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Decay spectroscopy of 225Pa: Study of octupole deformation in the neutron-deficient actinides

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The study of the structure of neutron-deficient actinides is of particular interest since several theoretical calculations predict strong octupole deformations in this region of the nuclear chart [1, 2, 3]. However experimental data are scarce due to very low production rates.

There is an ongoing program at the IGISOL (Ion Guide Isotope Separation On-Line) facility, University of Jyväskylä, to study actinide isotopes, including the decay spectroscopy of neutron-deficient actinides produced through proton-induced fusion-evaporation reactions on a ^{232}Th target. A successful experiment was performed in July 2020 where short-lived actinide isotopes were produced, mass separated and guided to a decay spectroscopy station. Using an experimental setup composed of Ge, Si and Si(Li) detectors, α, γ and electron decay spectroscopy of the selected nuclei was performed to reconstruct the decay schemes that are missing or incomplete in this region of the nuclear chart. In this presentation, I will show results focusing on ^{225}Pa, for which very little decay information was available before this experiment, as well as its daughter nucleus ^{221}Ac. Reconstruction of the decay scheme and measurement of α hindrance factors indicates a static quadrupole-octupole deformation in ^{221}Ac. In particular the level scheme of ^{221}Ac is interpreted in terms of parity-doublet bands arising from this octupole deformation.

The second goal of this experiment was to measure production yields in order to consider a laser spectroscopy program in the future. Indeed laser ionisation spectroscopy is well established as a powerful tool in nuclear structure studies [4]. It allows the measurement of spins, magnetic dipole moments, electric quadrupole moments and changes in the mean-square charge radii independently of nuclear models.
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In the near future, the possibility to perform laser ionisation spectroscopy of neutron-deficient actinides at S^3-LEB will allow to continue this program towards nuclei further from stability. In particular the SEASON (Spectroscopy Electron Alpha in Silicon bOx couNter) detector will enable the coupling of two approaches : laser ionisation spectroscopy and decay spectroscopy.
I will conclude my talk discussing perspectives for the study of octupole deformations in the neutron-deficient actinides, in particular those offered by SEASON at S^3-LEB.

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