TT 30: Nanomechanical systems (joint session HL/TT)

The session covers the physics of nanomechanical systems.

Time: Wednesday 15:00–15:45 Location: H17

TT 30.1 Wed 15:00 H17

Optimizing an Integrated Photonic Racetrack Resonator for Optomechanical Synchronization — •Agnes Zinth[1] and Menno Poot[1,2,3] — [1]Department of Physics, TUM School of Natural Sciences, Technical University of Munich, Garching, Germany — [2]Munich Center for Quantum Science and Technology (MCQST), Munich, Germany — [3]Institute for Advanced Study, Technical University of Munich, Garching, Germany

In the field of optomechanics, synchronization will be an essential tool in fields like sensing and quantum technologies. Towards this goal, we develop a photonic integrated optomechanical device consisting of a silicon nitride racetrack cavity with partly suspended waveguide that can vibrate freely. A second beam is added to improve the optomechanical coupling. The observed mechanical modes do not match in frequency, so we use a predisplaced beam instead [1]. The remaining frequency distance can be tuned by the laser power. As the light propagates in the predisplaced beam and only past the PhC beam, it shifts further than the photonic crystal one due to thermal effects. To synchronize them with optomechanical backaction, we also need to enhance the optical cavity. Therefore, we modify the transition from supported to suspended parts. Two different approaches lead to the desired improved optical quality. Currently, we are investigating their impact on the mechanics. We believe that, in the next generation of devices, we can synchronize the racetrack and photonic crystal beam.

[1] Geometric tuning of stress in predisplaced silicon nitride resonators. Nano Letters, 22(10), 4013-4019.

TT 30.2 Wed 15:15 H17

Quantum Mechanics in Two-Dimensional Dynamic Spaces — •Benjamin Schwager and Jamal Berakdar — Martin-Luther-Universität Halle-Wittenberg, Halle (Saale), Germany

In the study of systems with reduced dimensions one encounters quantum particles under spatial constraints. Their dynamics have to be modeled based on a configuration space that is a Riemannian manifold, in general, and the resulting quantum wave equations contain correction terms in dependence of its geometric properties. We consider particles which are confined to a flexible thin material shell by studying the Schrödinger equation on moving domains. The model assumes a static observer and couples the deformation dynamics of the material to the quantum dynamics it hosts via additional potential fields. Effects caused by the interplay of geometry and the temporal evolution of the underlying configuration space will be discussed.

TT 30.3 Wed 15:30 H17

Towards cavity optomechanics using 2D materials — •Petricia Sara Peter[1,2], Lukas Schleicher[1,2], Anne Rodriguez[1,2], Leonard Geilen[2,3], Alexander Musta[2,3], Benedict Brouwer[2,3], Alexander Holleitner[2,3], and Eva Weig[1,2] — [1]Chair of Nano and Quantum Sensors, TU Munich, Germany — [2]Munich Center for Quantum Science and Technology (MCQST), Munich, Germany — [3]Walter Schottky Institute, TU Munich, Germany

Two-dimensional (2D) materials, such as hexagonal boron nitride (hBN), are promising candidates for advancing cavity optomechanics due to their low mass, high mechanical strength, and unique optical properties. This work focuses on the fabrication of freely suspended hBN membranes on silicon oxide (SiO_2) and silicon nitride (Si_3N_3) substrates, utilizing a water-assisted wet transfer technique. Compared to the dry transfer method, this approach minimizes inhomogeneous stress and preserves optimal mode shapes, improving mechanical quality factors. A Michelson interferometer is used to measure the mechanical properties of the resulting drumhead resonators, including vibrational resonances, mode shapes, and quality factors. These results provide important insights into the performance and quality of the resonator, laying the groundwork for incorporating 2D materials into cavity optomechanical studies.