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Valley-controlled transport in graphene/WSe2 heterostructures under an off-resonant polarized light

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We investigate the electronic dispersion and transport properties of graphene/WSe_2 heterostructures in the presence of a proximity-induced spin-orbit coupling λ_v, sublattice potential Δ, and an off-resonant circularly polarized light of frequency Ω and effective energy term Δ_Ω. Using a low-energy effective Hamiltonian we find that the interplay between different perturbation terms leads to inverted spin-orbit coupled bands. At high Ω we study the band structure and dc transport using the Floquet theory and linear response formalism, respectively. We find that the inverted band structure transfers into the direct band one when the off-resonant light is present. The valley Hall conductivity behaves as an even function of the Fermi energy in the presence and absence of this light. At

Δ_Ω = λ_v - Δ a transition occurs from the valley Hall phase to the anomalous Hall phase. In addition, the valley Hall conductivity switches sign when the polarization of the off-resonant light changes. The valley polarization vanishes for Δ_Ω = 0 but it is finite for $\Delta_\Omega \neq 0$ and reflects the lifting of the valley degeneracy of the energy levels, for Δ_Ω = 0, when the off-resonant light is present. The corresponding spin polarization, present for Δ_Ω = 0, increases for $\Delta_\Omega \neq 0$. Further, pure K or K' valley polarization is generated with respect to the sign change in Δ_Ω.

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