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$K\alpha_{1,2}\alpha_3$ and $K^h\alpha_{1,2}$ satellite transition energies and rates for Ar and Ca

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Synopsis The calculations of radiative energies and transition rates for $K\alpha_{1,2}\alpha_3$ and $K^h\alpha_{1,2}$ satellite (M_1, $M_{2,3}$, and N_1 spectator holes) lines for Ar and Ca have been carried out by using the GRASP2K and AMBIT codes. The influence of electron correlation on transition rates has been studied.

The radiative transitions in K-shell hollow (i.e., having empty K shell) atoms can occur via one-electron one-photon (OEOP: $1s^{-2} \to 1s^{-1}2p^{-1}$, named $K^h\alpha_{1,2}$) or via much less probable two-electron one-photon (TEOP: $1s^{-2} \to 2s^{-1}2p^{-1}$, named $K\alpha_{1,2}\alpha_3$) transitions. It has been found that TEOP transition rates are very sensitive to the electron correlations [1], while OEOP transition rates are only weakly sensitive.

Table 1. Transition rates for $K^h\alpha_{1,2}$ and $K^h\alpha_{1,2}M_1^{-1}$ lines of Ar, calculated in length (A_L) and velocity (A_V) gauge. 'CI' means extensive Configuration-Interaction calculations.

Code	Transition rate (s^{-1})	
	A_L	A_V
$K^h\alpha_2$ ($1s^{-2} \to 1s^{-1}2p^{-1}_{1/2}$)		
GRASP2K	2.66E+14	2.57E+14
GRASP2K (CI)	2.69E+14	2.57E+14
AMBIT	2.56E+14	2.45E+14
$K^h\alpha_1$ ($1s^{-2} \to 1s^{-1}2p^{-1}_{3/2}$)		
GRASP2K	3.85E+12	3.44E+12
GRASP2K (CI)	3.54E+12	3.39E+12
AMBIT	3.43E+12	3.29E+12
$K^h\alpha_{1,2}M_1^{-1}$ ($1s^{-2}3s^{-1} \to 1s^{-1}2p^{-1}3s^{-1}$)		
GRASP2K	2.79E+14	2.68E+14
GRASP2K (CI)	2.64E+14	2.55E+14
AMBIT	2.58E+14	2.49E+14

We reported recently that incorporation of $K\alpha_{1,2}\alpha_3$ and $K^h\alpha_{1,2}$ satellite transitions is crucial to proper estimate the OEOP-to-TEOP branching ratio and $K\alpha_{1,2}\alpha_3$ linewidth [1]. Then the calculations of radiative energies and transition rates for satellite $K\alpha_{1,2}\alpha_3$ and $K^h\alpha_{1,2}$ lines for Ar and Ca atoms have been carried out by means of the GRASP2K [2] and AMBIT [3] codes, based on the Multi-Configuration Dirac–Hartree–Fock method. The influence of electron correlation on transition rates has been studied. The results of our studies set new theoretical limits for the TEOP transitions in the low-Z atomic range. We also hope that this work will guide future experiments with a high accuracy.

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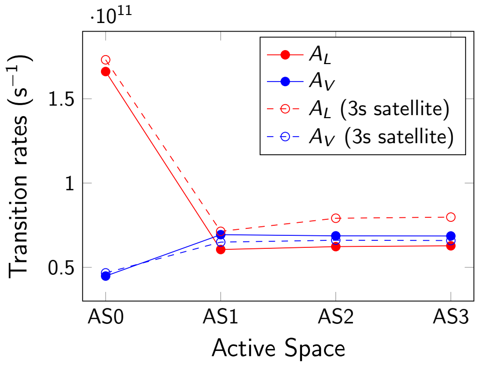

Figure 1. Convergence of calculations of $K\alpha_{1,2}\alpha_3$ and $K\alpha_{1,2}\alpha_3M_1^{-1}$ transition rates for Ar for various configuration-interaction active spaces.

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