Quantum sensors enable low-noise photon sensitivity “beyond the standard quantum limit”.

This measurement technique represents a novel application of quantum information technology to the field of particle physics. It has the potential to enhance axion search speeds by four orders of magnitude while enabling sensitivity to weak axion-photon coupling models.

Current Work

Quantum non-demolition (QND) techniques allow repeated measurement of Fock states, to arbitrary precision.

Even amplifiers operating at the quantum limit can be too noisy for efficient axion detection. Phase-preserving linear amplifiers simultaneously measure the occupation number and phase of a system, and these parameters have a nonzero commutator; they cannot be measured simultaneously to arbitrary precision. In a QND experiment, the phase of a photon state is randomized at every measurement so that amplitude (i.e. photon number) can be measured repeatedly and with high precision.

Background Suppression

false-positive rates for transmon qubits are ~ 1%.

Several qubits, all measuring the same photon state, can reduce this rate. For N qubits: \( p_{err} \rightarrow (0.01)^N \)