

## CONDENSED MATTER SEMINAR

Thursday 2 December at 14.00

### **“Revealing efficiency losses due to mobile ions in perovskite single- and multi-junction solar cells”**

Martin Stolterfoht

Institute of Physics and Astronomy, University of Potsdam, Germany

Perovskite semiconductors differ from most inorganic and organic semiconductors due to the presence of mobile ions in the active layer. Although the phenomenon is intensively investigated, important questions remain, such as the dominant species and overall density of the mobile ions and their exact impact on the steady-state power conversion efficiency (PCE) and device stability. In this talk, I propose a simple method to estimate the efficiency loss due to mobile ions via “fast-hysteresis” measurements by preventing the perturbation of mobile ions out of their equilibrium position at fast scan speeds (1000 V/s) and choosing a suitable prebias condition. The “ion-free” PCE is between 1.5-3% higher than the steady-state PCE in pin-type cells with low levels of apparent hysteresis at typical scan speeds (100 mV/s) demonstrating the importance of ion-induced losses. Moreover, the scan speed at the peak hysteresis provides important information on the effective ion diffusion constant. The conclusions are corroborated by recently developed device models and transient charge extraction and capacitance measurements, which provide important insights into the dynamics of free electronic charges and mobile ions. I will then show how the mobile ions affect various mixed cation/halide metal halide perovskite compositions and how these losses vary with the charge transport layer and device degradation under elevated temperatures or continuous light illumination. Finally, I will demonstrate our progress on the development of a new generation of solution processed tandem cells (all perovskite and perovskite/organic PV) and how a sub cell selective opto-electronic characterization allows to disentangle ion-induced bulk and interfacial recombination losses in the complete tandem devices. Overall, the proposed methods to quantify the ion-induced field screening and PCE losses allow for a better understanding of several key phenomena in perovskite solar cells and shed light on the complex device degradation process.

*Host: Pietro Caprioglio*  
Audrey Wood room/Zoom