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Probing the Unknown: Mass Measurements near N=126 with the FRS Ion Catcher

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To study the r-process, experimental information is scarce and modern r-process network calculations rely on theoretical models that give divergent predictions as one moves away from the valley of stability. Nuclear masses help to determine the r-process path and shed light on the nucleosynthesis environment.

The neutron-rich nuclei at $N = 126$ that populate the r-process third abundance peak are of specific interest, but they are challenging to produce. The use of high-energy heavy-ion beams with the Fragment Separator (FRS) at GSI facilitates the study of neutron-rich nuclei in this region. An experiment was performed within FAIR Phase-0 with the goal to search for new isotopes in the neutron rich region and to measure masses and half-lives, where the neutron-rich nuclei were produced at the FRS using a 1 GeV/u ^{208}Pb beam on a 4g/cm^2 thick ^{9}Be target using the fragmentation reaction. The novel technique of mean range bunching was used to measure multiple fragments in one setting, and the precise mass measurements were performed using the multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS). The MR-TOF-MS features a high resolving power of up to 1,000,000, short cycle times of a few tens of milliseconds, and mass accuracy down to 20 keV was achieved in this experiment.

During the experiment, masses of fifteen nuclei around $N = 126$ were measured, of which four masses were measured for the first time. The results of this experiment will be presented, including the first mass measurements of ^{204}Au and ^{205}Au, where significant deviations from the AME2020 extrapolations indicate a change in the nuclear structure. Irregularities in the mass surface are being studied using the Skyrme Hartree-Fock plus BCS calculations.

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