OPTICALLY-PUMPED AMMONIA TERAHERTZ LASER UP TO 5.5 THz

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Optically-pumped molecular THz lasers are powerful and versatile sources. We have demonstrated a continuous wave molecular laser emission based on ammonia (NH_3) optically pumped by a quantum cascade laser at about 1 THz [a]. The purpose of this work is to investigate NH_3 laser transitions at higher frequencies. This molecule is pumped by the pump laser from the ground state to the $v_2 = 1$ vibrational state. Within the excited state, two types of THz transitions can occur in this molecule: pure inversion transitions and rotation-inversion transitions. Inversion motion is a particular quantum phenomenon of the NH_3 molecule that splits the energy levels: the N atom is able to tunnel through the potential barrier formed by the three H triangle. The inversion splitting is about 1 THz in the $v_2 = 1$ state but rotation-inversion transitions can be used to generate higher frequencies. The investigation of molecular laser shows a lack of available databases of potentially lasing transitions for users to exploit. We propose a molecule dependent figure of merit which enables to discriminate potentially lasing transitions by their lasing potential. We report here its use to predict lasing lines of ammonia. The demonstration of its pertinence is made by observing 32 lasing lines of $^{14}NH_3$ and 5 lines of $^{15}NH_3$ up to 5.5 THz.
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[a] A. Pagies, G. Ducournau, and J.-F. Lampin, "Low-threshold terahertz molecular laser optically pumped by a quantum cascade laser," APL Photonics, vol. 1, 031302, 2016.