Manipulating valley currents in graphene nanostructures

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Two-dimensional materials are promising valleytronic candidates due to the K and K' valleys at the Dirac points. All-electronic control is particularly desirable for device applications. Many proposed setups exploit strain-induced pseudomagnetic fields which act oppositely in the K and K' valleys, e.g. graphene nanobubbles can filter or split a charge current into its different valley components [1]. Experimental approaches in this direction are advancing, but promising signatures of valley-dependent phenomena have also emerged from graphene/hexagonal boron nitride heterostructures.

Large non-local resistance signals here have been interpreted in terms of a valley Hall effect (VHE) driven by a bulk Berry curvature [2], which in turn emerges from a finite, global mass term. A complete understanding of such measurements in terms of either bulk [3]- or edge-driven [4] mechanisms is very much an open question.

Here [5] we demonstrate the emergence of bulk, valley-polarized currents in graphene-based devices, driven by spatially varying regions of broken sublattice symmetry, and revealed by non-local resistance (RNL) fingerprints. Using a combination of quantum transport formalisms, the presence of a non-uniform local bandgap is shown to give rise to valley-dependent scattering and a finite Fermi surface contribution to the valley Hall conductivity, related to RNL characteristics. Our findings suggest both an alternative mechanism for the generation of valley Hall effect in graphene, and a route towards valley-dependent electron optics, by materials and device engineering.

REFERENCES

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FIGURES

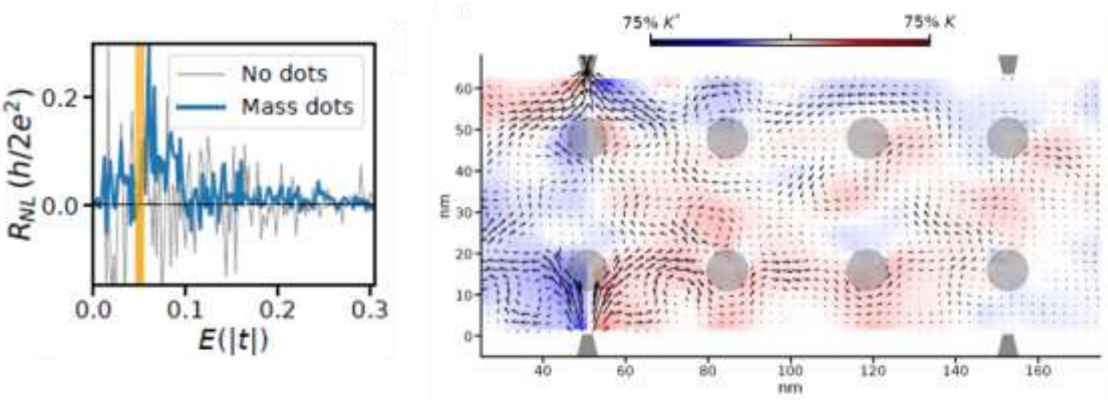

Figure 1: Nonlocal resistance and valley-dependent current flow in a graphene Hall bar with periodic mass dots [5].