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Rydberg Atom-Based Mixer for RF Phase Detection MATTHEW SIMONS, University of Colorado / NIST Boulder, ABDULAZIZ HADDAB, University of Colorado, JOSHUA GORDON, CHRISTOPHER HOLLOWAY, National Institute of Standards and Technology Boulder — Rydberg atoms have been shown to be effective tools for radio frequency (RF) electric (E) field measurements. Thus far, they have been used to accurately measure RF E-field amplitude and polarization. In this work, we demonstrate the last piece of the puzzle: RF phase measurements. Typical atom-based RF measurements monitor use electromagnetically-induced transparency (EIT) in an alkali vapor, where the coupling laser is tuned to a Rydberg state. Information about an incident RF field can be extracted from the change in probe laser transmission. The presence of a second, 'local-oscillator' RF field tuned to a Rydberg transition frequency creates a beat note with the incident RF field, that can be demodulated by the Rydberg atoms. The phase of the beat note is directly related to the phase difference between the local oscillator and incident RF fields. The atoms act as a natural mixer, demodulating an RF field resulting in a lower-frequency signal. This demonstrates the potential of atom-based RF technology for near-field RF metrology, radar, and communications applications. We used this method to measure the propagation constant for a plane-wave to within 1 % compared to the theoretical value.

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