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A new charge-reset method for determining Auger-electron emission multiplicities

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Targeted internal radiotherapy and patient-specific treatment is of great importance for treating advanced staged cancers, allowing for personalised radiotherapeutics to be deployed to treat otherwise unresponsive cancers. Within the radiotherapeutic armoury, Auger-electron therapy is of particular interest since the low-energy electrons deposit their energy over short distances (on the scale of nm-μm), resulting in a high linear energy transfer (LET), and allowing for precise targeting of cancerous cells [1, 2]. Auger electrons are emitted during atomic relaxation following the creation of a vacancy in an inner-atomic shell, for example, following electron capture decay or internal conversion. During the entire relaxation process multiple Auger electrons can be emitted into the surrounding environment. For determining the impact of Auger electron emission, precise nuclear data measurements are required, not just for the energy of the emitted electrons, but also the multiplicity, i.e. the average number of electrons emitted.

A new charge-reset method has been developed for determining emission multiplicities of Auger electrons following the creation of a vacancy in an inner-atomic orbital. Excited states are populated through below-barrier Coulomb excitation reactions. The de-excitation of states by internal conversion will then trigger a series of Auger cascades, increasing the charge state of the ion. The distribution of charge states can be measured by passing the ions through an electromagnetic spectrometer. The addition of a charge reset foil, placed between the target and the spectrometer, resets the atomic charge state of scattered ions to a nominal value. An internal conversion that occurs after the reset foil then induces an Auger cascade and so affects the distribution of charge states measured by the electromagnetic spectrometer. Here, I will present initial results, using the FMA+GRETINA setup at Argonne National Laboratory, to determining Auger-electron emission multiplicities in ^{177}Hf, daughter of ^{177}Lu.

References

[1] B. Cornelissen and K. A. Vallis, *Targeting the Nucleus: An Overview of Auger-Electron Radionuclide Therapy.* Current Drug Discovery Technologies, 7(4):263–279, 2010.

[2] A. Ku, V. J. Facca, Z. Cai, and R. M. Reilly, *Auger electrons for cancer therapy - a review.* EJNMMI Radiopharmacy and Chemistry, 4(1):27, 2019

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