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A semi-classical theory of backscattering in Coherent anti-Stokes Raman Spectroscopy for remote detection[1] JABIR CHATHANATHIL, GENGYUAN LIU, Stevens Institute of Technology, FRANK NARDUCCI, Naval Postgraduate School, SVETLANA MALINOVSKAYA, Stevens Institute of Technology — We develop the theoretical framework for the detection of hazardous molecules in the atmosphere 1 km away from the source using CARS (Coherent anti-Stokes Raman Spectroscopy) taking methanol as a prototype. The Maxwell-Liouville-von Neumann equations for chirped pulses of pump, Stokes, probe and anti-Stokes are derived for CARS scattering. A multilayer model of target molecule distribution with variable width is introduced considering the density distribution of molecules as Gaussian. The propagation of transform-limited pulses with pulse duration of 100 femtoseconds in the air is investigated and incorporated with the target molecule distribution considering the effects of scattering and absorption. The anti-Stokes pulses are significantly amplified to provide a detectable backscattered signal transferring energy from pump and probe pulses. The correlation of anti-Stokes amplification with coherence and population dynamics is examined and the effect of decoherence is studied. The conservation of energy and population during each scattering is verified for the model. The possibility of using deep learning to understand the phase changes of chirped pulses in the scattering process is investigated in order to further enhance the pulse intensity.

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