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Gate-tunable valley currents, non-local resistances and valley accumulation in bilayer graphene nanostructures

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Using the Büttiker-Landauer formulation of transport theory in the linear response regime, the valley currents and non-local resistances of bilayer graphene nanostructures with broken inversion symmetry are calculated. It is shown that broken inversion symmetry in bilayer graphene nanostructures leads to striking enhancement of the non-local 4-terminal resistance and to valley currents several times stronger than the conventional electric current when the Fermi energy is in the spectral gap close to the energy of Dirac point. The scaling relation between local and non-local resistances is investigated as the gate voltage varies at zero Fermi energy and a power-law is found to be satisfied. The valley velocity field and valley accumulation in four-terminal bilayer graphene nanostructures are evaluated in the presence of inversion symmetry breaking. The valley velocity and non-local resistance are found to scale differently with the applied gate voltage. The unit cell-averaged valley accumulation is found to exhibit a dipolar spatial distribution consistent with the accumulation arising from the valley currents. We define and calculate a *valley capacitance* that characterizes the valley accumulation response to voltages applied to the nanostructure's contacts.

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