PHD PROJECT DESCRIPTION
(4000 characters max., including the aims and work plan to de published online)

Project title: Systematic frequency shifts in a strontium optical lattice clock for next-generation timekeeping

1.1. Project goals

Comprehensive evaluation of systematic effects in a strontium optical clock to improve its accuracy and reliability for next-generation timekeeping applications.
The specific objectives are:
- identification and quantification of dominant systematic frequency shifts (e.g. black-body radiation, Zeeman, Stark, and collisional effects),
- development of methods for their evaluation and correction, including a consistent uncertainty budget

1.2. Outline

Optical atomic clocks are the most accurate frequency standards available and play a key role in modern timekeeping. This project focuses on the evaluation of systematic frequency shifts limiting the accuracy of such clocks. It includes the identification and quantitative analysis of dominant physical effects influencing the clock frequency, such as black-body radiation, Zeeman, Stark, and collisional shifts, as well as the development of reliable correction procedures and uncertainty evaluation.

The work is carried out in the context of next-generation timekeeping, including contributions to international clock comparisons and long-term measurement campaigns. Improving the accuracy and consistency of optical clock measurements is an important step in the ongoing roadmap towards the redefinition of the second.

1.3. Work plan

- Introduction to the operation of a strontium optical clock and participation in routine measurements (M1–M12)
- Identification and evaluation of dominant systematic frequency shifts and development of corresponding correction procedures (M6–M30)
- Development of methods for uncertainty evaluation and validation (M12–M36)
- Participation in international clock comparison campaigns, including preparation and analysis of data (M6–M42)
- Final analysis, publications, and writing and defense of the PhD thesis (M36–M48)

1.4. Literature (max. 7 listed as a suggestion for a PhD candidate preliminary study)

Ludlow A.D. et al., Rev. Mod. Phys. 87, 637 (2015),
Riehle F., “Frequency Standards: Basics and Applications”, Wiley-VCH 2005

1.5. Required initial knowledge and skills of the PhD candidate

- The applicant has to have finished a master degree within the last 6 years prior to recruitment in physics or a closely related field
- A strong academic record.
- Experience through coursework and/or a research project in atomic and molecular physics, quantum mechanics up to the second quantization.
- It is highly beneficial if the master thesis has been done in experimental atomic, molecular or optical physic

1.6. Expected development of the PhD candidate's knowledge and skills

Experimental physics, particularly in the field of optical atomic clocks and frequency metrology. This includes:

- optical spectroscopy and atom–light interactions in strontium optical lattice systems
- evaluation of systematic effects and uncertainty analysis in high-precision measurements
- operation of laser systems, optics, and ultra-high vacuum setups
- data analysis, statistical methods, and scientific programming
- experience in international collaboration, data reporting, and participation in precision measurement campaigns