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Dark Exciton States in PbSe Nanocrystals RICHARD SCHALLER, DAVID BUSSIAN, JIN JOO, JEFFREY PIETRYGA, VICTOR KLIMOV, Chemistry Division, Los Alamos National Lab, SCOTT CROOKER, National High Magnetic Field Lab, Los Alamos National Lab — Colloidal semiconductor nanocrystals (NCs) offer a size-tunable energy gap and unique physical processes that are of interest for optoelectronic applications. Single excitons in PbSe NCs recombine at room temperature slowly (hundreds of nanoseconds) relative to other NC compositions. Large dielectric screening effects may control the lifetime, but theoretical work indicates that the lowest energy state is an optically passive dark exciton. We measure photoluminescence lifetimes of single excitons in multiple NC sizes as a function of temperature and magnetic field in an attempt to understand the detailed electronic structure. Our measurements indicate that the single exciton lifetime increases from $\sim$800 ns at 298 K to $\sim$5 μs at 1.6 K whereas application of magnetic fields at low temperature reduces lifetime. Such behavior is indicative of thermally activated emission from a lower-energy dark state with an exchange splitting of order 1 to 10 meV. This data suggests that relaxation in PbSe NCs at room temperature is dominated by dielectric screening.

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