Contribution ID: **73** Type: **On-site planned, but remote also possible**

Designing nanomechanical resonators for high-frequency gravitational wave detection

Background

The levitated sensor detector is a novel kind of gravitational wave detector targeting signals in the frequency range of 10 −300 kHz [1,2]. It comprises a dielectric disk trapped by the light field inside an optical cavity. A passing gravitational wave displaces the disk from its equilibrium position (i.e., the antinode of the trapping field), which results in a restoring force. This interaction is resonantly enhanced if the frequency of the gravitational matches the frequency of the optical trap. An additional probe field is used for measuring the disk's motion via phase modulation. As a complementary approach, we investigate a similar setup comprising a "partially-levitated"membrane instead of a "fully-levitated"disk. A goal of this approach is to enable using a cavity end mirror compatible with current technology, by virtue of the design flexibility for the membrane.

Tasks

- Simulate mechanical resonance frequency and Q factor of a membrane in COMSOL (with and without optical trap)
- Identify optimal designs by systematic variation of design parameters
- Carry out supporting data analysis in Python, Matlab, or similar
- Take part in the experimental characterization of mechanical membrane resonators (if the pandemic situation permits it)
- Bonus: investigate advanced approaches for design optimization (e.g., topology optimization, Bayesian optimization/machine learning)

References

[1] Arvanitaki, Asimina, and Andrew A. Geraci. "Detecting high-frequency gravitational waves with optically levitated sensors." Physical review letters 110.7 (2013): 071105

[2] Aggarwal, Nancy, et al. "Searching for new physics with a levitated-sensor-based gravitational-wave detector." arXiv preprint arXiv:2010.13157 (2020)

Field

B3: Development of experimental particle physics equipment (hardware-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

ALPS

Special Qualifications:

Primary authors: LINDNER, Axel (ALPS (ALPS _ Any Light Particle Search)); SINGH, Udai Raj (ALPS (ALPS _ Any Light Particle Search)); REINHARDT, Christoph (ALPS (ALPS _ Any Light Particle Search))