Contribution ID: **27** Type: **not specified**

Muonic Cascade Calculations

Thursday, 5 September 2024 14:30 (15 minutes)

"Muonic X-ray Emission Spectroscopy is a non-destructive method of elemental analysis, which has recently been used in cultural heritage [1] for finding the chemical composition of artifacts. It is desirable to have a robust way of computationally modelling these experiments, to allow for simpler and more systematic identification of elemental X-ray intensities. When a muon is captured by an atom, it may transition down the energy levels via two routes: radiative transitions, and Auger electron emission. Muonic cascade calculations are performed to calculate both of these contributions. Throughout the literature, this has often been done by using the cascade code developed by Akylas [2].

An important feature of cascade calculations is the initial angular momentum distribution of the muon when it is captured by the atom. Different parameterised distributions have previously been investigated [3], but newer computational techniques now allow for more systematic investigations. This talk will show the effect of different l-distributions on calculated X-ray intensities, as well as detailing the theory behind the Akylas cascade code. I will also outline the path forward to updating the cascade code with more modern theoretical and computational techniques.

(1) Sturniolo, S.; Hillier, A. Mudirac: A Dirac Equation Solver for Elemental Analysis with Muonic X-Rays. X-Ray Spectrometry 2021, 50 (3), 180–196. https://doi.org/10.1002/xrs.3212.

(2) Akylas, V. R.; Vogel, P. Muonic Atom Cascade Program. Computer Physics Communications 1978, 15 (3), 291–302. https://doi.org/10.1016/0010-4655(78)90099-1.

(3) Hartmann, F. J.; Bergmann, R.; Daniel, H.; Pfeiffer, H.-J.; von Egidy, T.; Wilhelm, W. Measurement of the Muonic X-Ray Cascade in Mg, AI, In, Ho, and Au. Z Physik A 1982, 305 (3), 189–204. https://doi.org/10.1007/BF01417434."

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Session Classification: Science Session