Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Energy transfer between quantum dots and 2D materials: graphene versus MoS_2 ARCHANA RAJA, JOHANNA ZULTAK, XIAOXIAO ZHANG, ANDRES MONTOYA-CASTILLO, ZILIANG YE, CYRIELLE ROQUELET, AREND VAN DER ZANDE, DANIEL CHENET, LOUIS BRUS, TONY HEINZ, Columbia University — Understanding charge and energy transfer processes at the interface of nanostructures is an important area of research, both from the fundamental and application points of view. Interactions between 0D semiconductor quantum dots and 2D van der Waals materials have been a subject of recent investigations [1,2]. Here, we report highly efficient near-field energy transfer from core-shell quantum dots to monolayer and few layer graphene, a semimetal and MoS_2, a semiconductor. We observe both quenching of single quantum dot photoluminescence (PL) and decreasing lifetime in time resolved PL. Our measurements show that increasing the number of layers in the acceptor van der Waals material results in contrasting trends in the rate of non-radiative energy transfer. The energy-transfer rate increases significantly with increasing layer thickness for graphene, but decreases with increasing thickness for MoS_2 layers. Energy transfer rates on the order of 1-10ns^{-1} are determined. We interpret the results in terms of differences in the interplay between dielectric loss and screening.
[1] Z. Chen, S. Berciaud, C. Nuckolls, T. F. Heinz, and L. E. Brus, ACS Nano 4, 2964 (2010). [2] F. Prins, A. J. Goodman, and W. A. Tisdale, Nano Lett. ASAP, (2014).

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Date submitted: 12 Nov 2014 Electronic form version 1.4