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Ejected-electron spectra of Ba close to the $5p^6$ excitation threshold

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Synopsis The ejected-electron spectra arising from the decay of the $5p^5n_1l_1n_2l_2n_3l_3$ autoionizing states in Ba atoms were precisely measured for electron impact energies between 15 and 20 eV. The excitation threshold of the $5p^6$ subshell was evaluated at 15.63 ± 0.05 eV. The excitation thresholds and decay paths of the lowest states in $5p^55d6s^2$ and $5p^55d^26s$ configurations were determined.

The excitation of the $5p^6$ subshell in Ba atoms is affected by the strong mixing effects which result in formation of the $5p^5[6s^2 \times 5d6s \times 5d^2]nl$ configurations. The overlapping energy structure and the multichannel decay mode of corresponding autoionizing states are two main reasons for the situation when the lines in photoabsorption spectra [1] and in ejected-electron spectra [2], [3] are still unclassified. Meanwhile, it is well known that the accurate experimental data on excitation thresholds and decay channels of atomic levels is the first requirement for their accurate spectroscopic classification.

In order to determine the excitation thresholds and decay channels of the $5p^5n_1l_1n_2l_2n_3l_3$ lowest autoionizing states in Ba atoms we have measured the ejected-electron spectra in series, step-by-step for electron impact energy values between 15 and 20 eV with the increment step of 0.1 eV. The apparatus and measuring procedure were described elsewhere [4]. Spectra were recorded at the incident- and ejected-electron energy resolution of 0.2 eV and 0.06 eV, respectively. The incident-electron and ejected-electron energy scales were calibrated by using the photoabsorption data [5] for the autoionizing state at 15.80 eV. The uncertainties of energy scales were estimated to be ± 0.07 eV for incident and ± 0.05 eV for ejected electrons.

The excitation dynamics of ejected-electron spectra is shown in figure 1. As can be seen, in spectrum at 15.65 eV the only line 5 at 10.42 eV is observed. In accordance with our calculations based on the Dirac-Fock-Slater approach [6] this line can be assigned as $(5p^55d6s^2)^3P_0$ dipole-forbidden state at 15.63 eV. Thus, this is the lowest $5p^6$ -core excited atomic autoionizing state in Ba atoms with the single decay channel into the $5p^66s$ Ba⁺ ground state.

The excitation thresholds and decay channels were determined for ten autoionizing states

from $5p^55d6s^2$ and $5p^55d^26s$ configurations located between 15.63 and 16.70 eV. Most states possess the multichannel electron decay into the $5p^66s, 5d$ Ba⁺ states.

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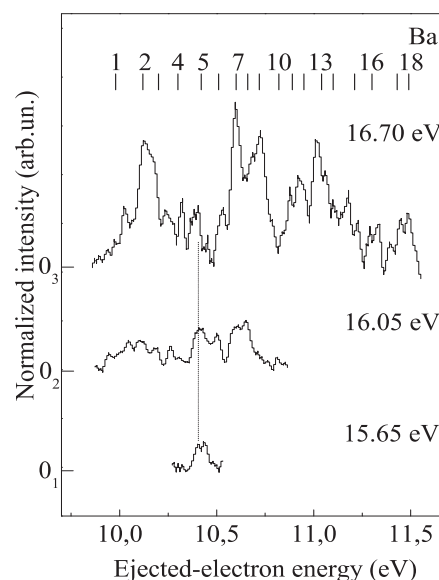


Figure 1. Ejected-electron spectra of Ba atoms for different electron impact energies. The polynomial background function was subtracted in all spectra.

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