Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Gate Tuning of Different Phase-Particle Escape Regimes in Graphene-Based Josephson Junctions GIL-HO LEE, DONGCHAN JEONG, JAE-HYUN CHOI, Dept. of Physics, POSTECH, YONG-JOO DOH, Dept. of Display and Semiconductor Physics, Korea University Sejong Campus, HU-JONG LEE, Dept. of Physics, POSTECH — Graphene-based Josephson junctions (GJJs) provide a unique system to investigate superconducting proximity effect with in-situ tunable Josephson coupling strength. While the phase-coherent behaviors of a GJJ under a magnetic field and microwave irradiation have been observed previously[1], we investigated the stochastic switching behavior of the supercurrent in this system. Here, we present the observation of the three different escaping regimes for a phase particle from a washboard potential of the GJJ; macroscopic quantum tunneling (MQT), thermal activation (TA), and phase diffusion (PD).[2] The crossover temperature (T^*_{MQT}) between the classical to quantum regime can be controlled by the gate voltage, implying that discrete energy levels of a phase particle are also gate-tunable. Moreover, direct observation of energy level quantization (ELQ) by microwave spectroscopy shows the consistent gate dependence of T^*_{MQT}. A new class of hybrid quantum devices such as a gate-tunable phase qubit is potentially realized by utilizing the MQT and ELQ behavior of the GJJs.

[1]H. B. Heersche et al., Nature 446, 56 (2007); D. Jeong et al. Phys. Rev. B 83, 094503 (2011).
[2]G.-H. Lee et al., Phys. Rev. Lett. 107, 146605 (2011).

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Date submitted: 11 Nov 2011 Electronic form version 1.4