

774th ASRC Seminar

Date: 12月10日(火) 14:45 ~

Location: Meeting Room 302, ASRC bldg.
先端基礎研究交流棟 第二会議室 (302号室)

Speaker: Dr. Francesca Giacoppo (独GSI)

Title: High-precision mass measurements
of the heaviest elements with SHIPTRAP

要旨: Exploring the limit of the nuclear chart and identifying the heaviest elements that can be synthesized are among the key unanswered questions in nuclear physics. The survival of superheavy elements as bound systems is closely correlated to nuclear shell effects, which can be experimentally probed by mass measurements. Experiments around this region are hampered by extremely low production rates of down to few ions per month. Nonetheless, the Penning-trap mass spectrometer SHIPTRAP, located at the GSI in Darmstadt, Germany, has shown that direct high-precision measurements of atomic masses of $_{102}\text{No}$ and $_{103}\text{Lr}$ isotopes around the deformed shell closure $N = 152$ are feasible and provide indispensable knowledge on binding energies, shell effects and yield important anchor-points on α -decay chains, affecting absolute mass values up to the heaviest elements. To continue this groundbreaking program and to proceed towards heavier and more exotic nuclides, the drop in production rate has to be compensated by several improvements. The Penning-trap system was recently relocated, allowing to integrate a more efficient second-generation gas-stopping cell, operating at cryogenic temperatures. In addition, the Phase-Imaging Ion-Cyclotron-Resonance (PI-ICR) technique was developed, increasing the sensitivity of mass measurements. To fully exploit its enhanced mass resolving power required improving the temporal stability of the electric and magnetic fields. Furthermore, its applicability in low-rate measurements, accumulating only few ions in total, yet had to be proven.

In the SHIPTRAP experimental campaign in summer 2018, we extended direct high-precision Penning-trap mass spectrometry into the region of the heaviest elements using the PI-ICR technique. For the first time, direct mass measurements of ^{251}No , ^{254}Lr and the superheavy nuclide ^{257}Rf were performed with rates down to one detected ion per day. Despite lowest rates the PI-ICR technique allowed resolving the isomeric states $^{251\text{m},254\text{m}}\text{No}$ and $^{254\text{m},255\text{m}}\text{Lr}$ from their respective ground states with mass resolving powers of up to 10.000.000 and to accurately determine their excitation energies, which had previously been derived only indirectly via decay spectroscopy. In this talk an overview of the technical developments and the recent results will be given together with an outlook of the upcoming beamtime in February 2020.

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