Directional THz generation in hot Rb vapor excited to a Rydberg state

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We experimentally observe the generation of terahertz (THz) beams at 3.3 THz and 7.8 THz by optically exciting a hot Rubidium vapor to a low-lying Rydberg state $10D_{5/2}$ [1]. Directional THz radiation is created from population inversion between Rydberg states, followed by amplified spontaneous emission (ASE), i.e., amplification via stimulated emission in free space. The presence of THz radiation was previously inferred from the observed UV light generated by four-wave mixing [2]. In our current experiment, generated THz fields are detected directly, which is achieved by a custom-built vacuum cell with a silicon window that transmits THz radiation. We characterize the generated THz power over the detuning and power of pump lasers, and identify experimental conditions favoring THz and UV generation, respectively. We find that the generated THz power is of the order of several μW for moderate pump laser powers achievable with compact diode lasers. The observed THz generation may be used for developing Rydberg-atom-based THz electrometry and THz imaging and for producing high-power narrow-band THz radiation via further amplification.

[1] Mark Lam, Sambit B. Pal, Thibault Vogt, Martin Kiffner, and Wenhui Li, Directional THz generation in hot Rb vapor excited to a Rydberg state, arXiv:2012.15449 (2020).
[2] Mark Lam, Sambit B. Pal, Thibault Vogt, Christian Gross, Martin Kiffner, and Wenhui Li, Collimated UV light generation by two-photon excitation to a Rydberg state in Rb vapor, Opt. Lett. **44**, 2931 (2019).