Tytuł projektu

Ultrastabilne wnęki optyczne w KL FAMO dla metrologii i fizyki fundamentalnej

Project title

Ultra-stable optical cavities in KL FAMO for metrology and fundamental physics

Dyscyplina /Area of science

Nauki fizyczne

PROJECT DESCRIPTION

The proposed PhD project consists of two main parts. In the first part two state-of-the-art ultra-stable high-Q cavities will be designed and constructed in The National Laboratory FAMO (KL FAMO) and in the National Laboratory for Photonic & Quantum Technologies (NLPQT). The stabilities of these cavities play the crucial role in the quality of frequency standards based on optical atomic clocks.

Special glass (ULE), from which a cavity is built, has zero thermal expansion for a certain specific temperature, which yields the thermal insensitivity of the cavity length. The properties of ULE glass make this characteristic temperature usually around room temperature (0-30^{o}C) and therefore a cryogenic system is unnecessary. Mechanical stresses and bending of the cavity due to its support points are largely minimized by using the right geometry, which require careful mechanical design and simulations usually made with the FET method.

The environmental conditions around the cavity must be controlled extremely well. The cavity has to be placed in an ultra-high vacuum environment. The temperature stability must be kept under 1 mK and the time constant of the thermal isolation must be on the order of days. The whole vacuum system must be kept in the anti-vibration and noise-suppressing system. With the fractional stability of the cavity length better than 10^{-15}, thermal vibrations of the mirror surfaces start to be the hard limit. Better stability can be achieved either with longer cavities or by using a special crystalline coating of the mirrors.

In the second part of the project the freshly made cavity must be characterised and compared with the cavity that is already operational in KL FAMO. A three-cornered-hat method allows determining the stability and precision of each cavity used in the comparison. After that, the cavities will be used in new experiments performed in KL FAMO, in particular in detecting gravitational fields in the laboratory or in detecting coupling between standard model fields and scalar model Higgs fields as well as topological defects in these scalar fields that are one of the candidates for components of the dark matter.

Required initial knowledge and skills of the PhD candidate

- ➔ An excellent academic record
- ➔ Experience through coursework and/or a research project in atomic physics.

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