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Triplet excitons in single walled carbon nanotubes[1]

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Photophysics of single-wall carbon nanotubes (SWCNTs) is intensively studied due to their potential application in light harvesting and optoelectronics. The excited states of SWCNTs form strongly bound electron-hole pairs, excitons, of which only those with a singlet spin symmetry participate in application relevant optical transitions. The presence of long-living spin-triplet states affects the application relevant optical properties and are also candidates for quantum information storage. Therefore knowledge of the triplet exciton energy structure, in particular in a SWCNT chirality dependent manner, is greatly desired. The development of a unique optically detected magnetic resonance (ODMR) spectrometer, which is tailored to match the requirements of energy selective excitation and energy resolved detection in the near-infrared range, was the key to this study. We report the direct observation of light emission from the triplet state recombination, i.e. phosphorescence, for several SWCNT chiralities. This yields the singlet-triplet gap as a function of SWCNT diameter and it closely follows the theoretical predictions based on quantum confinement effects. We also show that the ODMR spectrum can sensitively discriminate whether the lowest optically active state is populated from an excited state on the same nanotube of through a Förster exciton energy transfer from a neighboring nanotube.

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