Fast Light, Slow Light, and Optical Precursors in Cold Atoms

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THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY COLLABORATION — We report experimental observations of optical precursors generated from a square-modulated probe laser pulse, with finite rise and fall time, propagating through a cold atomic ensemble, in either a two-level Lorentz absorber or a three-level system with electromagnetically induced transparency (EIT). Because of the finite rise (fall) time, the precursor signal decreases as we increase the optical depth ($\alpha_0L$). We find that the absorption of the precursor peak magnitude can be controlled by varying the rise (fall) time. At $\alpha_0L = 42$, we increase the precursor peak transmission from 8% to 27% by shortening the rise (fall) time from 7 ns to 3 ns. Meanwhile, we observe no violation to Einstein’s causality in both slow and fast light mediums. In the EIT system at a high OD, the main field propagates with a slow group velocity and is separated from the precursor. In the two-level system, we confirm the negative group velocity in the anomalous dispersion regime, but no advancement to the rising edge.

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