Rydberg excitation efficiency in nitric oxide using a three photon excitation scheme for a trace gas sensor

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At the beginning of the 1990s it was known, that nitric oxide (NO) plays an important role as a signaling molecule in the mammalian system, and a change of its concentration in the exhaled breath may indicate certain diseases [1, 2]. We showed in a proof–of–concept experiment the operation of a NO trace–gas sensor at ambient pressure [3] at a concentration of 10 ppb. At this point we are optimizing the efficiency and sensitivity of our experimental setup. We already resolved the hyperfine structure of the ground state transition $\mathrm{A}\,^2\Sigma^+ \leftarrow \mathrm{X}\,^2\Pi_{3/2}$[4].

Our detection principle is based on the electronic amplification of a current generated by free charges resulting from collisions of NO molecules in a Rydberg state with background particles. For the excitation we use continuous–wave (cw) laser systems for the transitions

$$nl(N^+)\ \mathrm{X}^{+\,1}\Sigma^+ \leftarrow \mathrm{H}\,^2\Sigma^+ \leftarrow \mathrm{A}\,^2\Sigma^+ \leftarrow \mathrm{X}\,^2\Pi_{3/2} \qquad ,$$

which are at about $226\,\mathrm{nm}$, $540\,\mathrm{nm}$ and $835\,\mathrm{nm}$, respectively.

We report on the collisional shift and line broadening of Rydberg states in nitric oxide (NO) with increasing density of a background gas at room temperature [5]. As a background gas we either use NO itself or nitrogen (N_2) and identify pressures for an optimal operation of our sensor.

We also show Stark shift measurements to investigate optimized electric fields for our NO detection.

References

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