Berry opto-electronics: new tools for engineering light-matter interaction

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Dirac fermions possess emergent quantum mechanical properties that can give rise to new, and unusual opto-electronic properties. One striking example is Berry curvature in two-dimensional gapped Dirac materials (GDM) such as transition metal dichalcogenides (TMDs). In these, Berry curvature can enable photoinduced Hall currents in the absence of an applied magnetic field. However, the effect of Berry curvature and its related Hall currents measured in TMDs have been small.

I will describe how photoresponse in GDMs with small bandgaps is dramatically enhanced by Berry curvature. For example, in these even a small number of photoexcited carriers can carry large anomalous Hall currents. Narrow gap GDMs include G/hBN, or dual-gated Bilayer graphene, and can possess Hall currents orders of magnitude larger than those previously observed in large gap TMDs. Under the right conditions, the induced Hall currents in narrow gapped Dirac materials can overwhelm longitudinal motion along the applied electric field providing access to a novel type of Hall regime that manifests in new types of transport behavior.