Doppler effect in the slow pulse propagation and distortion through FWM medium

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Most of the work on pulse propagation in alkali vapors is for FWM parameters that ensure preservation of Gaussian-like pulse at the exit from the vapor. Here we extended the range of parameters to include conditions when twin pulses in FWM medium begin to depart from Gaussian, to distort and split. Calculated pulse waveforms were compared with the experimental results for the propagation of 80 ns probe pulse through the potassium vapor contained in 4 cm K cell. The FWM was established using non-degenerate, non-resonant double Λ configuration.

We used Maxwell-Bloch equations to model FWM. For its atomic part we formed several Optical Bloch equations. Equations governing the electrical fields of beams are derived from Maxwell equations in slowly varying envelope approximation for plane waves.

Calculated waveforms of twin beams agree with the experimental results for the large range of FWM parameters that include cases when pulses are distorted and split, only with a proper Doppler averaging on density matrix elements. Since the extra-large number of velocity classes for Doppler averaging present a big computational burden, we have a good agreement with a relatively small number of velocity classes with nonuniform widths, the narrowest are around the pump detuning or around the maximum gains of probe and conjugate, depending on one-photon detuning.

Results of twin beam propagation through the K vapor in off-resonant FWM, will be given for one-photon detuning in the range of 0.7 to 1.5 GHz, two-photon detuning in the range od ± 20 MHz, and vapor temperatures between 120 C and 150 C. The possible causes for pulse distortion at certain FWM parameters will be discussed.