Elektronais sužadinto Ba atomo autojonizacijos skerspjūvis

Autoionization cross section of Ba atoms excited by electron impact

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The electron decay of autoionizing states is in fact an indirect ionization process which can result in essential enhancement of the ionization cross section of atoms. Such autoionization contribution reaches 30-40% of the total ionization cross section in heavy atoms with outer p^6 subshell [1, 2]. The direct measurements of this contribution (autoionization cross section) are known only for alkali atoms (see [3] and references therein).

In the present work we report the first data on the autoionization cross section of barium atoms. It was obtained as a sum of normalized intensities of lines observed in ejected-electron spectra arising from the decay of the $5p^5n_1l_1n_2l_2n_3l_3$ *LSJ* autoionizing states. The spectra were measured at the 'magic' angle of 54.7° for the incident electron energies from the lowest autoionization threshold at 15.61 eV up to 600 eV. The measurements were performed by using the apparatus described in detail elsewhere [4]. The obtained relative data were put on the absolute scale by normalizing the excitation function of the $5d6s^2\ ^3D_1$ state to the calculated cross section [4] at 600 eV. The summary relative error did not exceed 30%.

Figure 1 shows the autoionization cross section σ_{aut} of barium atoms in an impact energy range 10-600 eV. As can be seen, the dominant features of the cross section are the strong near-threshold maximum containing structures (*a*), (*b*) and a broad maximum around 100 eV. The cross section reaches the maximum value 6.7×10^{-16} cm^2 at 17.4 eV (feature *a*).

The position of the near-threshold maximum coincides with an energy region where the $5p^5n_1l_1n_2l_2n_3l_3$ *LSJ* autoionizing states are known in barium atoms (see bars on top of figure 1). As follows from the spectroscopic classification of these states [4] and from the analysis of their excitation dynamics [5], the feature (*a*) is formed by the resonances present in electron impact excitation of the states from $5d6s^2$ and $5d^26s$ configurations lying between 15.6 and 17.5 eV.

The origin of feature (*b*) is due to the resonance excitation of two group of states from autoionizing configurations $6s^26p$, $5d^26s$ and 5d6s7s, $5d^26p$,6d,7d lying between 17.8 and 21.8 eV. The dominance of the near-threshold maximum points out that the strong resonance excitation is a common feature both for dipole-allowed and dipole-forbidden AIS in barium.

The behavior of the cross section σ_{aut} around 100 eV and at higher impact energies reflects the total contribution from dipole-allowed AIS. Note, however, that due to strong mixing and correlation effects in $5p^6$ excitation of barium atoms [4, 6] dipole-forbidden AIS ($J\neq1$) also participate in formation of the autoionization cross section above 100 eV impact energy.

The calculations of electron-impact ionization and excitation-autoionization cross sections for $6s^2$ and $5p^6$ shells will be our next steps in further analysis of the autoionization cross section of barium atoms.

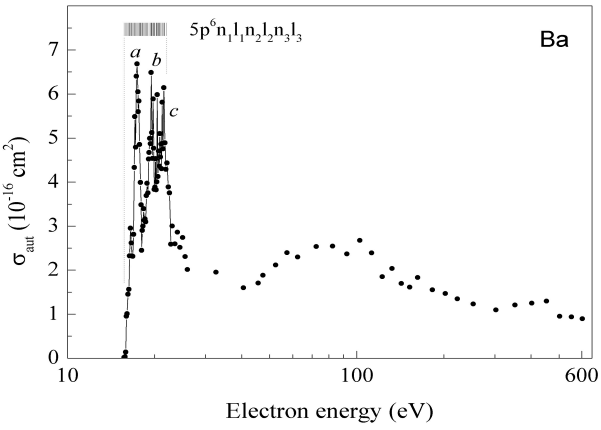

Figure 1. The $5p^6$ autoionization cross section of Ba atoms excited by electron impact. The solid line is used to show the resonance features (*a*) and (*b*) at low impact energies. Bars on top mark the location of the $5p^5n_1l_1n_2l_2n_3l_3$ *LSJ* autoionizing states.

Keywords: experiment, atomic theory, autoionization, electron-impact excitation cross sections.

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