Giant spin polarization in a chiral molecular superconductor

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Superconducting spintronics is a remarkable field of research which combines superconductivity with spintronics to immensely enhance spin-related effects such as spin transport and magnetoresistance[1]. Spin-polarized superconducting current is important for injecting spin into a device and is required to be produced efficiently. However, normal superconducting current doesn't have spin angular momentum because of the singlet nature of Cooper pairs, although triplet state is theoretically predicted. Injecting spin from ferromagnetic electrode doesn't significantly affect the entire spin polarization.

Chiral molecular materials can emit a spin-polarized current with a high polarization rate despite its constituent light elements. This effect is known as a chirality-induced spin selectivity (CISS) effect[2]. In this presentation, we report on a spin-polarized transport in a chiral molecular superconductor κ-(BEDT-TTF)$_2$Cu(NCS)$_2$ (κ-NCS), which can be attributed to CISS effect in the superconducting state. In this crystal, relative configuration of constituent molecules exhibits chiral structure in spite of each molecule being achiral. Superconducting CISS effect was demonstrated by detecting a voltage drop (V) generated at the interface between κ-NCS and a nickel electrode by applying an a.c. electric current. We investigated the magnetic field (H) dependence of V and confirmed that it surely corresponded to the magnetization curve of nickel, which means that V originates in the interface spin accumulation. This spin dependent voltage drop was three orders of magnitude larger than theoretically estimated voltage that was based on Edelstein effect with the standard spin diffusion equation[3]. The direction of spin polarization was determined by the H angle dependence, and the spin direction turned out to be dependent on the position of the electrodes inside the κ-NCS crystal. Also, nonlocal measurement implied that the spin polarization prevails in a whole crystal.

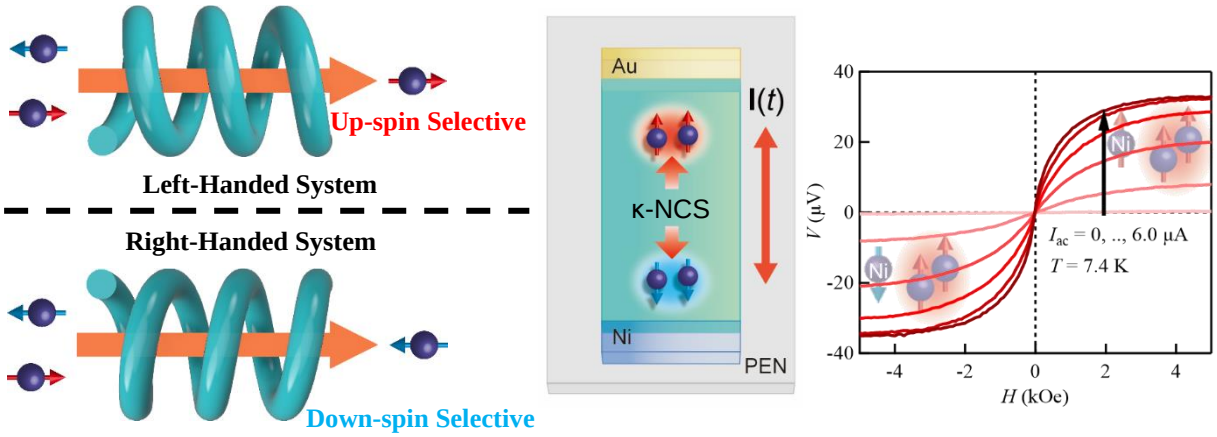

Fig. Conceptual schematic of CISS effect (left), Schematic of κ-NCS device (center) and Magnetic field dependency of the output voltage (right)

References

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