Exchange of optical vortices using an electromagnetically induced transparency based four-wave mixing setup

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We propose a scheme to exchange optical vortices of slow light using the phenomenon of electromagnetically induced transparency (EIT) [1] in a four-level double- Lambda atom-light coupling scheme illuminated by a pair of probe fields as well as two control fields of larger intensity. We study the light-matter interaction for a situation where one control field carries an optical vortex, and another control field has no vortex. We show that the orbital angular momentum (OAM) [2] of the vortex control beam can be transferred to a generated probe field through a four-wave mixing (FWM) process and without switching on and off of the control fields. Such a mechanism of OAM transfer is much simpler than in a double-tripod scheme in which the exchange of vortices is possible only when two control fields carry optical vortices of opposite helicity [3]. The losses appearing during such OAM exchange have been analyzed. It is found that a single photon detuning plays an important role in minimizing the losses. An approximate analytical expression for the optimal one-photon detuning is obtained defining a condition where the losses are minimum while the intensity of generated probe field is maximum [4]

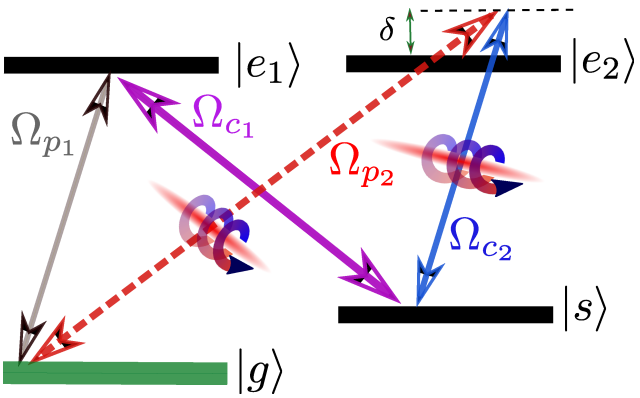

FIG. 1: Ecxhange of OAM in double- Lambda atomic scheme.

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