1. PHD PROJECT DESCRIPTION (4000 characters max., including the aims and work plan)

Project title:

QuRIOUS - Quantum Research and Innovation in Optical clocks for Upcoming Scientists
MSCA Doctoral Networks

R10 ESR7 - Superradiant Sr clock with sequential loading

Duration: 36 months,

Objectives:

1. **Active clock based on superradiant lasing of Sr atoms**
   - **Task 1:** Within *the Quantum Flagship project iqClock*, we set up an apparatus for an active optical superradiant clock with sequential loading. The Doctoral Candidate (DC) will finalize the construction of the apparatus, including assembling an in-vacuum superradiant cavity, aligning necessary optics, and preparing ultra-cold Sr atoms in the excited $^3P_0$ state inside a blue-detuned optical lattice co-aligned with the superradiant cavity.
   - **Task 2:** The DC will improve the Nicolaus Copernicus University (UMK) superradiant system with procedure and electronics developed for transportable clocks within *the Quantum Flagship project AQuRA* and the *Euramet project TOCK*. This includes a new open hardware control system based on the **Sinara** and **ARTIQ** ecosystems.
2. **Continuous superradiant lasing**
   - **Task 3**: The DC will test continuous loading of the superradiant cavity from a source based on an optical conveyor belt made of a red-detuned lattice inside a bow-tie power build-up cavity.
   - **Task 4:** The DC will test continuous loading from a source based on a hollow core fibre developed within *the QuantERA project QuantumGuide*.
   - **Task 5:** The DC will compare the performance of the superradiant strontium clock with at least two of the three available passive clock systems: the Sr1 and Sr2 strontium optical clocks operating at UMK, and the AQuRA transportable clock.

Expected Results:

1. ultracold atoms in conveyor belt (M20).
2. ultra-cold Sr atoms in the excited $^3P_0$ state inside a blue-detuned optical lattice (M30).
3. continuous loading of the superradiant cavity from a source based on an optical conveyor belt or a hollow core fibre (M42).

Planned secondment(s):

CNRS-LPL (5M) to perform experiment on the LPL superradiant setup, MEN (V), NKT (V), QUBIG (V)

Required initial knowledge and skills of the PhD candidate

The applicant must apply for a position at Nicolaus Copernicus University in Toruń described under advertisement:
https://www.umk.pl/en/jobs/?task=offer&action=one&id=4811
https://euraxess.ec.europa.eu/jobs/384274

- The applicant has to have finished a master degree within the last 4 years prior to recruitment in physics or a closely related field.
- Candidates can be any nationality, but can not apply for a position in if they have lived in Poland more than 12 months in the last 3 years.
- An excellent academic record.
- Experience through coursework and/or a research project in atomic physics.
- It is highly beneficial if the master thesis has been done in experimental atomic or molecular physic.
- Computer programming skills or electronic engineering skills.