Contribution ID: **75** Type: **not specified**

Multiple photoionization for the Fe+ 2p subshell

Wednesday, 17 May 2023 09:50 (20 minutes)

Photoionization plays a key role in the production of highly charged ions in active galactic nuclei (AGNs). The inner shell photoionization leads to highly excited states that are the subject of radiative and Auger cascade. An electron from a higher shell fills the inner-shell vacancy while simultaneously causing the removal of another electron from the atomic system during the Auger decay. As a result of the Auger cascade, the produced ions have higher charge states than the initial ion. However, the final ion population eventually stabilizes in states that are below the ionization threshold of the corresponding ion.

The aim of the current work is to study multiple photoionization of the $2p$ subshell of the Fe^+ $3d^6 4s$ configuration. The investigation of multiple photoionization for the iron atom and ions was the subject of our earlier work [1, 2], and this study represents a continuation of that research. The Fe^+ ion is an important diagnostic tool for the study of AGNs. The Fe^+ emission is thought to arise from gas in the broad line region. The spectral lines of the Fe^+ ion were also identified from the inner torus wall. On the other hand, the higher ionization stages of Fe were observed in spectra from AGNs [3].

Multiple photoionization cross sections are studied for all 63 energy levels of the Fe^+ $3d^6 4s$ configuration. The study also includes partial photoionization cross sections to the configurations of produced ions. The photoionization of the $2p$ subshell of the Fe^+ $3d^6 4s$ configuration leads to the autoionizing Fe^{2+} $2p^5 3d^6 4s$ configuration which has 360 energy levels.

Decay of the Fe^{2+} $2p^5 3d^6 4s$ configuration through a cascade of radiative and Auger transitions produces 9 final configurations which population exceeds 0.01%: Fe^{2+} $3d^5 4s$, Fe^{3+} $3d^5$, Fe^{3+} $3d^4 4s$, Fe^{4+} $3d^4$, Fe^{4+} $3d^3 4s$, Fe^{4+} $3p^5 3d^5$, Fe^{5+} $3d^3$, Fe^{5+} $3d^2 4s$, Fe^{5+} $3p^5 3d^4$. The study of the cascade includes only electric dipole transitions. The produced configurations can lead to further decay through radiative transitions of higher multipoles.

The main populations of the cascade decay reside in states of the Fe^{4+} and Fe^{5+} ions. The yield of the Fe^{6+} ion is lower than 0.01% for all levels of the Fe^{2+} $2p^5 3d^6 4s$ configuration from which the cascade starts. It has to be noted that the largest ion yields depend on the level of the Fe^{2+} $2p^5 3d^6 4s$ configuration. The largest population of the Fe^{4+} ion amounts to ∼72% for the ground level of the Fe^{2+} $2p^5 3d^6 4s$ configuration. The lowest ion yield of ∼30% corresponds to the highest levels of the initial configuration of the cascade. On the other hand, the largest population of ∼57% for the Fe^{5+} ion is produced from the level with index 160 while the lowest population of ∼24% is a result of cascade decay from the level with index 9. What is more, the yield of the Fe^{3+} ion varies from ∼1.7% (index 1) to ∼24.6% (index 137).

The strongest branch of the cascade when population of levels is proportional to their statistical weights lead to Fe^{5+}: Fe^{2+} $2p^5 3d^6 4s \rightarrow Fe^{3+}$ $3p^4 3d^6 4s$ (44%) $\rightarrow Fe^{4+}$ $3p^5 3d^4 4s$ (36%) $\rightarrow Fe^{5+}$ $3d^3$ (34%).

References

[1] S. Kučas *et al.*, Astron. Astrophys. **643**, A46 (2020).
[2] S. Kučas *et al.*, Astron. Astrophys. **654**, A74 (2021).
[3] F.C. Cerqueira-Campos *et al.*, Mon. Not. R. Astron. Soc. **500**, 2666 (2020).

Presenting Author

Aušra Kynienė

Presenting Author Affiliation

Vilnius University

Presenting Author Gender

Female

Country

Lithuania

Presenting Author Email Address

ausra.kyniene@tfai.vu.lt

Primary authors: Dr KYNIENĖ, Aušra; Dr KUČAS, Sigitas; Dr MASYS, Šarūnas; JONAUSKAS, Valdas

Presenter: Dr KYNIENĖ, Aušra

Session Classification: Fundamental Data and Modelling

Track Classification: Fundamental Data and Modelling