Floquet-Engineered Dichromatic Two-Photon Excitation

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Two-photon excitation (TPE) is a cornerstone in the quantum-dot (QD) community when exciting biexcitons. In TPE, two degenerate photons are absorbed by the QD simultaneously, which excites it into the biexciton state [1].

We show that this excitation still occurs when both photons are detuned symmetrically, so the sum of their energies matches the ground state-to-biexciton transition. The level scheme for this excitation is shown in Fig. 1. This scheme becomes most efficient when the detuning δ significantly exceeds the biexciton binding energy E_B and when a small delay between the pulses is used. We refer to this scheme as Floquet-engineered two-photon excitation (FTPE).

FTPE presents concrete advantages over regular TPE. In particular, it is more robust towards laser-power variations, allows more efficient laser filtering and we find theoretically and experimentally that it significantly outperforms regular TPE in excitation efficiency despite the presence of phonons [2].

The proposed scheme is fundamentally different from conventional schemes, which also make use of two lasers exciting two transitions. We show how it can be understood using Floquet theory and that it is sufficient to use stroboscopic models for its investigation.

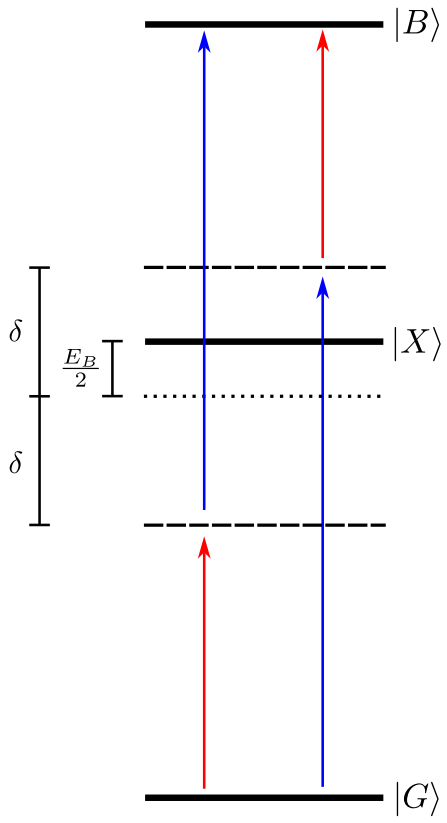

Figure 1: Energy levels of the three-level system, where E_B is the binding energy of the biexciton $|B\rangle$. Two lasers with the detunings $-E_B/2 \pm \delta$ from the $|G\rangle \leftrightarrow |X\rangle$ transition are applied. This scheme becomes regular TPE for $\delta = 0$.

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References

[1] S. Stufler, P. Machnikowski, P. Ester, M. Bichler, V. M. Axt, T. Kuhn, and A. Zrenner, Phys. Rev. B **73**, 125304 (2006).
[2] J. Y. Yan, P. C. A. Hagen et al., in preparation.

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