# Dark to Bright: Using quantum dots to harvest non-emissive triplet excitons in the infrared

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Spin-triplet excitons are ubiquitous in organic optoelectronics. However, they are often an undesirable energy sink because they are both spin-forbidden from emitting light, and strongly bound relative to free electron-hole pairs. Consequently, harvesting their energy is an important technological challenge. Here, we demonstrate direct exciton energy transfer from 'dark' triplets in the organic semiconductor tetracene to emissive colloidal PbS nanocrystals, thereby successfully harnessing molecular triplet excitons in the short-wave infrared (SWIR; λ:1–3μm).

We use steady-state excitation spectra to demonstrate that the transfer efficiency is at least 90±13%, while transient photoluminescence and magnetic field-dependent studies show that the mechanism is a Dexter hopping process—the simultaneous exchange of two electrons—that is sensitive to local geometry. Triplet exciton transfer to nanocrystals is expected to be broadly applicable in solar and SWIR-emitting applications, where effective molecular phosphors are lacking. By contrast, quantum dots are ideal SWIR sensitizers, as their excitonic spin-states are fully mixed at room temperature, and both the optical gap and ionization energy can be tuned via colloidal synthesis. In particular, this route to 'brighten' low-energy molecular triplet excitons may permit the sensitization of conventional silicon solar cells with singlet exciton fission materials—a route to overcome the Shockley-Queisser efficiency limit.