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Electron-impact excitation of the $(4p^5 5s5p)^4S_{3/2}$ quasimetastable state in Rb

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Synopsis The ejected-electron excitation function of the $(4p^5 5s5p)^4S_{3/2}$ quasimetastable state in rubidium was experimentally investigated by electron-impact in the energy range from the excitation threshold at 16.64 eV to 100 eV. The obtained data at 0.12 eV energy resolution indicate the presence of negative-ion resonances just above excitation threshold. A comparison is made with the optical excitation function of the $(4p^5 5s5p)^4S_{3/2} \rightarrow (4p^6 5p)^2P_{3/2}$ transition (λ = 82.37 nm), measured earlier with a lower energy resolution of ≈1.5 eV.

It is known that in alkali atoms (K, Rb, Cs) there is a subclass of p^6-core excited quartet states which is due to the mixing with doublet states of the same total electronic angular momentum J possess both radiative and electronic decay channels [1]. As a rule, the radiative decay dominates for such quasimetastable states, while autoionization probability remains small. The latter makes difficult the experimental observation of quasimetastable states in ejected-electron spectra [2]. The optical excitation function for the $(4p^5 5s5p)^4S_{3/2} \rightarrow (4p^6 5p)^2P_{3/2}$ transition (λ = 82.37 nm) in Rb was measured earlier with an incident-electron energy resolution of ≈1.5 eV [3]. In the present work we obtained the ejected-electron excitation function of the $(4p^5 5s5p)^4S_{3/2}$ state with an improved 0.12 eV energy resolution by using energy-selective electron beam and by accurate measurement of the ejected-electron spectra in a broad impact energy range.

The apparatus and the experimental procedure were described in details earlier [4]. The ejected-electron spectra were measured at 54.7° observation angle. Due to the overlapping of the $^4S_{3/2}$ line with the high intensity neighboring line $(4p^5 4d5s)^4P_{1/2}$ with 16.69 eV excitation threshold, the total relative uncertainty is approximately 40% for the most of our data.

Figure 1 shows the measured ejected-electron excitation function of the $(4p^5 5s5p)^4S_{3/2}$ state and the optical excitation function for λ = 82.37 nm [3] in an impact-energy range from the 16.64 eV excitation threshold up to 100 eV. Our comparison shows that there is a fairly good agreement between the two types of data. Due to the better energy resolution of the present measurements, the "fine" structure *a-b* is clearly seen in the ejected-electron function just above the excitation threshold. The broad

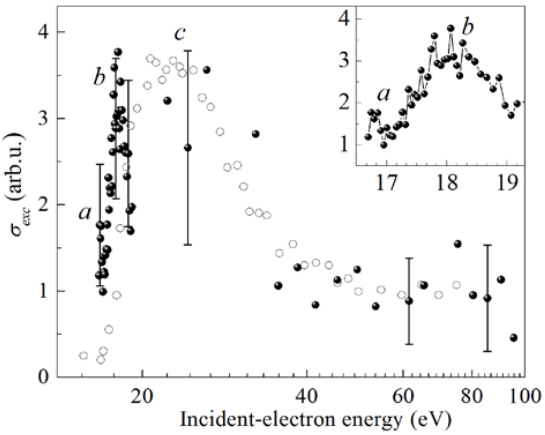

Figure 1. The electron-impact excitation functions of the $(4p^5 5s5p)^4S_{3/2}$ state in rubidium: ● - present data; ○ - optical data [3]. The inset shows the threshold region of the present data. The data [3] and our data are normalized with incident-electron energy of 65 eV.

maximum *c* in our data [3] corresponds to the spin-exchange character of the electronic excitation of the $^4S_{3/2}$ state. The notable scatter of experimental data, which is observed between 20 and 25 eV in the ejected-electron excitation function could reflect the combined effect of several overlapping resonances.

In order to obtain the absolute values of the excitation cross sections for the $(4p^5 5s5p)^4S_{3/2}$ and other p^6-core excited states in rubidium, we have performed relativistic distorted-wave calculations.

References

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