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Title of the Presentation: Impact of dark excitons on the population and relaxation kinetics of biexcitons in two-dimensional halide perovskites

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Short Biography:

Prof. Jang received his Ph.D. in Physics from the University of Illinois at Urbana-Champaign in 2005. He was a post-doctoral researcher at Northwestern University and an assistant professor at the State University of New York (SUNY) at Binghamton. He awarded Smart Energy Transdisciplinary Area of Excellence from SUNY. He is currently an associate professor of Physics at Sogang University. Prof. Jang specialized in the area of experimental condensed matter physics and nonlinear optics.

Abstract:
Two-dimensional (2D) semiconductors are ideal for studying various excitonic matter under strong quantum and dielectric confinements. However, such effects can be seriously overestimated for Coulomb binding of two excitons to form a biexciton by a naive interpretation of the corresponding photoluminescence (PL) spectrum. By using 2D halide perovskite single crystals of $BA_2Pb_{1-x}Mn_xBr_4$ (x = 0–0.09), we show that the biexciton is formed by binding of two dark excitons, which are partially bright, but it radiatively recombines to yield a bright exciton in the final state. This renders the spectral distance between the exciton peak and the biexciton peak as very different from the actual biexciton binding energy (φ) because of large bright–dark splitting. We show that Mn doping improves the biexciton stability as evidenced by increase in φ and the increase of the exciton–exciton capture coefficient C within our doping range. The precisely determined φ values are significantly smaller than the previously reported ones, but they are consistent with the instability of the biexciton against thermal dissociation at room temperature. Our results demonstrate that electron–hole exchange interaction must be considered for precisely locating the biexciton level; therefore, the φ values should be reassessed for other 2D halide perovskites that even do not exhibit any dark exciton PL.

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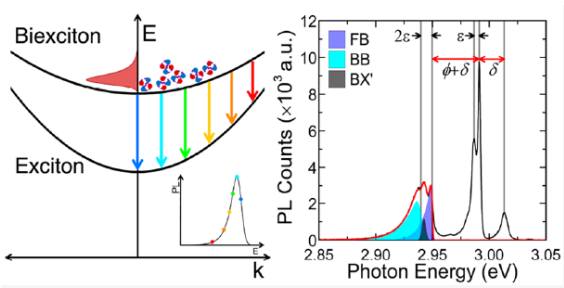

Fig. 1. Schematic for the biexciton PL and the PL spectrum at 8.5 K in a single crystal of 2D perovskite.

[1] A. Steinhoff et al., Nat. Phys. 14, 1199-1204 (2018).
[2] W. Choi et al., J. Am. Chem. Soc. 143, 19785-19793 (2021).
[3] H. Ryu et al., Adv. Mater. (under review).