# Rydberg Atomic Vector Electrometer (RAVE) for Static Electric Fields

I Novikova[1], R Behary[1], W Torg[1], E E Mikhailov[1], and S A Aubin[1]

[1]*Physics, College of William and Mary, Williamsburg VA, USA*
Contact Email: inovikova@physics.wm.edu

Full vector information about local electric field distribution is required to reconstruct charge density. The magnitude of the electric field can be measured using quadratic Stark shifts of highly excited Rydberg states by monitoring the exact frequency of Electromagnetically Induced Transparency (EIT) resonances. However, these resonances may also help to determine the direction of the electric field. Relative amplitudes of EIT resonances depend on the relative orientation between the laser polarization and the external electric field vectors due to selection rules in various geometries. We experimentally study variations in the amplitude of the Stark-split EIT resonances and identify viable approaches for electric field direction detection. We also present a simplified semi-analytical model that closely resembles the experimental observations.

We apply these models to reconstruct spatially inhomogeneous electric field, produced by a biased conducting wire. For these measurements we rely on EIT fluorescence measurements to obtain 2D spatial resolution. Our measurements agree with the expected angular dependencies quite well, given experimental uncertainty. These results suggest that simultaneous analysis of frequency shifts and amplitudes of Rydberg EIT resonances may enable vector electrometry of electrostatic fields, necessary for many quantum sensing applications.