Dvispalvės lėtos šviesos osciliacinis reiškinys kvantinėje terpėje

Oscillation phenomenon of two-color slow light in quantum medium

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Two-color slow light is a novel approach in the research of electromagnetically-induced transparency (EIT) having potential applications in quantum light storage, quantum processing and nonlinear optics. Most of its properties are yet to be studied theoretically and experimentally [1-3].

In this work, we have studied the oscillation phenomenon between the two slow light components controlled by the two-photon detuning in a double tripod (DT) light-atom coupling scheme [3]. The oscillation phenomenon as well as the interaction of the probe fields with the atomic medium is determined by the coupling fields applied to the medium. Specifically, the oscillations are induced by the coupling between the two ground-state coherences due to the non-zero detuning. This leads to the interaction between the probe fields and their oscillations during the propagation in the atomic medium.

In the co-propagating DT scheme as only one probe pulse was sent to the input and the four coupling fields were constantly present, the outputs of both probe pulses were measured at different two-photon detunings δ. Two outputs oscillate alternatively: when one reaches minima, the other becomes maxima and vice versa (Fig. 1c). Their total transmitted energy decays as the detuning increases, because the detuning away from the EIT resonance is associated with losses. The transparency peak or the maximum transmission corresponds to the two-photon resonance in the EIT spectrum [4]. The number of oscillation cycles can be considerably increased with the storage and retrieval of SSL. The idea is based on the intuition that the propagation time of the light pulses in the medium is equivalent to the storage time of motionless ones transformed into the atomic coherences.

The data of the light-storage DT scheme were used to determine the two-photon detuning (or anything that can affect it) with the satisfactory accuracy and precision. The sensitivity of our method is based on the fact that the light is stored in a superposition of two atomic levels, that is, in two atomic coherences. Therefore, for sufficiently long storage times, even a slight energy mismatch between these levels can lead to a large accumulated phase which can be detected by measuring the conversion of the regenerated light into another component. The storage time and the measurement precision were of the orders of 100 μs and 100 Hz, respectively.

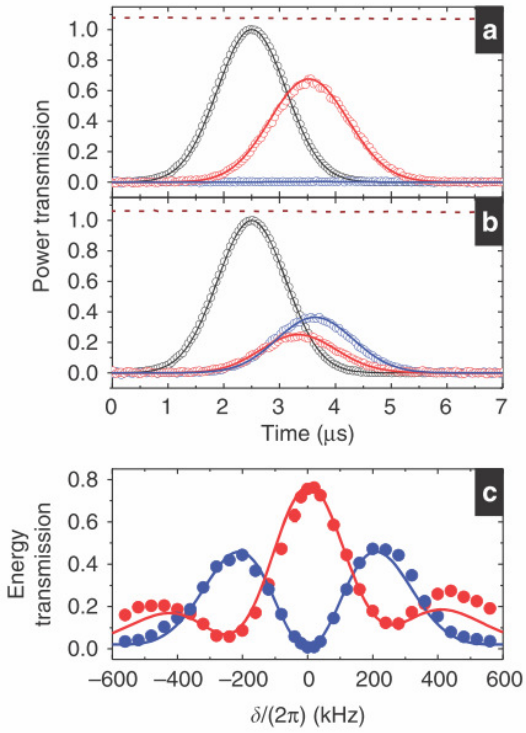

Fig. 1. Oscillation phenomenon in the double-tripod atom-light coupling scheme.

Keywords: double tripod, two-photon detuning, field oscillations, transmission, atomic coherence.

Literature

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