Spatially Correlated Optical Instabilities of Individual Perovskite Crystals

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Stochastic photoluminescence (PL) intermittency (blinking) between bright and dark intensity levels (blinking) has been long recognized to be characteristic of single emitters. Apart from fluorescent molecules, a variety of quantum-confined semiconductor nanocrystals also exhibit PL blinking. In contrast, such PL instability is seldom reported beyond nanoscale dimensions as spatiotemporally uncorrelated intensity fluctuations are expected to be averaged out over the ensemble. Interestingly, upon investigation of organo-metal halide perovskite (OHP) crystals where charge carriers are not confined, we discovered a bizarre phenomenon where entire micron-sized $(CH_3NH_3)PbBr_3$ disks/films undergo multi-level blinking (*flickering*) on top of a base emission. Intriguingly, such photoinduced optical instability was found to be spatially-synchronous across each micro-crystal, indicating effective communication amongst carriers photogenerated at distal locations of each crystal. Moreover, we often observe such spatiotemporal correlation in blinking/flickering to be diverse over both space and time, which makes it even more challenging to interpret. We propose a model involving few highly efficient metastable traps coupled with correlated carrier migration – excited carriers can recombine non-radiatively within a certain zone of influence of a transient quencher. In this lecture, I will discuss plausible mechanisms and factors responsible for spatiotemporally (in)homogeneous optical instabilities in perovskites, which may be relevant in terms of their usage as active layers in solar PV or light emissive devices.