Quantum enhanced Target Ranging

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We analyze the Quantum Target Ranging task in the context of multi-hypothesis testing and its applicability to real-world LiDAR systems. We find the theoretical bounds and the advantages of quantum ranging (see Fig. 1a) in presence of background considering time-of-flight measurements, the operational mode of most LiDAR systems. Moreover, we focus on the covert scenario, in which the sensing is performed while avoiding detection from an adversary (see Fig.1b). Interestingly, we discover that against a technologically evolved adversary, covertness is only possible with a quantum probe state constrained by a low mean number of photons, while classical transmitter fails to ensure covertness. We realize an experimental demonstration of the protocol exploiting commercial sources of photon pairs @telecom wavelength and superconducting nanowire single photon detectors in a tree configuration. We demonstrate a large quantum advantage with respect to a conventional approach that uses short-pulsed laser at the same power.

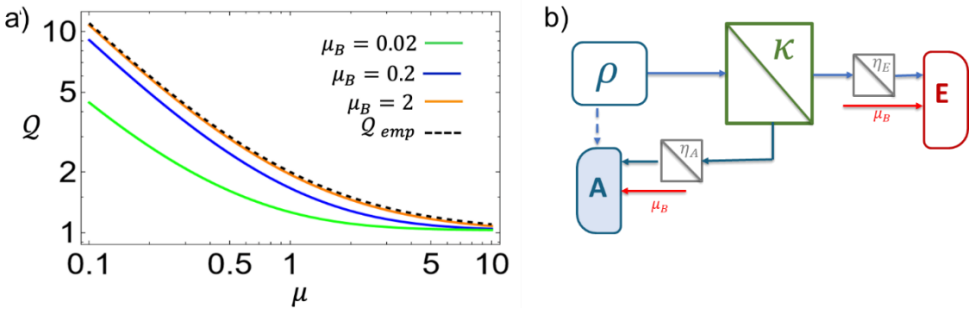

Fig. 1: *a) quantum advantage, Q, in the Target Ranging task in function of the mean photon number, μ, of the probe. The μ_B is the mean background photon number, and Q_{emp} is limit for large μ_B. b) The scheme of covert sensing: Alice (A) send a mode of a state ρ to the target with reflectivity k for the target sensing. The photons which are not reflected back to the Alice receiver, are supposed under the control of an adversary, Eve (E), aiming to detect Alice.*

Our results represent a new perspective on optical quantum sensing and provide strong motivation for the development of quantum LiDAR.

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References

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