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Cascade of elementary processes in Se^{1+}

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Cascade of elementary processes in Se^{1+}

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Synopsis Analysis of radiative and Auger cascade following creation of the K shell vacancy in the Se atom is presented. Calculations of radiative and Auger transition probabilities are performed by using Dirac-Fock-Slater approximation. Radiative and Auger spectra as well as ion yield produced by cascade are studied.

Merger of two neutron stars or neutron star with black hole leads to production of heavier than iron elements through the rapid neutron capture (r-process) nucleosynthesis [1]. Electromagnetic radiation from the merged stars as the counter-part of the gravitational waves is observed by the onboard satellites (Chandra X-ray Observatory, XMM-Newton). Interaction of x-ray radiation with atoms and ions in the surroundings of the merged stars can lead to emission of electron from inner shell. The highly excited state decay through cascade of elementary processes. The cascades of elementary processes are the main source of formation for the higher ionization stages of ions in the surrounding of merged stars.

Cascade of radiative and Auger transitions following a vacancy creation in the K shell of the Se^{1+} ion is investigated by considering transitions among subconfigurations. Energies of subconfigurations, radiative and Auger transition probabilities are studied using Flexible Atomic Code (FAC) [2] which implements Dirac-Fock-Slater approximation.

Ion yields produced by cascades are presented in Fig. 1. The results correspond to decay of the $1s_{1/2}4p^2_{1/2}4p^2_{3/2}$ subconfiguration. Radiative transitions play a significant role in the first step of cascade. The Se^{1+} $1s\,4p^4$ configuration decays with the probability of ∼54% to Se^{1+} $2p^5 4p^4$ through radiative transitions. Population of the Se^{1+} $3p^5 4p^4$ and $4p^3$ configurations reached by radiative transitions corresponds to ∼7.2% and ∼0.4%, respectively. Transition to the next ionization stage from Se^{1+} $1s\,4p^4$ amounts to 38%. The Se^{1+} $2p^5 4p^4$ and $3p^5 4p^4$ configurations decay further mainly through Auger transitions and that leads to negligible contribution to Se^{1+}. Decay of other two subconfigurations ($1s_{1/2}4p^1_{1/2}4p^3_{3/2}$ and $1s_{1/2}4p^4_{3/2}$) of the $1s\,4p^4$ configuration agrees within 1% for the ion yield.

The data for Auger cascade are compared with the results that in addition to Auger transitions involve the radiative process. It can be seen that radiative transitions play a crucial role in the formation of ions in the various ionization stages. The higher ionization stages are reached when only Auger cascade is included in the study. The highest population of ions corresponds to Se^{7+} for the Auger cascade. The radiative and Auger cascade produces the Se^{4+} and Se^{5+} ions with the largest population. It has to be noted that the highest ionization stage reached by the cascades is larger than the number of shells in the Se^{1+} ion.

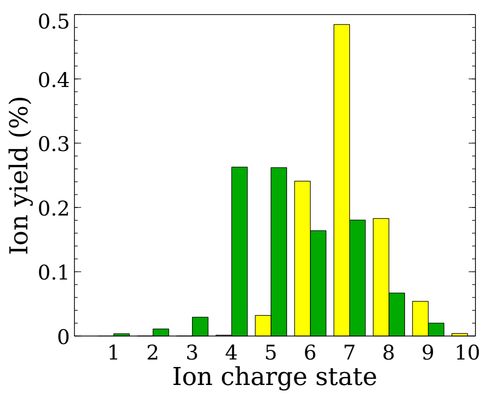

Figure 1. Ion yield produced in Se^{1+} by cascades: Auger cascade (yellow), radiative and Auger cascade (green).

References

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