TAILORED SPIN-TEXTURES IN HYBRID SUPERCONDUCTING-FERROMAGNETIC STRUCTURES

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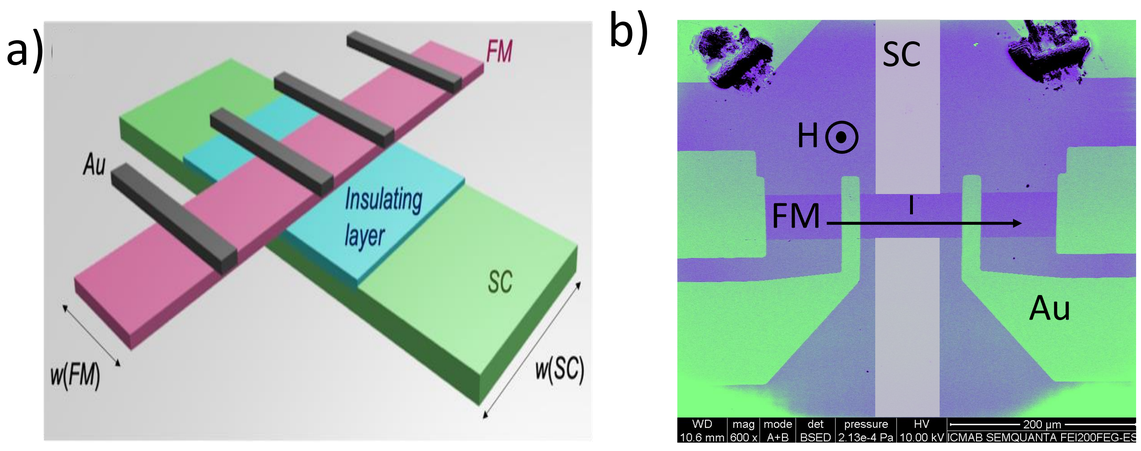
INTRODUCTION

Superconducting cuprates mixed with ferromagnetic materials (FM-SC hybrids) present novel and unique electromagnetic tunability. Here, we show that by combining YBCO (SC) and permalloy (FM) materials in hybrid devices, one can manipulate magnetic textures, through loss-less superconducting stray fields or transport super-currents. Multiple magnetic states with different magnetoresistance signal can be stabilized at remanence and modified by applying small magnetic fields or currents . The proposed approach opens new venues for energy-efficient information storage and manipulation.

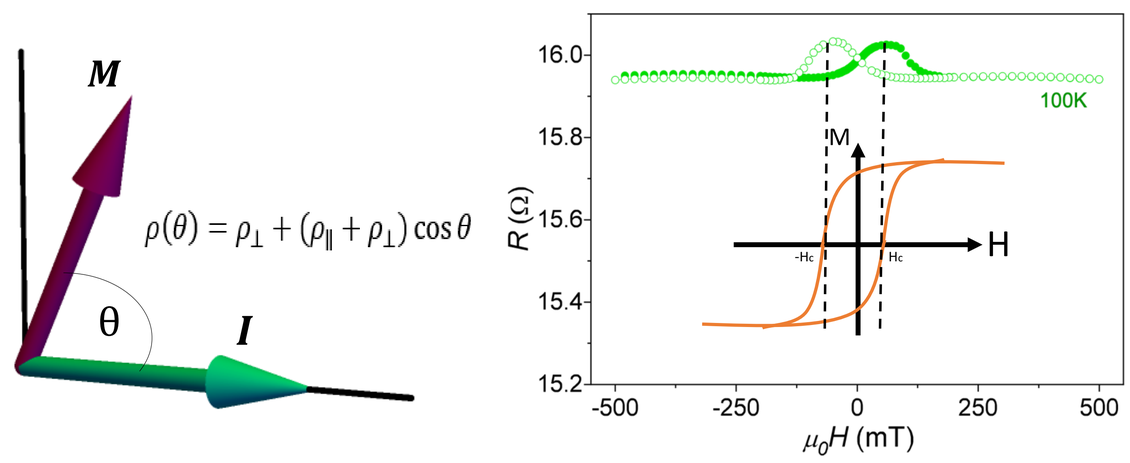
Hybrid SC-FM structures

The devices used in this study are composed of a YBCO (SC) strip perpendicular to a permalloy (FM) wire. Electrical measurements are based on magnetoresistance of permalloy by using four-point configuration and out-plane magnetic field.



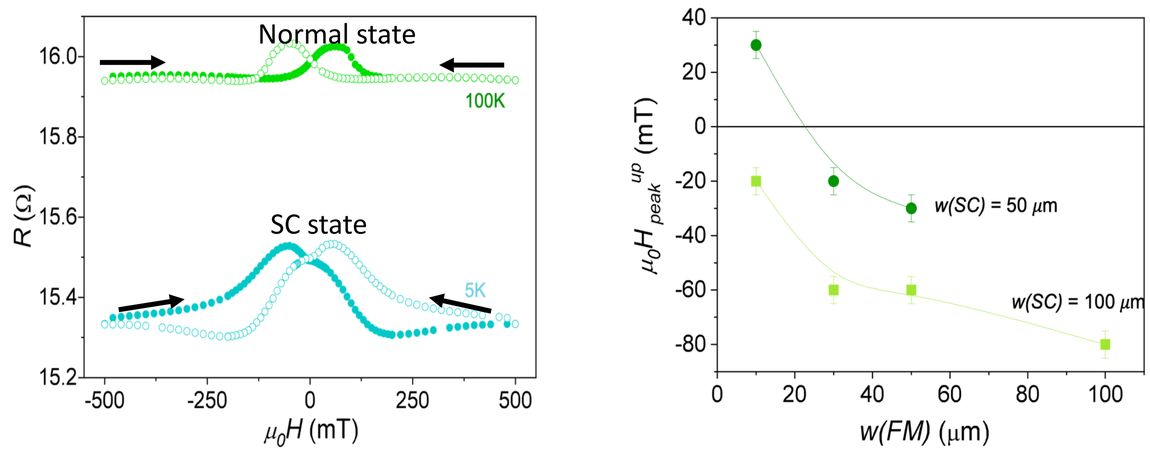
Anisotropic Magnetoresistance

Depending on the angle between permalloy magnetization and current direction, permalloy resistance changes. Magnetoresistance peaks obtained at the coercive field (maximum disorder of magnetic domain distribution).



