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Photon detection based on microwave-optical quantum transducer

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Photon detection at radio frequencies (RF) plays an essential role in high-energy physics such as dark matter search. The detection of weak signal converted from dark matter in the presence of excess quantum and classical noise can be achieved by exploiting high-quality superconducting RF cavities in the presence of strong magnetic field. However, this is a nontrivial detection problem due to the weak energy of microwave photons and their vulnerability to thermal noise. One can gain advantage in sensing performance if the RF photons can be converted to high frequencies with larger energy and robustness against thermal noise. Quantum transduction, which faithfully converts photons from microwave to optical frequencies, has opened new horizons for quantum detection of weak RF signals. Here we propose and introduce a quantum-transduction-based on a three-dimensional electro-optic cavity system. The transducer enables high conversion efficiency between microwave and optical frequencies at low thermal noise condition. We also discuss the dark matter detection scheme in the presence of magnetic field based on our transducer. The proposed detection scheme can bring advantage to the sensor's performance by leveraging photon counting at optical bands.

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