Non-equilibrium effects in superconducting thin films probed by time-domain THz spectroscopy

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Superconducting logic holds the promise of significant improvement compared to traditional semiconductor logic, both in terms of computational power and energy consumption, due to the lack of ohmic losses when transferring bits. However, most of these advantages are negated by the lack of a suitable cryogenic memory that can be coupled to the superconducting logic.

The ambition of superconducting spintronics is to integrate magnetic and superconducting elements in a unique device that combines permanent storage and low power logic characteristics. The new opportunities that superconductivity offers to spintronics were realised only quite recently. Instead, conventional superconductivity and magnetism were long believed to be mutually exclusive since in s-wave superconductors, Cooper pairs are in a singlet state and are therefore inadequate for carrying spin-information. But recently, new discoveries have shown new routes for superconductivity and magnetism to co-operate, enabling novel device concepts based on the interplay between spin, charge and superconducting phase coherence. This includes the condensation of spin-polarised triplet Cooper pairs in conventional superconductors interfaced by heavy metals [1-5].

THz transmission spectroscopy is an extremely powerful tool to characterise conventional superconductors because the superconducting gap falls within the bandwidth of the THz pulse that is generated for example by optical rectification in a ZnTe crystal. The great advantage of THz transmission spectroscopy, in comparison to other gap-spectroscopy techniques such as STM, resides in the fact that it is time-resolved. We can therefore apply it to quantify the melting/recovery dynamics of the superconducting condensate subject to a fast perturbation and to detect new transient superconducting correlation states. In this talk I will give an overview on the non-equilibrium studies carried in superconductors via time-domain spectroscopy and show our very recent effort in using time-domain THz spectroscopy to resolve the interactions at the interface between thin-films superconductors and normal metals and how these affect the superconductor's dynamics.

References

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