Microscopic Origin of the Valley Hall Effect in Transition Metal Dichalcogenides

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The band structure of many semiconducting monolayer transition metal dichalcogenides (TMDs) possesses two degenerate valleys with equal and opposite Berry curvature. It has been predicted that, when illuminated with circularly polarized light, interband transitions generate an unbalanced nonequilibrium population of electrons and holes in these valleys, resulting in a finite Hall voltage at zero magnetic field when a current flows through the system. This is the so-called valley Hall effect that has recently been observed experimentally. Here, we show that this effect is mediated by photogenerated neutral excitons and charged trions and not by interband transitions generating independent electrons and holes. We further demonstrate an experimental strategy, based on wavelength dependent spatial mapping of the Hall voltage (see Figure 1), which allows the exciton and trion contributions to the valley Hall effect to be discriminated in the measurement. These results represent a significant step forward in our understanding of the microscopic origin of photoinduced valley Hall effect in semiconducting transition metal dichalcogenides and demonstrate experimentally that composite quasi-particles, such as trions, can also possess a finite Berry curvature.[1]

References

[1] N.Ubrig, et al, Nano Lett., 17 (2017), 5719

Figures

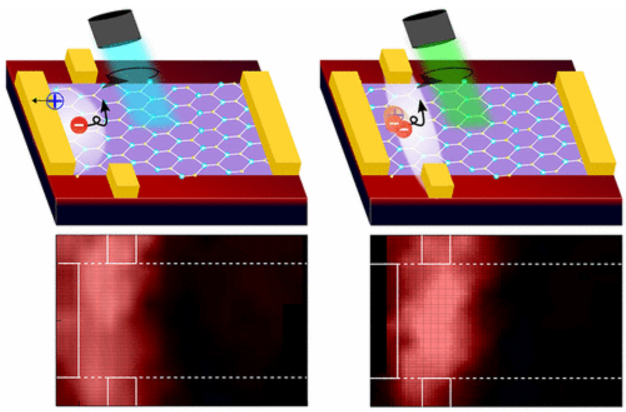

Figure 1: Schematic illustration of the experimental setup (top) and spatial dependent response of the Hall voltage of the valley Hall effect mediated by excitons (left) and trions (right).