STRAIN CONTROL OF CHARGE-, VALLEY-, AND SPIN DEGREES OF FREEDOM IN TMDS

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We discuss new nanomechanical approaches to manipulate excitons in TMDs. We show how mechanical strain fields are used to move excitons around, convert between their different types, create new hybridized excitonic states, and manipulate spin/valley degrees of freedom.

First, we develop a experimental approach to generate tunable spatially non-uniform strain fields and explore their effects. We show that the presence of such a strain results in the transport of excitons to the position of the highest strain. In addition, we find that in presence of non-uniform strain, neutral excitons are effectively converted into their charged counterparts. Second, we develop an approach to generate high strain up to 3% in high-quality WSe2 at cryogenic temperatures. We demonstrate that at specific strain values, dark excitons are brought into resonance with defect-related states. In that situation, a new hybrid state with giant oscillator strength is formed. We show the control of that state and explain how its presence explains many traits of single quantum emitters in WSe2. Finally, we examine the effect of strain on spin- and valley- degrees of freedom. We use mechanical strain to controllably transfer spin information between free- and defect-bound excitons. This, in turn, allows long-term storage of spin information.

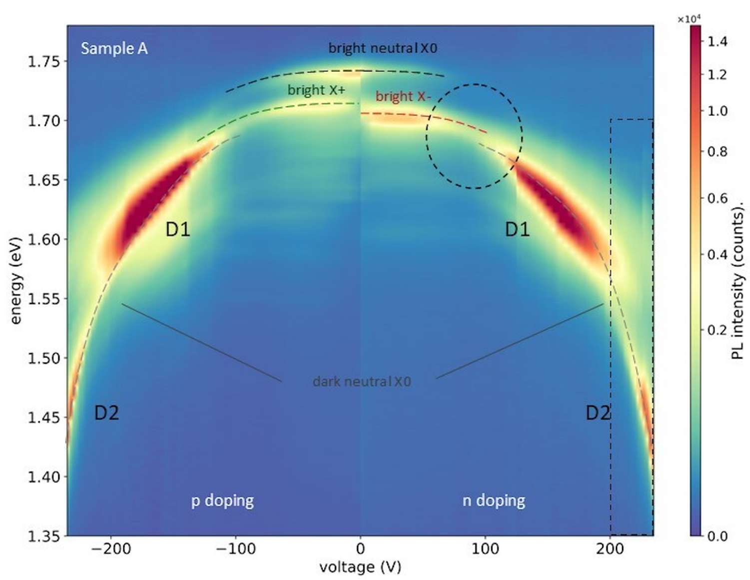

Figure 1: The evolution of excitonic states in WSe2 under strain. A new hybridized state (labelled D1) becomes visible at high strain.

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