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Rotational Quantum Beat Lasing Without Inversion MARIA RICHTER, Max-Born-Institute Berlin, MARIANNA LYTOVA, Physics Dept., University of Ottawa, FELIPE MORALES, Max-Born-Institute Berlin, STEFAN HAESSLER, Laboratoire d'Optique Appliquee, CNRS, Ecole Polytechnique, ENSTA Paris, Institut Polytechnique de Paris, OLGA SMIRNOVA, Max-Born-Institute Berlin, MICHAEL SPANNER, Physics Dept., University of Ottawa, MISHA IVANOV, Max-Born-Institute Berlin — In standard lasers, light amplification requires population inversion between an upper and a lower state to break the reciprocity between absorption and stimulated emission. But, in a medium prepared in a specific superposition state, quantum interference may fully suppress absorption while leaving stimulated emission intact, opening the possibility of lasing without inversion (LWI). Conventional LWI schemes generally strive to maintain a specific phase relationship between the lower-lying states that carry most of the population. We will present a scheme that does not follow this tradition. It uses only the natural dynamics of a multi-level quantum system and requires no coherence between the excited and the lower electronic states; effectively, LWI comes "for free". We will show that this mechanism is active in the highly efficient generation of 391 nm radiation during propagation of intense femtosecond laser pulses in air, under standard conditions where the process known as "laser filamentation" leads to self-guiding of light. Identifying the mechanism responsible for this "air lasing" effect has been a long-standing puzzle. We show how it arises naturally; triggered by the combination of molecular ionization and molecular alignment, both unavoidable in intense light fields.

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