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The ro-vibrational 'conveyor belt' for all-optical lasing during laser filamentation in Nitrogen MISHA IVANOV, Max Born Institute Berlin, MARIA RICHTER, Universidad Autonoma de Madrid, FELIPE MORALES, OLGA SMIRNOVA, Max Born Institute Berlin — Inducing and controlling lasing in the open air is an intriguing challenge. Recent experiments on laser filamentation in the air have demonstrated generation of population inversion and lasing on the 391 nm line in the nitrogen ion, which corresponds to the transition between its second excited $B^2\Sigma_u^+$ and the ground $X^2\Sigma_g^+$ electronic states. Importantly, lasing at this transition appears to be a very general effect, arising during filamentation of virtually any incident radiation, from visible to mid-infrared. We analyze the possible mechanisms that can be responsible for the generation of the population inversion between the $B^2\Sigma_u^+$ and $X^2\Sigma_g^+$ states of N_2^+, focusing on the interplay between tunnel ionization of neutral nitrogen to different electronic states, ultrafast laser driven electronic excitations in the ion, molecular vibrations, laser induced alignment and rotations. We show how the strong laser field creates a ro-vibrational 'conveyor belt' carrying the population away from the ground electronic state $X^2\Sigma_g^+$ and enabling population inversion in $B^2\Sigma_u^+$. We show that this mechanism is robust with respect to the incident laser wavelength, and analyze its optimization with respect to the fundamental wavelength and pulse duration.

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