Superconducting spintronics

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ABSTRACT

Ferromagnetism and superconductivity are usually considered competing order, because the former encourages the parallel alignment of spins, while the latter associated with electron attraction in an anti-parallel spin orientation to form Cooper pairs. Thus, the combination between ferromagnetic-metal (FM) and superconductor (S) in close proximity has led to a range of novel and interesting phenomena, including π Josephson Junctions in which the phase of the supercurrent undergoes a sign change due to the oscillatory pair-amplitude in FM which leads to re-entrant superconducting critical currents with temperature and FM layer thickness and spin-polarization dependent proximity effects [1]. In a superconducting ring with a S/FM/S π-junction exhibits a spontaneous current without an external magnetic field and the corresponding magnetic flux is half a flux quantum in the ground state [2]. Such a π-ring provides so-called "*quiet qubit*" [3] that can be efficiently decoupled from the fluctuation of the external field.

In the first part of my talk, I will give a review on superconducting spintronics [4,5]. Next, I will show our theoretical studies on novel Josephson effect in S/FI(ferromagnetic insulator)/S *junctions* [6] as well as recent experimental studies of *spin-filter Josephson junction* [7,8]. In addition, we will also discuss about potential practical applications of S/FI junctions for *quantum computer* [9] and *electron refrigeration* [10].

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