ATOMIC-SCALE 0-π TRANSITION IN A SUPERCONDUCTOR/ FERROMAGNETIC-INSULATOR HETEROSTRUCTURE

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A superconducting ring with a p-junction made from superconductor (S) / ferromagnetic-metal (FM) / superconductor (S) exhibits a spontaneous current without an external magnetic field and the corresponding magnetic flux is half a flux quantum in the ground state [1]. Such a p-ring provides so-called "quiet qubit" that can be efficiently decoupled from the fluctuation of the external field [2]. However, the usage of FM gives rise to strong Ohmic dissipation. Therefore, the realization of p-junctions without FM is highly desired for qubit applications. We theoretically consider the possibility of the p-junction formation in the Josephson junctions with ferromagnetic insulators (FI) by taking into account the band structure of such materials. In the case of the fully polarized FIs, e.g., La_2BaCuO_5 and K_2CuF_4, we found the formation of a p-junction. More remarkably, we show that the ground state of such junction alternates between 0- and p–states when the thickness of FI is increasing by a single atomic layer [Fig. 1] [3].

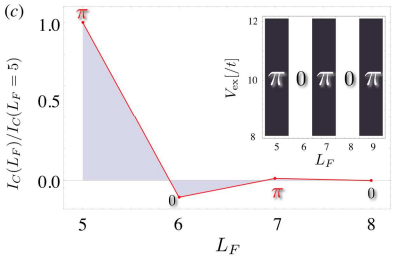

Fig. 1: Josephson critical current *IC* as a function of the thickness of FI layer L_F.

Such FI-based Josephson p-junctions may become an element in the architecture of future quantum information devices [4].

References

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