

Enhancing optoelectronic devices with exciton topology

Joshua Thompson¹, Wojciech Jankowski¹, Robert-Jan Slager^{1,2}, Bartomeu Monserrat¹

¹University of Cambridge, Cambridge, United Kingdom. ²University of Manchester, Manchester, United Kingdom

Abstract

The properties and performance of many optoelectronic devices, from solar cells to light-based biosensors, depends on the behaviour of excitons. Schemes to enhance the transport of these excitons are highly desirable, as transport is often one of the key limiting factors in device performance. Inspired by the topology of electrons, we explore how the topology of excitons in a real organic material system can be induced, depending on a complex interplay between the topology of the underlying electronic states and their interactions [1]. Using a combination of microscopic theory and ab-initio calculations, we provide a blueprint for how the topological phase can be tuned via chemical design. Importantly, we demonstrate that topological excitons undergo significantly enhanced transport compared to their trivial counterparts, across a wide range of time scales and regimes [2]. We explore the impact of exciton topology on the material response to strain, phonons and non-uniform electric fields. Owing to the generality of our findings, our work provides a new, ubiquitous tool through which excitonic properties can be controlled and enhanced, for the betterment of state-of-the-art optoelectronic devices.