Dark-bright exciton spin-flip rates of quantum dots determined by a modified local density of optical states

This work investigates the influence of dark excitons on the radiative dynamics of semiconductor quantum dots (QDs). Dark excitons have total angular momentum of 2 and contribute to the fine structure of the exciton ground state. As opposed to bright excitons that have total angular momentum 1, dark excitons cannot recombine directly via electric dipole transitions. However, slow recombination does take place since the dark exciton can undergo a spin-flip process thereby transferring it into a bright exciton. A technique is demonstrated to extract the dark-bright exciton spin-flip rate based on time-resolved detection of spontaneous emission. Using the modified local density of optical states of a GaAs-air interface and its known dependence on distance (z), it was recently shown that the bright exciton radiative and non-radiative processes could be fully unravelled. Hence, the spin-flip rate can be extracted. The spontaneous emission decay curves are found to be bi-exponential and the dark excitons contribute to the slow component with a rate dominated by non-radiative processes. The spin-flip rate can be extracted reliably from the ratio of the amplitudes of the slow and fast components.