Quantifying Förster-type energy transfer from single perovskite quantum dots to organic dyes

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Colloidal quantum dots (QDs) are promising photoredox catalysts that offer broadly tunable potentials, high absorption coefficients and regenerability. These properties have prompted QDs to be examined for various photocatalytic reactions, from water splitting and CO2 reduction to various organic transformations [1]. An even wider parameter space emerges upon coupling QDs with other homogeneous catalysts – transition metal complexes or organic dyes – in hybrid nanoassemblies exploiting energy transfer (ET). Such nanoassemblies could significantly exceed the performance of the individual constituents thanks to the very large absorption cross section of QDs combined with the long-lived triplet states of co-catalysts [2]. However, understanding the complex behavior arising in hybrid nanoassemblies requires methods with high spatio-temporal resolution [3]. Here, we probe ET from single lead halide perovskite QDs to organic dye molecules employing single-particle photoluminescence spectroscopy with single-photon resolution. We identify ET by spatial, temporal, and photon-photon correlations in the QD and dye emission. Exploiting the high temporal resolution of our experiment as well as the discrete quenching steps due to photobleaching of individual organic dyes, we observe a characteristic Förster-type ET, with efficiencies higher than 70% in the sole case of a strong donor-acceptor spectral overlap. Our work sheds light on the processes occurring at the QD/molecule interface and demonstrates the feasibility of sensitizing organic catalysts with QDs.

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