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Atom-Based Electric Field Sensing

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We have shown that Rydberg atoms can be used for high-sensitivity, absolute sensing of high frequency electric fields. We have achieved high sensitivity using several different read-out strategies. These methods demonstrated read-out laser shot-noise limited performance. Fundamental limits to the sensitivity of the Rydberg atom-based RF electric field sensing have been addressed. Depending on the spectral resolution of the read-out, either the RF induced transmission line frequency splitting, the Autler-Townes regime, or a change in the on-resonant absorption, the amplitude regime, can be used to determine the RF electric field. In this paper we address some practical improvements to these methods. We present theoretical results of a 3-photon read-out scheme which enables the Autler-Townes regime of Rydberg atom-based RF electrometry to be extended to lower RF electric field strengths. We show experimentally that the residual Doppler shifts can be reduced and signal strengths increased using the approach. We also address implementing this strategy using small subwavelength vapor cells that we have constructed, which have extremely low scattering cross-sections and uniform fields in the measurement region. Imaging of electromagnetic fields at high data rates with the capacity to implement signal processing protocols not available using standard cameras will be described.