Enhancement and Narrowing of the Aharonov-Bohm Oscillations Due to Built-in Electric Field in Stacked Type-II ZnTe/ZnSe Quantum Dots

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Introduction

The Aharonov-Bohm (AB) effect can be viewed as the interference of a quantum charged particle moving along a closed trajectory in a region enclosing magnetic flux and where no classical Lorentz forces are present. It was predicted that the AB effect for the dipole can be observed via optical emission of radially polarized excitons in nanorings and disk-like type-II quantum dots (QDs)— so-called excitonic AB effect—due to the interaction of the dipole associated with the polarized excitons with the vector potential. In this work [1], we study AB oscillations in the intensity of magneto-photoluminescence (PL) from stacked type-II ZnTe/ZnSe QDs.

Experimental

The structures studied here are stacked type-II ZnTe/ZnSe QDs grown via migration-enhanced epitaxy. The magneto-PL experiments were performed in the Faraday geometry either with a 15/17 T (NHMFL EMR Facility) or a 9 T (CUNY) superconducting magnet outfitted with fiber optic probes, used to excite and collect the PL.

Results and Discussion

Robust and narrow AB oscillations were observed in magneto-PL intensity of stacked ZnTe/ZnSe QDs due to the presence of built-in electric field. A spectral analysis allowed for qualitative probing of lateral size of type-II excitons. Two samples grown using different growth sequences were analyzed and compared. The magnetic field value at which the AB transition takes place changed across the spectra for one of the samples, indicating a presence of two distinct QD stacks; a “double peak” in the AB oscillation is clearly distinguished in the spectral region where emissions from each stack overlap. The presence of built-in electric field was confirmed by behavior of the PL intensity as a function of temperature.

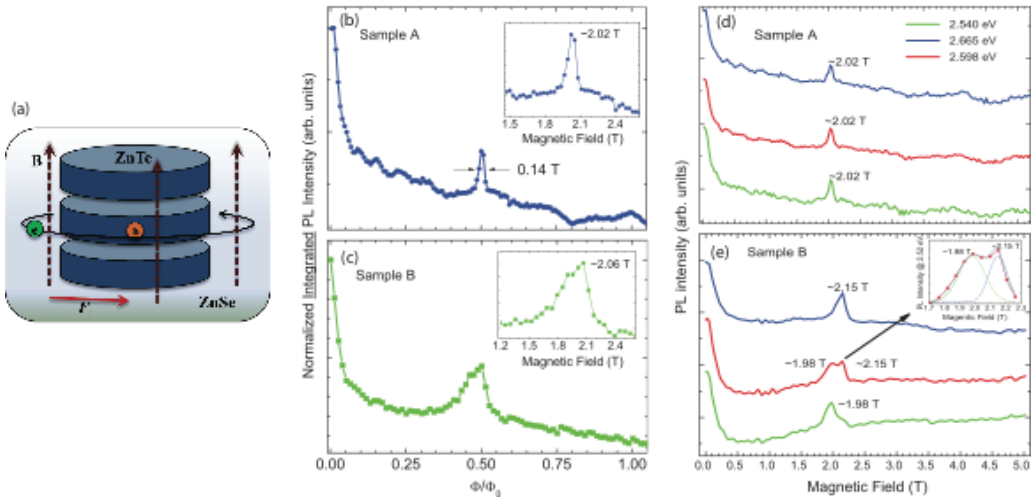

Figure 1. (a) Schematic of the stacking of QDs; type-II exciton is comprised by the electron in ZnSe and the hole strongly confined within the ZnTe QD. The magnetic field (B) is applied in the Faraday geometry. (b,c) Normalized integrated PL intensity as a function of normalized magnetic flux. (c,d) Magneto-PL at three selected spectral positions.

Acknowledgements

This work is supported by NSF Award No. DMR-1006050 and DOE/BES/DE-FG02-10ER46678.

References

[1] Roy, B., *et al.*, Phys. Rev. B, **86**, 165310 (2012).