Quantum Stroboscope: A Note on Quantum Illumination of Moving Targets

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Abstract

In this note the authors consider quantum illumination when the object is in motion. They focus on the special case of periodic motion.

In traditional quantum illumination, the object to be illuminated is at rest. What might be the requirements on the protocol when the object is in motion? For instance, one can consider periodic motion of the object and wish to capture "stationary" snapshots of it when it is at the same location repeatedly. This is known as stroboscopic [1] photography. In [2] the author mentions the number of trials required to decide on the presence of an object with and without entanglement. In each trial a photon is sent at the object. Suppose the interval between successive trials is known. Then we can estimate the number of seconds t required to decide on the presence of an object. Assume the object retains a single position in its orbit during this time. Let the period of the orbit be T. Thus after $T + t$ seconds, the orbit will return to the initial position and stay there for t seconds. This would go on repeatedly. Since t is shorter with quantum entanglement [2], the effective period is shorter with entanglement and so the frequency permissible is higher. Thus quantum illumination with entanglement permits stroboscopic studies where the object's periodic motion is at a higher frequency as compared with normal illumination without entanglement. This could be relevant in quantum optomechanics which is used in gravitational wave detectors.

References

[1] Austin J O-Leary. A simple stroboscope. *JOSA*, 25(11):375–380, 1935.

[2] Seth Lloyd. Enhanced sensitivity of photodetection via quantum illumination. *Science*, 321(5895):1463–1465, 2008.