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The $4p^6$ electron energy-loss spectrum of Rb atoms

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Synopsis The scattered electron energy-loss spectrum due to the excitation of the $4p^5 n_1 l_1 n_2 l_2$ states in rubidium atoms was measured at 25.6 eV impact energy. New optically forbidden non-autoionizing states located between 16.5 and 16.8 eV were observed.

The first spectroscopic classification of the $4p^6$ core-excited states in rubidium atoms was performed in 1934 by Beutler [1] by measuring the photoabsorption spectrum between 800 and 600 Å. At present, however, the assignment only of the eight high-lying states from $4p^5 5s4d, 5p$ configurations and of the $(4p^5 5s^2)^2P_{3/2,1/2}$ leading autoionizing doublet can be regarded as certain [2]. Notably poor situation exists about the optically forbidden and non-autoionizing states though the excitation thresholds of the latter were established experimentally [3]. In the present work, by measuring the energy-loss spectrum of scattered electrons in the region of the $4p^5 n_1 l_1 n_2 l_2$ states their formation was studied directly in the excitation channel.

The measurements were performed by using the electron spectrometer and experimental procedure described in detail earlier [4]. The energy-loss spectrum at 25.6 eV impact energy was obtained at an observation angle of 54.7° with an incident electron energy resolution of 0.1 eV. Figure 1 shows this spectrum in the energy region of the $(4p^5 5s^2)^2P_{1/2}$ and other high-lying $4p^5 n_1 l_1 n_2 l_2$ autoionizing states (see bars on top of the spectrum).

The least-squares fit of the data was performed by using an asymmetrical apparatus function with the width of 0.1 eV (FWHM). Surprisingly, but no visible lines can be seen in the energy region A where the first metastable threshold at 15.8±0.3 was reported in rubidium atoms [3]. However, above the second metastable threshold B at 16.4±0.3 eV the fitting results reveal at least three non-autoionizing states lying between 16.5 and 16.8 eV. Configuration interaction calculations of energies, decay rates and excitation cross sections of the $4p^5 n_1 l_1 n_2 l_2$ states were performed for the classification of lines observed in electron and optical spectra of rubidium atoms. These results will be presented at the conference.

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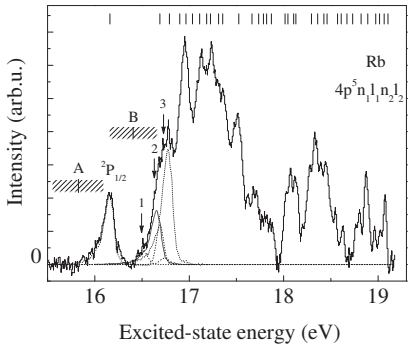

Figure 1. The electron energy-loss spectrum of rubidium vapors at 25.6 eV impact energy. Bars on top of the spectrum mark the position of the $4p^5 n_1 l_1 n_2 l_2$ autoionizing states whereas arrows mark the non-autoionizing states.

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