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Single-Photon Detection for Axion Haloscopes with RAY

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Single-photon readout is a compelling technique for the next generation of dark matter haloscope experiments; it would entirely eliminate the quantum measurement noise seen in linear amplifier readout. The Rydberg/Axions at Yale (RAY) collaboration is developing single-photon detectors based on Rydberg atoms, highly-excited atomic states with exquisite sensitivity to electric fields. These detectors can be used for axion dark matter searches between $40 \mu\text{eV}$ and $200 \mu\text{eV}$ (10 GHz and 50 GHz) and would be compatible with a wide variety of haloscope cavity designs. I will present our recent work (Phys. Rev. D 109, 032009) detailing our single-photon detector concept and its potential to offer scan rate enhancements up to a factor of 10^4 over traditional linear amplifier readout. I will also share updates on our progress towards building a proof-of-principle Rydberg atom single-photon detector.

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