Contribution ID: **34** Type: **Poster**

A compact He-buffer-gas-cell ion source for delivery of $^{229(m)}Th^{3+}$ ions into a cryogenic Paul trap

Monday 8 July 2024 16:38 (2 minutes)

The ^{229}Th nucleus has the unique property of a very low-lying isomeric first excited state with an excitation energy of only 8.338(24) eV [1], which is addressable with state-of-the-art VUV frequency comb laser systems. Storage in the isolated environment of a cryogenic ion trap will allow for lifetime measurements of the excited isomeric state (expected in the range of a few 10^3 seconds), precise spectroscopy of the nuclear transition, and eventually the creation of the first nuclear clock with an estimated systematical uncertainty approaching 10^{-19} [2].

For loading of $^{229}Th^{3+}$ ions into the ion trap, a compact version of the very successful He-buffer-gas-cell ion source used in [3-5] has been designed, built, and commissioned at LMU. The compactness of the setup will allow the installation on the laser table next to the ion trap where $^{229}Th^{3+}$ will be trapped and sympathetically cooled by laser-cooled $^{88}Sr^{+}$ ions. The challenging boundary conditions of 32 mbar He in the buffer gas cell and $< 10^{-8}$ mbar in the ion trap require several stages of differential pumping, which have been implemented.

In this contribution, we report on the commissioning of the compact He-buffer-gas-cell ion source, including the demonstration of the fulfilment of the differential pumping requirements, and first experiments towards transferring $^{229}Th^{3+}$ to and trapping of $^{229}Th^{3+}$ in the ion trap. In addition, we report on efforts to integrate an ablation ion source for $^{88}Sr^{+}$ into the ion guide between the buffer gas cell and the ion trap for combined extraction of $^{229}Th^{3+}$ and $^{88}Sr^{+}$.

This work was supported by the European Research Council (ERC grant agreement No. 856415) and BaCaTec (7-2019-2).

[1] S. Kraemer *et al.*, Observation of the radiative decay of the ^{229}Th nuclear clock isomer, *Nature* **617**, 706–710 (2023).
[2] C. Campbell *et al.*, Single-ion nuclear clock for metrology at the 19th decimal place, *Phys. Rev. Lett.* **108**, 120802 (2012).
[3] L. von der Wense *et al.*, Direct detection of the ^{229}Th nuclear clock transition, *Nature* **533**, 47–51 (2016).
[4] B. Seiferle *et al.*, Lifetime Measurement of the ^{229}Th Nuclear Isomer, *Phys. Rev. Lett.* **118**, 042501 (2017).
[5] B. Seiferle *et al.*, Energy of the ^{229}Th nuclear clock transition, *Nature* **573**, 243–246 (2019).

Authors: Dr WIESINGER, Markus (LMU Munich); HOLTHOFF, Georg (LMU Munich)

Co-authors: SCHARL, Kevin (LMU Munich); Dr HUSSAIN, Mahmood I. (LMU Munich); LÖBELL, Lilli (LMU Munich); MORITZ, Daniel (LMU Munich); ROZIBAKIEVA, Tamila (LMU Munich); Prof. THIROLF, Peter (LMU Munich)

Presenters: Dr WIESINGER, Markus (LMU Munich); HOLTHOFF, Georg (LMU Munich)

Session Classification: Poster session

Track Classification: Nuclear Physics