IQLEV NEWSLETTER MAR. 2022 | VOL. 2

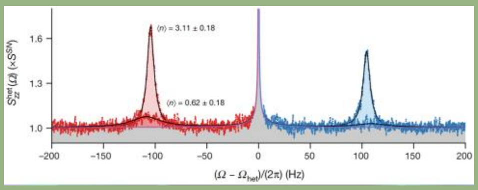
Levitated Particle Meets Inertial Sensor

From theory to experiment, researchers from iQLev made progresses towards inertial sensors based on levitated particles

The 'Coolest' Particle

Aspelmeyer Group, Uni Wien

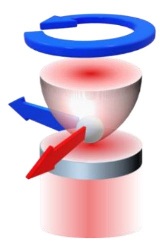
Uni Wien has implemented real-time optimal control of the quantum trajectory of an optically trapped nanoparticle. Confocal position sensing close to the Heisenberg limit is combined with optimal state estimation via Kalman filtering. This allows to track the particle in real time with a position uncertainty of 1.3 times ground state extension of its wavefunction. Optimal feedback allows us to realize quantum ground state cooling from room temperature.



The results establish quantum Kalman filtering as a method to achieve quantum control of mechanical motion. An immediate application is mechanical sensing of weak stationary or transient forces as we can discriminate momentum kicks to the particle as small as Δp = 1.6 × 10−23 kg m/s (29 keV/c), only a factor 1.2 away from the fundamental quantum limit for continuous sensing. This is smaller than the momentum kick by almost 10% of the surrounding gas molecules at room temperature.

Let's Rotate !

Photonics Laboratory, ETH Zurich

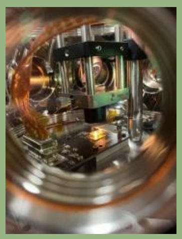


Inspired by the MEMS gyroscopes, the team from the photonics laboratory at ETH Zurich are building prototypes of gyroscope based on optically levitated micro-particle.

The mechanism for rotation detection is based on either amplitude transfer between the two axes of the particle's motion, or the orientation changes of a levitated nano-dumbbell.

Levitation on Chip

Nanophotonic Systems Laboratory ETH Zurich



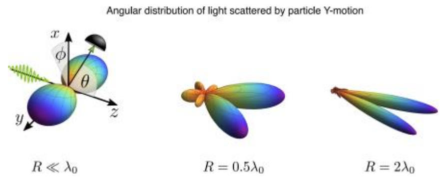
For sensors used in different environments, it is generally of advantage to have a compact and robust sensor.

In the Nanophotonic Systems Laboratory at ETH, we realize levitation and control of a nano-particle on a chip. This reduces the complexity and size of standard levitation platforms and is the first step towards levitation sensors outside the laboratory.

With an Optimal 'Eye'

Romero-Isart Group, Uni Innsbruck

The team at the University of Innsbruck has developed a quantum theory describing the interaction of light with dielectric particles of arbitrary size. The results enable to optimize techniques of collecting information about particle motion, as well as explore quantum-enhanced sensing with larger particles.



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