4-year Postdoctoral Position

In the ERC Synergy Grant Project "ThoriumNuclearClock" at LMU Munich/Germany (together with Fraunhofer ILT/Aachen, Germany)

ThoriumNuclearClock is an ERC Synergy Grant project that started on February 1st 2020, for a duration of 6 years. 4 international research teams (3 experimental: LMU Munich/Germany, PI: P.G. Thirolf, TU Vienna/Austria, PI: T. Schumm, PTB Braunschweig/Germany, PI: E. Peik; 1 theoretical: U Delaware/USA, PI: M. Safronova) join forces to build world's first optical nuclear clock and apply it to fundamental physics studies.

Project background:

Today's most precise time and frequency measurements are performed with optical atomic clocks. However, it has been proposed that they could potentially be outperformed by a nuclear clock, which employs a nuclear transition instead of an atomic shell transition. There is only one known nuclear state that could serve as a nuclear clock using currently available technology, namely, the isomeric first excited state of ^{229}Th. Since more than 40 years nuclear physicists have targeted the identification and characterization of the elusive isomeric ground state transition of ^{229m}Th. Evidence for its existence until recently could only be inferred from indirect measurements, suggesting since 2009 an excitation energy of 7.8(5) eV. Thus the first excited state in ^{229}Th represents the lowest nuclear excitation so far reported in the whole landscape of known isotopes. In 2016, the first direct detection of this nuclear state could be realized via its internal conversion decay branch, laying the foundation for precise studies of its decay parameters [1]. Subsequently, a measurement of the half-life of the neutral isomer was achieved, confirming the expected reduction of 9 orders of magnitude compared to the one of charged ^{229m}Th [2]. Recently, collinear laser spectroscopy was applied to resolve the hyperfine structure of the electronic states of the thorium ion with the nucleus in the isomeric first excited state, providing information on nuclear moments and the charge radius [3]. Most recently, also the cornerstone on the road towards the nuclear clock, which is a more precise and direct determination of the excitation energy of the isomer, could be achieved [4, 5]. Thus major progress on the properties of this elusive nuclear state could be achieved in the last three years, opening the door towards an all-optical control and thus the development of an ultra-precise nuclear clock. Such a nuclear clock promises intriguing applications in applied as well as fundamental physics, ranging from geodesy and seismology to the investigation of possible time variations of fundamental constants.

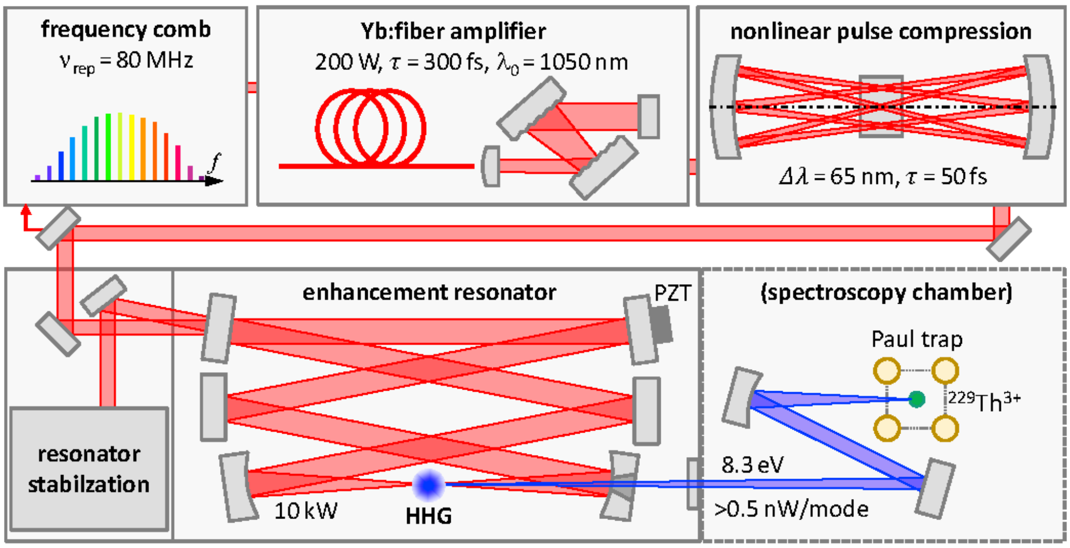
[1] L. v.d. Wense et al., Nature 533, 47-51 (2016).
[2] B. Seiferle, L. v.d. Wense, P.G. Thirolf, Phys. Rev. Lett. 118, 042501 (2017).
[3] J. Thielking et al., Nature 556, 321 (2018).
[4] B. Seiferle, L. v.d. Wense, P.G. Thirolf, Eur. Phys. Jour. A 53, 108, (2017).
[5] B. Seiferle et al., Nature 573, 243 (2019).

Project description:

Supporting the development, setup and commissioning of a VUV frequency comb laser source as driver for the nuclear clock transition in ^{229m}Th

Target of the project is (i) the development, setup and commissioning of a coherent VUV source suitable for the optical excitation of the ^{229}Th nuclear clock transition at Fraunhofer Institute for Laser Technology (ILT) Aachen/Germany and (ii) the transfer of the source to LMU Munich, followed by on-site commissioning and first application in nuclear-clock-related studies.

In order to pursue the research on the ^{229}Th nuclear-clock transition a coherent VUV source is required in a wavelength range covering the expected nuclear transition (around 150 nm, 8.3 eV), in order to determine this energy with high precision by scanning the VUV frequency, and in order to drive the transition for a nuclear clock. For this purpose, a VUV frequency comb is suited, which at the same time covers a large search range with its bandwidth and offers a small linewidth of the comb modes. The excitation requires a large power per comb mode and therefore a large average power in the VUV. This can be reached with a laser system of an IR frequency comb, a high-power femtosecond amplifier, an enhancement resonator and generation of the seventh harmonic in a gas target. This concept is shown in the sketch below.



The laser system will be developed and set up at the Fraunhofer ILT in Aachen. The successful candidate will be fully integrated in the development process for about 2.5 years in Aachen, then he/she will organize the transfer of the laser system to LMU Munich (to the research campus in Garching). Here the candidate will transfer his/her operational know-how to the local team and start up the experimental program with the laser for another ca. 1.5 years.

We seek an experienced laser physicist with a background in the following fields:

- Frequency combs
- High-harmonic generation
- Laser spectroscopy
- Atomic clocks
- Phase noise

If you are highly motivated to work at the forefront of physics and technology in a dynamic and internationally highly visible project and in close collaboration with other leading experimentalists and theorists, then you are encouraged to apply to join our team for the described Postdoctoral Fellow position.

Applications including a list of professional experience and educational history, transcripts of grades, publication list and 2 letters of recommendation should be sent - latest by October 31st - to:

Contact:

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