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Classical and quantum bounds for remote optical sensing[1]
ZACHARY DUTTON, BBN Technologies, Cambridge, MA, JOHN MYERS, School of Engineering & Applied Sciences, Harvard University — We investigate resolution in a remote sensing laser radar system and map out the limits of classical versus quantum enhanced sensing. We here define resolution to be the ability to distinguish between two targets using binary hypothesis decision theory. In particular we derive the optical quantum limit of this resolution given reception of a coherent state. For targets with well defined phase, we find the minimum resolvable target separation scales with signal-to-noise (SNR) as $\mathrm{SNR}^{-1/2}$. This scaling matches homodyne and heterodyne detection methods, though with a different front factor. It also beats direct photon detection, which is found to scale as $\mathrm{SNR}^{-1/4}$. We then go on to compare with cases where the targets exhibit random and unknown phase fluctuations (speckle).

[1]DARPA Quantum Sensors Program

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