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Valley current generation by electrically induced Berry curvature in double gated bilayer graphene

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Valley degree of freedom is defined for an electronic system having degenerate band structure in a certain crystal configuration and can be used to generate non-dissipative current with accompanying no net charge flow by breaking the spatial inversion symmetry. Graphene and transition metal dichalcogenide are two typical valley materials having K and K$'$ valleys due to the existence of two sub-lattices. The valley current has only recently been studied for monolayer graphene on h-BN where the spatial inversion symmetry is structurally broken by the superlattice potential. We use a double gated bilayer graphene device to electrically break the spatial inversion symmetry and control the Berry curvature. We use valley hall effect to generate a transverse pure valley current and inverse valley hall effect to detect the current. In this device the Fermi energy and the bandgap are independently varied and this allows to prove existence of valley hall effect in the insulating regime where the local resistivity increases with lowering temperature. The insulating regime is particularly interesting because the electric field to valley current conversion is less dissipative in contrast to the case for conventional spin or valley hall systems.