Abstract Submitted
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Radiative properties of multi-carrier bound excitons in GaAs[1]
KAI-MEI FU, TODD KARIN, University of Washington, RUSSELL BARBOUR, Spectrum Lab, CHARLES SANTORI, HP Labs, YOSHIHISA YAMAMOTO, Stanford University, YOSHIRO HIRAYAMA, Tohoku University — Excitons in semiconductors can have multiple lifetimes due to spin dependent oscillator strengths and interference between different recombination pathways. In addition, strain and symmetry effects can further modify lifetimes via the removal of degeneracies. We present a convenient formalism for predicting the optical properties of k=0 excitons with an arbitrary number of charge carriers in different symmetry environments. Using this formalism, we investigate the radiative lifetime of the neutral acceptor-bound exciton (A^0X) in GaAs. We predict three distinct lifetimes for the 12-state three-carrier complex. We confirm this prediction through polarization dependent and time-resolved photoluminescence experiments. We find the acceptor bound-exciton lifetimes to be $(T_0, 3T_0, 0.75T_0)$ where $T_0 = (0.61 \pm 0.12)$ ns. Furthermore, we provide an estimate of the intra-level and inter-level exciton spin-relaxation rates. The results are in contrast to the previously reported single 1.6±0.6 ns lifetime for this system and highlight the importance of a unified treatment of all recombination pathways when deriving the radiative properties of multi-carrier excitons.

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