Comparing amplitude-based and phase-based quantum plasmonic biosensing

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ABSTRACT

The utilization of quantum resources can enhance the sensitivity of conventional measurement techniques beyond the standard quantum limit (SQL). The objective of quantum metrology is to enable such quantum enhancements in practical devices. To achieve this objective, it is essential to have devices that are compatible with existing quantum resources operating within the SQL. Plasmonic sensors are promising candidates among these devices since they are extensively employed in biochemical sensing applications. Plasmonic sensors exhibit a response to slight variations in the local refractive index, which manifests as a shift in their resonance response. This shift, in turn, induces changes in the amplitude and phase of the probing light. By utilizing quantum states of light, such as NOON states, squeezed states, or Fock states, to probe these sensors, the measurement noise floor can be lowered, enabling the detection of signals below the SQL. In this study, we compare two configurations of quantum plasmonic sensing: phase-based and amplitude-based. By considering the Quantum Cramér Rao bound for both configurations, we demonstrate that the phase-based configuration can more effectively exploit the available quantum resources than the amplitude-based configuration. A limitation of this work is that it did not consider loss.

Keywords: Quantum biosensing, plasmonic, coherent state, NOON.