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High precision mass measurements and separation of nuclear isomers with a multiple-reflection time-of-flight mass spectrometer

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Abstract

Multiple-reflection time-of-flight mass spectrometers (MR-TOF-MS) are powerful devices for experiments with exotic nuclei. Due to their high accuracy, sensitivity and short cycle time, direct mass measurements of short-lived and rare nuclei with half lives longer than a few milliseconds and with just a few detected ions can be performed [1, 2]. Because of their high mass resolving power and broadband characteristics, they are also ideally suited for the search

for and measurement of isomers and can even be employed for the production of isomerically clean beams [3].

The masses of more than 40 short-lived ground and isomeric states were measured using the MR-TOF-MS of the FRS Ion Catcher at the FRS at GSI Darmstadt. They were produced at relativistic energy in ^{238}U and ^{124}Xe projectile fragmentation and fission. Among them 9 nuclides were measured for the first time directly. Those data help to understand nuclear structure phenomena around the double magic nucleus ^{208}Pb [2] and in the vicinity of ^{100}Sn, where isomeric states are of special interest. The results are compared with shell model and mean field calculation.

A novel method for the measurement of half-lives and decay branching ratios has been developed and demonstrated experimentally [4]. It employs a gas-filled stopping cell as ion storage device and an MR-TOF-MS for identification and counting of the precursors and decay products. Perspectives for the measurement of $N = Z$ nuclides using the FRS Ion Catcher in the region below ^{100}Sn, including ground state masses, excitation energies of isomers, and decay branching ratios, will be discussed.

References

[1] W. R. Plaß at al., *Int. J. Mass Spectrom.* **349**, 134144 (2013).

[2] S. Ayet San Andres et al., *Phys Rev. C* **99**, 064313 (2019).

[3] T. Dickel et al., *Phys. Lett. B* **744**, 137-141 (2015).

[4] I. Miskun et al., accepted for publication by EPJ A; arXiv:1902.11195.