Contribution ID: **10** Type: **Oral presentation**

Lifetime measurements of low-energy octupole states in radium-224

Thursday 13 March 2025 15:00 (30 minutes)

For certain nuclei long-range octupole-octupole residual interactions can cause a reflection-asymmetric (pear) shape to occur. This octupole deformation, combined with quadrupole deformation, causes a separation between the centre of mass and centre of charge in the nucleus, resulting in a significant electric dipole (E1) moment. This effect enhances the strength of the E1 and electric octupole (E3) transitions, characteristic features of such nuclei.

The presence of these low lying J= $1^-$and 3^- is indicative of octupole deformation. An example of one of these nuclei is radium-224 which is octupole deformed in the ground state as evidenced by the observation of enhanced E3 transitions[1]. Their work measured a large E3 strength but could only give an upper limit on the reduced transition probability of the E1 transition (B(E1)).

The aim of this experiment was to measure the lifetimes of the low-lying J= $1^-$and 3^- states in radium-224 and, therefore, measure the E1 strength. This was done by observing the beta decay of francium-224 ions which were produced at the ISAC facility in TRIUMF. The lifetime of these states was measured by using the $LaBr_3$(Ce) detectors of the GRIFFIN array and the generalised centroid difference method. Measuring the lifetime of these states makes it possible to perform a direct measurement of the low-energy dipole response in radium-224 for the first time.

References

[1] L. P. Gaffney et al., "Studies of pear-shaped nuclei using accelerated radioactive beams,"Nature, vol. 497, pp. 199–204, May 2013.

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Session Classification: Day 2

Track Classification: Nuclear structure: Nuclear structure from fast-timing measurements