Quantum-enhanced fiber-optic inertial sensors

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Quantum technologies have gained significant attention as a way to improve the performance of measurements aimed at metrological tasks. For instance, the achievable accuracy through interferometric measurements with classical schemes can be in principle surpassed by quantum-optics methods, e.g. using squeezed states or entangled photons, pointing to the so-called Heisenberg limit. While progress has been made with trapped atoms and standard optical interferometers, less attention has been given to the quantum advantage in measuring the phase shift caused by accelerations or rotations with fiber-optic sensors. In addition to various technical noise sources that basically hamper the achievable performance of fiber systems, a fundamental limitation come from the quantum fluctuations related to photon detection. Here, fiber-optic sensors with different interrogation schemes are presented for measurements of strain, acceleration, vibration and rotation. Their conventional readout based on classical light sources and their intrinsic limitations are discussed with regard to on-going experiments. Potential improvements deriving from quantum-interferometry methods using non-classical light sources and/or non-linear optical techniques in combination with fiber-optic resonators are considered and quantified in view of possible applications

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