d\vartheta} = \frac{\sigma}{4\pi}\left[1 + \sum_{k>0} \beta_k P_k(\cos(\vartheta))\right].$$

Here σ is the total excitation cross section [3] of an atom, $P_k(cos(\vartheta))$ is the Legendre polynomial, ϑ is the polar angle of the scattered electron with respect to the direction of the incoming electron, the asymmetry parameter β_k of the angular distribution of the scattered electrons is defined as [3, 4]:

$$\beta_k = \frac{(2k+1)B^{ex}(0,k,0,k,k,0,k,0,k)}{B^{ex}(0,0,0,0,0,0,0,0,0)}.$$

The expression for B^{ex} is presented in [4], and the summation parameter k can acquire the values $max(|\lambda_1 - \lambda_1'|, |\lambda_2 - \lambda_2'|) \leq k \leq min(\lambda_1 + \lambda_1', \lambda_2 + \lambda_2')$ for each set of the partial wave momenta which can be very large depending on the energy of the projectile electron.

The calculations of the parameters β_k were performed by using our own computer codes in the basis of the intermediate coupling Hartree-Fock state wave functions. The calculated factors

$$C = 1 + \sum_{k>0} \beta_k P_k(\cos(\vartheta))$$

characterizing the increase or decrease of the intensity of the scattered electrons at the \`magic\` angle ϑ=54.7° are presented in table 1 for some of low-lying autoionizing states of Rb atoms as a function of the energy E of impacting electrons.

Table 1. The factors C for the autoionizing states of Rb in the case of the registration of the scattered electrons at 54.7° angle.

E(eV)	$5s^2\ ^2P_{1/2}$	$5s^2\ ^2P_{3/2}$	$5s(^1P)5p\ ^2P_{3/2}$	$4d(^1P)5s\ ^2P_{3/2}$
19	0.33	0.31	0.50	1.62
25	0.58	0.56	0.71	1.06
30	1.06	1.08	1.09	0.69
35	1.14	1.16	0.30	0.63
40	1.12	1.14	0.13	0.61
45	1.48	1.49	0.04	0.57
50	0.89	0.92	0.00	0.52
55	0.82	0.84	0.01	0.47
60	0.76	0.78	0.03	0.46
65	0.68	0.70	0.05	0.45
70	0.62	0.64	0.09	0.47
75	0.60	0.61	0.11	0.48
80	0.57	0.57	0.13	0.48

The results in table 1 show, that the differential excitation cross sections for all states except $4d(^1P)5s\ ^2P_{3/2}$ state should increase from the excitation threshold and reach a maximum at the energy of about 35 eV. In the case of $5s^2\ ^2P_{1/2,3/2}$ the cross sections decrease with increasing impacting electron energy. The cross section of $5s(^1P)5p\ ^2P_{3/2}$ state achieves a minimum at 55 eV and then starts to increase. In the case of $4d(^1P)5s\ ^2P_{3/2}$ state, the cross section should decrease from the threshold, reach a minimum at 65 eV and then slowly increase with increasing the energy of incoming electrons. The present data will be used for analysing the experimental energy-loss spectra of Rb atoms [5].

Keywords: electron-impact excitation, autoionizing states, electron angular distribution.

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