A bulk perspective of valley Hall effect in graphene

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Recent experiments point to topological valley currents as the source of non-local signals in the Hall bar geometry [1-4]. It has been stated that these currents exist despite the lack of edge states, and thus are mainly a bulk phenomenon. In this work, we compute the valley Hall conductivity in graphene with a staggered potential using the full tight-binding Hamiltonian, which allows us to capture the intervalley physics without any approximation. For this purpose, we developed a real-space Kubo method which allows us to compute the quantum conductivity due to specific regions of the Brillouin zone [5]. Using this method we find a quantized valley Hall current, and we show that this state is robust against long-range and short-range disorder, and is suppressed only in the presence of strong intervalley scattering.

References

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Figures

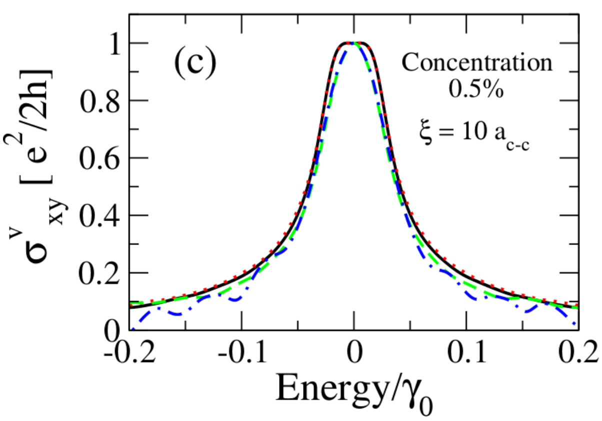

Figure 1: Valley conductivity as a function of the Fermi energy for different disorder strengths.

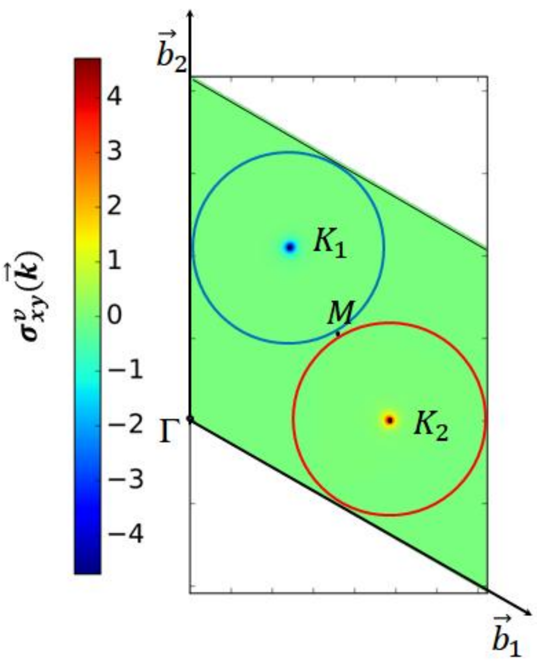

Figure 2: The graphene Brillouin zone, where the circles represent the regions we define as the Dirac Cones, and the color represents the contribution to the valley Hall conductivity for the pristine case.