Non-local Spin Current Injection into a Superconductor

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Recently the ferromagnetic metal/superconductor hybrid structure has been studied intensively since the interplay between superconductivity and ferromagnetism entails incompatible spin order. As for the spin current in the superconducting state, there are some experiments using the current-perpendicular-to-plane structure. This configuration, however, is not preferable for future low energy consumption devices. In this work, we have studied the non-lcoal injection of pure spin current into the superconducting state using the current-in-plane geometry.

Our device is based on the lateral spin valve structure, consisting of $Ni_{81}Fe_{19}$ and Nb wires bridged by a Cu wire. The pure spin current is induced in the Nb wire via Cu by flowing the charge current non-locally from the $Ni_{81}Fe_{19}$ wire.[1] Above the critical temperature (T_c) of Nb, the pure spin current are strongly absorbed into the Nb wire because of its strong spin-orbit interaction. Below T_c, on the other hand, we still observe a large spin current absorption.[1] This fact indicates that the injected pure spin current is absorbed not in the superconducting state but in the quasi-particle state of Nb. With decreasing the injection charge current, the spin current absorption rate is getting small, which supports the above sinario.

[1]K. Ohnishi, T. Kimura, and Y. Otani, Appl. Phys. Lett. **96**, 192509 (2010).