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Spectroscopy of Fl decay chains and plans for Lundium

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In the wake of the discovery of superheavy elements, nuclear spectroscopy experiments aim at providing anchor points at the uppermost end of the nuclear chart for nuclear structure theory, which otherwise had to solely rely on extrapolations. In two runs in 2019 and 2020, such a nuclear spectroscopy experiment was conducted to study α-decay chains stemming from isotopes of flerovium (element Z = 114) [1,2]. One incentive to study flerovium isotopes is that many, but not all, nuclear structure models or model parametrizations favour Z = 114 as the next magic proton number beyond lead, Z = 82.

The U310 experiment employed an upgraded TASISpec decay station, which is shown in Fig.1. It was placed behind the gas-filled separator TASCA. The fusion-evaporation reactions ^{48}Ca+^{242}Pu and ^{48}Ca+^{244}Pu provided a total of 32 flerovium-candidate decay chains in effectively 18 days of beam time. Two and eleven decay chains were firmly assigned to even-even ^{286}Fl and ^{288}Fl isotopes, respectively. The – admittedly unexpected – observations include (*i*) an excited 0^+ state at 0.62(4) MeV excitation energy in ^{282}Cn, and (*ii*) a Q_α = 9.46(1) MeV decay branch (1 out of 51) from ^{284}Cn into ^{280}Ds [2]. Both observations indicate that there is hardly any shell gap at proton number Z = 114 - at least not at neutron numbers $N \approx$ 172-174. This statement is supported by demanding beyond-mean-field model calculations, which include the necessary triaxial shapes [3,4]. The existence of the excited 0^+ state in ^{282}Cn requires "an understanding of both shape coexistence and shape transitions for the heaviest elements" [1]. Second, using the known Q_α = 10.79(4) MeV for the ^{292}Lv → ^{288}Fl α decay as well as the now precisely measured Q_α = 10.06(1) MeV for ^{288}Fl → ^{284}Ds, a smooth Q_α sequence *across* Z = 114 could be established.

An update on the new Lundium decay station and a future proposed experiment into neutron-deficient plutonium isotopes will also be presented..

References

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