**Energy transfer in single quantum dot assemblies.**

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**Introduction** Quantum dots (QDs) are photostable with large absorption cross-sections at energies higher than their band-gap. These properties make them promising candidates as solar harvesting moieties. Hybrid systems containing both QDs and molecular dyes have potential to exploit the properties of the inorganic material. In these systems, the QD may be utilised as the absorbing species, with subsequent directed energy transfer to the attached dye, resulting in energy transfer across the QD interface. This resonant energy transfer has been investigated in CdSe QD based assemblies, particularly QD:dye ensembles. However, for ensemble data, only an average rate for energy transfer is able to be accessed. For samples of this type, the rate is averaged across the polydispersity of the QDs themselves as well as the ligand distribution on the QDs, which follows a Poisson distribution.

**Aims** We aim to measure energy transfer from single CdSe QDs to covalently linked naphthalene diimide (NDI) dyes.

**Methods** We employ single nanoassembly spectroscopy (where the nanoassembly consists of a quantum dot and a dye) to measure a dataset of intrinsic rates for energy transfer in QD:dye systems. The photoluminescence (PL) trajectories, decay profiles and spectra were collected synchronously from single assemblies at the two different wavelengths characteristic of the QD and dye.

**Results and Discussion** Single particle measurements are able to overcome the limitation of ensemble averaging, uncovering rare events. QD:dye assemblies containing one NDI acceptor dye were formed and identified from their spectral and time-resolved data. A decrease in the lifetime of the single QD along with growth of the luminescence signal due to the NDI was observed. The energy transfer rate within the single QD donor NDI acceptor complexes was measured for two different NDI linker lengths from the rise time of the NDI luminescence. A distribution of energy transfer rates was observed across the nanoassemblies for a given linker length. The spectral data collected concurrently with the photon trajectories allows for exact calculation of the spectral overlap between the energy donor and acceptor, free from the effects of QD polydispersity, in addition to unambiguous verification of energy transfer within the single nanoassembly. The reasons for this will be discussed and the results for different linker lengths presented. Details and considerations for energy transfer across semiconductor (QD) interfaces will be discussed.

**Conclusion** Energy transfer from a QD to a single covalently bound NDI molecule was measured. A distribution of energy transfer rates, with some dependence on the NDI linker length, were obtained.

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Figure 1. QD:dye donor acceptor system, PL trajectory from QD band-edge and PL trajectory from naphthalene diimide dye for the same time-slice. Photobleaching of the NDI at 6.5 seconds is observed.

**References**

1. Ali, A. A. A., Bell, T. D. M. & Funston, A. M. Manuscript in Preparation.