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Lasing in the nitrogen molecular ion

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Lasing in the nitrogen molecular ion
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Intense light-matter interaction beyond a unimolecular limit faces unique challenges. In this regime, light and matter both have a non-negligible effect on each other. It is in this complex environment that lasing has been discovered on a nitrogen molecular ion transition [1].
We investigate the gain dynamics in nitrogen ions created from a neutral gas by an intense ultrashort laser pulse. To isolate the phenomenon, we use a one atmosphere pure-nitrogen 200 μm thick gas jet in a vacuum chamber. The gain is initiated by an 800 nm pump pulse with intensity in the range of 2-4 x10ˆ14 W/cmˆ2 and pulse duration of 27 fs. A weak second harmonic probe pulse monitors the time dependence of the gain on the B (v=0) to X (v=0) transition.
We observe a peak gain of approximately 2 over a distance of about 200 μm and we measure gain as a function of nitrogen concentration, density, and intensity of the pump and probe. While the gain is present immediately (i.e. within the duration of the 27 femtosecond pump pulse) we observe two time-scales of decay: population inversion decay and rotational wave packet decay.

[1] see for example, G. Point, Y. Liu, Y. Brelet, S. Mitryukovskiy, P. Ding, A. Houard, and A. Mysyrowicz, "Lasing of ambient air with microjoule pulse energy pumped by a multi-terawatt infrared femtosecond laser" , OPTICS LETTERS, 29, 1725, (2014)

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