Azimuthal modulation of electromagnetically induced transparency using structured light

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Abstract

An increased attention has turned recently to the usage of the special optical beams in electromagnetically induced transparency (EIT) [1], particularly optical vortices [2,3]. An optical vortex is a beam with nonzero orbital angular momentum (OAM), meaning that its optical phase is a function of azimuthal coordinate and the wavefront is helical [4]. The OAM serves as an additional degree of freedom for a photon and hence represents a system of a higher dimension for the high capacity information transmission.

Recently a scheme has been proposed for detection of the structured light by measuring the transmission of a vortex beam through a cloud of cold rubidium atoms with energy levels of the Lambda-type configuration [5]. This enables observation of regions of spatially dependent EIT. Here we suggest another scenario for detection of the structured light by measuring the absorption profile of a weak nonvortex probe beam in a highly resonant five-level combined tripod and Lambda (CTL) atom-light coupling setup (Fig. 1)[3,6].

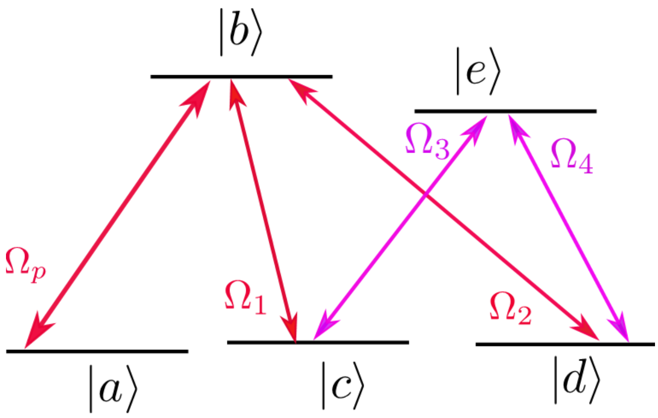

FIG. 1: Five-level combined tripod and Lambda atom-light coupling setup.

We demonstrate that due to the closed-loop structure of CTL scheme, the absorption of the probe beam depends on the azymuthal angle and the OAM of the control vortex beams. This feature is missing in simple Lambda or tripod schemes, as there is no loop in such atom-light couplings. One can identify different regions of spatially structured transparency through measuring the absorption of probe field under different configurations of structured control light [3].

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