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Quantum-enabled optical large-baseline interferometry: applications, protocols and feasibility

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Optical Very Long Baseline Interferometry offers the potential for unprecedented angular resolution in both astronomical imaging and precision measurements. Classical approaches, however, face significant limitations due to photon loss, background noise, and the requirements for dynamical delay lines over large distances.

We surveys recent developments in quantum-enabled VLBI, which aim to address these challenges using entanglement-assisted protocols, quantum memory storage, and nonlocal measurement techniques. While its application to astronomy is well known, we also examine how these techniques may be extended to geodesy – specifically, the monitoring of Earth's rotation.

Particular attention is given to quantum-enhanced telescope architectures, including repeater-based long-baseline interferometry and quantum error-corrected encoding schemes, which offer a pathway toward high-fidelity optical VLBI.
To aid the discussion, we also compare specifications for key enabling technologies to current state-of-the-art experimental components, including switching rates, gate times, entanglement distribution rates, and memory lifetimes.

By integrating quantum technologies, future interferometric networks may achieve diffraction-limited imaging at optical and near-infrared wavelengths, surpassing the constraints of classical techniques and enabling new precision tests of astrophysical and fundamental physics phenomena.

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