Sr atomo sužadinto $4p^6$ sluoksnio būsenų spektroskopinė klasifikacija

Spectroscopic classification of the $4p^6$ shell excited states in Sr atoms

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The electron excitation and radiationless decay of the $4p^5n_1l_1n_2l_2n_3l_3$ *LSJ* states in Sr atoms have been the subject of many experimental and theoretical investigations (see e.g. [1-3] and references therein). However, poor energy resolution of the measurements, limited energy region understudy and the lack of systematic calculations resulted in a situation when only six lowest states from $4p^54d5s^2$ configuration were associated with the lines observed in photoabsorption [2] and ejected-electron spectra [1].

In the present work, basing on experimental studies of the intensity behavior of ejected-electron spectra in a broad electron impact-energy range and on *ab initio* calculations of energies, decay rates and excitation cross sections of the $4p^5n_1l_1n_2l_2n_3l_3$ *LSJ* states by employing the standard software package Flexible Atomic Code (FAC) [4], the lines in ejected-electron spectra [1] and the most intense lines in photoabsorption spectra [2, 5] were classified/re-classified as attributed to the excitation and subsequent radiationless multichannel decay of 99 atomic states predominantly from $4p^55s^2nl$, $4p^54d^2nl$ and $4p^54d5snl$ configurations.

The experiments were performed using an electron spectrometer with an incident electron energy resolution of 0.2 eV [3]. The ejected-electron spectra were obtained at an observation angle of 54.7º and at impact energies starting from the appearance of the first spectral line up to 102 eV. Unlike previous studies, we investigated the entire ejected-electron energy region 12-21 eV where the lines arising from the decay of atomic AIS can be observed. The uncertainty of the line energies was determined at ±0.05 eV.

The calculations of energies, autoionization probabilities, oscillator strengths of electric dipole transitions, and electron impact excitation cross sections were performed in the basis of mixed relativistic configurations by using FAC computer code [4]. The radial orbitals for the construction of basis state wave functions were derived from a modified self-consistent Dirac-Fock-Slater iteration. The total number of both odd and even states included in calculations was 29824.

In table 1 the excitation thresholds E_{exc}, spectroscopic classification and decay channels for eleven lowest AIS $4p^5n_1l_1n_2l_2n_3l_3$ *LSJ* in Sr are presented. The excitation energy of the $4d5s^2\ ^3P_0$ lowest AIS at 20.98 ± 0.05 eV determines the excitation threshold of the $4p^6$ subshell in strontium atom.

Table 1. Excitation thresholds E_{exc}, classification and decay channels of the $4p^5n_1l_1n_2l_2n_3l_3$ *LSJ* lowest AIS in Sr atoms.

E_{exc} (eV)		Configuration *LSJ*	Decay channel
Exp.	Theor.		
20.98	20.961	$4d5s^2\ ^3P_0$	$5s_{1/2}$
21.12	21.134	$4d5s^2\ ^3P_1$	$5s_{1/2}$
21.38	21.432	$4d5s^2\ ^3P_2$	$5s_{1/2}$
21.62	21.685	$4d5s^2\ ^3F_4$	$5s_{1/2}$
			$4d_{5/2}$
			$5p_{3/2}$
21.82	21.685	$4d5s^2\ ^3F_3$	$5s_{1/2}$
			$4d_{3/2}$
			$5p_{1/2}$
22.06	22.121	$4d5s^2\ ^3F_2$	$5s_{1/2}$
			$4d_{3/2}$
			$5p_{3/2}$
22.22	22.243	$5s^25p\ ^3P_1$	$5s_{1/2}$
			$5p_{3/2}$
22.35	22.364	$4d^2(^3P)(^4P)5s\ ^5P_3$	$4d_{5/2}$
22.43	22.504	$4d5s^2\ ^3D_3$	$4d_{5/2}$
22.45	22.601	$5s^25p\ ^3D_3$	$5s_{1/2}$
			$4d_{5/2}$
			$5p_{1/2}$
			$5p_{3/2}$

Keywords: electron-impact excitation, autoionizing state, decay channels.

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