Triggered Source of Single Photons based on Controlled Single Molecule Fluorescence

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(Received 11 February 1999)

We use the method of adiabatic following to prepare a single molecule in its fluorescing excited state. Spontaneous emission from this state gives rise to a single photon. With our current experimental conditions, up to 74% of the sweeps lead to the emission of a single photon. Since the adiabatic passage is done on command, the molecule performs as a high rate source of triggered photons. The experimental results are in quantitative agreement with quantum Monte Carlo simulations.
Observation of Autler-Townes Splitting of Biexcitons in CuCl

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(Received 18 October 1993)

Wave-vector-selective ac Stark effect of the Γ1-biexciton state is clearly observed in the steady

FIG. 1. (a) Schematic level diagram of the exciton and biexciton system. The exciton and biexciton states are coherently mixed by the resonant pump field. The resulting dressed states are probed by two-photon polarization (TPP) spectroscopy. (b) Calculated Autler-Townes splitting taking into account the exciton-polariton effect with spatial dispersion. The pump field mixes the lower branch polariton (LBP) with the biexciton branch. TPP spectroscopy probes the K = 2k0.

FIG. 2. TPP spectra around the biexciton line, 3.186 eV, for various pump powers. The pump detuning is almost zero.

FIG. 3. Calculated TPP spectra around the biexciton line for various pump laser detunings. The biexciton dephasing

Optical Stark Effect in a Quantum Dot: Ultrafast Control of Single Exciton Polarizations

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(Received 30 October 2003; published 16 April 2004)

We report the first experimental study of the optical Stark effect in single semiconductor quantum dots (QD). For below band gap excitation, two-color pump-probe spectra show dispersive line shapes caused by a light-induced blueshift of the excitonic resonance. The line shape depends strongly on the excitation field strength and is determined by the pump-induced phase shift of the coherent QD polarization. Transient spectral oscillations can be understood as rotations of the QD polarization phase with negligible population change. Ultrafast control of the QD polarization is demonstrated.
FIG. 1. The schematic of the excitation (thick solid arrow) of biexcitons near $K_x=0$ and the emissions (dashed arrow) shown with respect to the biexciton and polariton-dispersion curves. To show correctly the directions of the polariton wave vectors under the momentum conservation, the upward arrows are used for both excitation and emission processes. The LP($H$) and UP($H$) emissions are emitted in the observation direction while the LP($L$) and UP($L$) emissions are observed by internal reflection on the back surface.

FIG. 3. High-repetition synchronized two-color tunable picosecond uv laser. The powers are improved from those in the previous paper (Ref. 33) shown in the parentheses. ERF, birefringent filter; $\lambda/2$, half-wave plate; $\rightarrow$, horizontal polarization; $\uparrow$, vertical polarization.

FIG. 5. Biexciton emission spectra for the wave numbers from $K_x=0$ to 0.70 ($\times 10^6$ cm$^{-1}$). The LP($L,H$), UP($L,H$) emissions are from $k^{(1)}+k^{(0)}$ biexcitons and the $M_{7,1}$, EX, LEP, and HEP emissions are from $k^{(1)}-k^{(0)}$ biexcitons. The longitudinal exciton energy is denoted by $E_1$. The emissions labeled by UBP are attributed to polaritons distributed in the upper-polariton branch as a result of the intraband relaxation of the UP polaritons.

Fig. 1-9 Transmission spectra around the GTA band of CuCl obtained with a circular polarized single laser beam (a) and a linear polarized single laser beam (b) at 2K. The intensity of the excitation light was 4MW/cm$^2$. 
248-Bit optical data storage in Eu$^{3+}$:YAlO$_3$ by accumulated photon echoes

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Received August 10, 1989; accepted October 28, 1989

The successful storage and retrieval of 248-bit temporal optical data in Eu$^{3+}$:YAlO$_3$ by accumulated photon echoes is reported. Owing to the long storage time of this crystal, the input data can be written bit by bit by quickly varying the separation of two laser pulses, while the stored data are recalled simultaneously after some storage period, which extends up to a few hours. The maximum data length, previously thought to be limited by the optical dephasing time $T_2$, has been found to be four times shorter than $T_2$ and attributable to spectral diffusion.

Fig. 1. Bit-by-bit writing of the optical data using accumulated photon echoes. (a) The first pulse and the second pulse are located at $t_1 = -300$ nsec and $t_2 = 0$, respectively, and a first echo is observed at $t_3 = 200$ nsec. (b) The first pulse is suddenly shifted to $t_1 = -250$ nsec, and an additional echo appears. (c) The first pulse is further shifted to $t_1 = -350$ nsec, creating a third echo.

Fig. 2. Photon-echo signal for Eu$^{3+}$:YAlO$_3$ corresponding to the 248-bit optical input data representing the term “NTT Basic Research Laboratories.” Top trace: the complete data; the storage time is 10 sec. Middle trace: the leading portion of the above signal. Bottom trace: the echo signal for the same input data as the middle trace but recalled after 2 h of storage time. The binary values and decoded characters are shown at the bottom. The vertical scales are the same for the two lower traces.
Holographic motion picture by Eu³⁺:Y₂SiO₅

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Received November 15, 1983

Real-time recording of a moving object was made with persistent spectral hole burning of a cryogenic Eu³⁺:Y₂SiO₅ crystal. In a basic holographic configuration the ultraviolet laser frequency was continuously scanned within the ⁴F₇/₂→⁴I₈/₂ absorption line (typically 200 MHz) while the object was in motion, thus permitting the storage and reconstruction of the moving image. The success of this motion picture is attributable to (1) the kilohertz-wide hole width, (2) the quasi-persistent hole lifetime, and (3) the high hole-burning quantum efficiency of this material.

Fig. 1. Hole-burning spectra obtained by various readout methods—transmission, luminescence, and holography—for the ⁴F₇/₂→⁴I₈/₂ transition of Eu³⁺:Y₂SiO₅ at T = 7 K. First, a hole was burned by application of a burn laser of a fixed frequency for 50 ms. Then the probe laser was scanned only once (no averaging) while the transmitted power, the photoluminescence (PL) intensity, and the diffracted power were detected for each measurement.

Fig. 2. Experimental setup for the holographic motion picture. The components in parentheses were used only for the reading stage.

Fig. 3. Two typical stills from the reconstructed moving image.
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DBATT (dibenzanthrene) in a \( \pi \)-hexadecane matrix at 1.8K