A Novel Concept to Mechanically Detect Tiny Bio-Magnetic Fields in the fT-Regime

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Tracking frequency changes of high-Q mechanical resonators can be employed to detect very small signals. Since all the set-ups presented in this talk operate at low temperature and use an all-fiber interferometric detection scheme, I will shortly explain our main design concepts and how we are able to adjust the interferometer with pm-precision in a cryogenic vacuum environment while keeping the system as rigid as possible.

Thereafter, I present three examples demonstrating the general versatility of this approach: (i) atomic resolution using an atomic force microscopy set-up, (ii) a hybrid-quantum system set-up and (iii) hybrid magnetometer set-up. I will explain the latter set-up in much greater detail as it is an innovative and very scalable approach to detecting small magnetic fields.

Basically, the hybrid-magnetometer device comprises a superconducting pick-up loop with a constriction that acts as a field-to-gradient converter and a magnetically sensitive high-Q mechanical resonator placed above the constriction. Proof-of-concept measurements demonstrate the feasibility of this approach. By optimizing the constriction-resonator geometry, the signal-to-noise ratio can be increased dramatically, and thus the magnetometer can be expected to achieve the fT sensitivity required to localize centers of brain activity in a non-invasive magnetoencephalography (MEG) set-up.