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Supercurrent Reversal in Bilayer Graphene Flakes

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Abstract:

We investigate the Josephson effect in a bilayer graphene flake contacted by two monolayer sheets deposited by superconducting electrodes. It is found that when the electrodes are attached to the different layers of the bilayer, the Josephson current is in a \pi state, if the bilayer region is undoped and there is no vertical bias. Applying doping or bias to the junction reveals \pi-0 transitions which can be controlled by varying the temperature and the junction length. The supercurrent reversal here is very different from the ferromagnetic Josephson junctions where the spin degree of freedom plays the key role. We argue that the scattering processes accompanied by layer and sublattice index change give rise to the scattering phases, the effect of which varies with doping and bias. Such scattering phases are responsible for the \pi-0 transitions. On the other hand if both of the electrodes are coupled to the same layer of the flake or the flake has AA stacking instead of common AB, the junction will be always in 0 state since the layer or sublattice index is not changed.