Carrier recombination in different halide perovskites dimensionalities and on different length scales

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Halide perovskites are generating enormous excitement for next-generation optoelectronic devices including photovoltaics, light-emitting diodes (LEDs) and detectors. Here, I will outline recent work in our group towards the development and understanding different length scales of new halide perovskite semiconductors.

I will first cover topics around recombination in bulk 3D absorbers, delving into the extraction of rate constants from optical spectroscopy data – including the pitfalls with existing approaches. I will propose methods to reliability extract these constants using only luminescence techniques, and robust fitting algorithms.

I will then show results around the microscale behaviour of recombination in films tailored for either photovoltaics or LEDs. There is an interplay between local carrier traps and radiative recombination. I will show results extended to full operating devices, and how this provides rich information about performance and stability of the optoelectronic devices.

Finally, I will show results on new 2D perovskite systems with optically or electro-active 2D molecules. Through optical spectroscopy, we can track charge transfer between the active 2D space and the inorganic backbone. These results open up new degrees of freedom whereby the spacer layer can be actively involved in charge carrier separation and transport.