Effect of SC stray magnetic fields

Magnetic interaction between SC and FM materials is clearly observed in the magnetoresistance measurements .

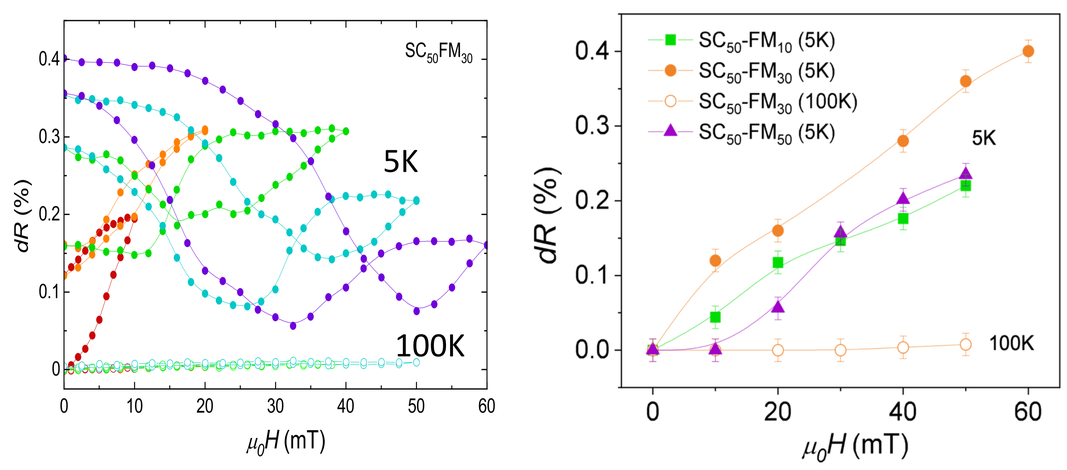


Peaks are shifted as a consequence to the coercive field variation.

Peak shift enhanced for devices with wider SC and FM widths.

SC trapped magnetic fields

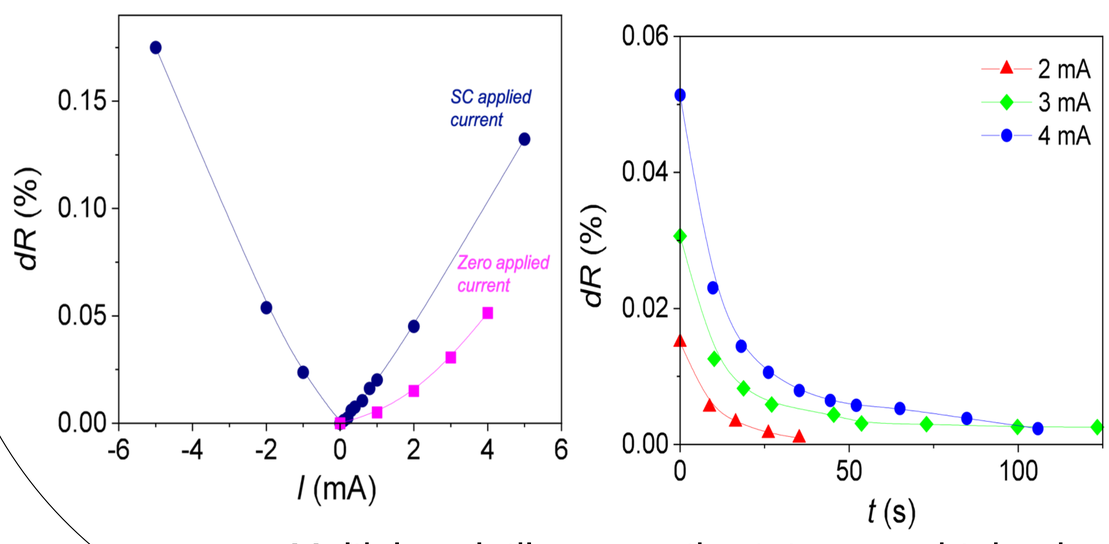
Magnetic states are stabilized at remanent state (0mT) depending on the maximum applied magnetic field .



Multiple non-volatile magnetic states can be obtained depending on the device geometry or the applied magnetic.

Loss-free supercurrents

Injecting supercurrent through YBCO wire also generates a magnetic interaction with permalloy.



Multiple volatile magnetic states are obtained depending on the applied electrical current.

Conclusion

- Modulation of multiple magnetic states by combining FM/SC materials.
- Importance of geometry (SC and FM width) and the applied magnetic field o electrical current.
- Multiple and stable magnetic states can be achieved with magnetic field modulation.
- Loss-free supercurrents also allow to manipulate volatile magnetic states that decay in time.
- Application for different types of encoding and reading magnetic states.

REFERENCES

[1] J. Alcalà et al., Springer Nature Book, Chapt. 6. (2021)

ACKNOWLEDGEMENTS

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