Abstract Submitted
for the DAMOP20 Meeting of
The American Physical Society

Investigation of Five-Level Excitation Schemes for Rydberg Atom-based Radio Frequency Field Metrology AMY ROBINSON, University of Colorado, Boulder, MATTHEW SIMONS, CHRISTOPHER HOLLOWAY, National Institute of Standards and Technology, GEORG RAITHEL, University of Michigan, Dept. of Physics — Electromagnetically-induced transparency (EIT) techniques have been used to successfully detect and characterize radio frequency (RF) fields. This approach typically uses a four-level excitation scheme, which include a probe laser (levels $|1\rangle \rightarrow |2\rangle$), a coupling laser to Rydberg states ($|2\rangle \rightarrow |3\rangle$), and an RF source to couple two Rydberg states ($|3\rangle \rightarrow |4\rangle$). In this talk we explore five-level excitation schemes. In the first scheme we add a fifth level, which is another Rydberg state, that is coupled by a second RF source ($|4\rangle \rightarrow |5\rangle$). The second scheme is a five-level "Y" scheme, which includes two ground state transitions, $|1\rangle \rightarrow |2\rangle$ ($5S_{1/2,F=3} \rightarrow 5P_{3/2,F=3}$), and $|3\rangle \rightarrow |2\rangle$ ($5S_{1/2,F=2} \rightarrow 5P_{3/2,F=3}$). A coupling laser generates Rydberg states ($|2\rangle \rightarrow |4\rangle$), and RF couples two Rydberg states ($|4\rangle \rightarrow |5\rangle$). We show experimental results for the two different 5-level schemes and discuss novel features observed in the spectra of these five-level schemes. We describe their dependence on frequency detuning and power variations, and compare with theoretical models.

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Date submitted: 03 Feb 2020 Electronic form version 1.4