9th JEMS Conference 2018
Joint European Magnetic Symposia
3rd – 7th September 2018 • Mainz • Germany
General Chair: Prof. Dr. Jairo Sinova
Co-General Chair: Prof. Dr. Mathias Kläui
www.jems2018.org

SP 2 Electronic correlations, superconductivity, superconducting spintronics

SP2 - Parallel session 1

SP2 - Parallel session 1

SP2.1.02

Dynamic coupling in superconducting/ferromagnet interfaces

X. Palermo, D. Sanchez, M.-W. Yoo, S. D'Ambrosio, A. Sander, V. Cros, J. Santamaría, V. Cros, A. Anane, J. E. Villegas

Text We experimentally investigate two mechanism of dynamic coupling between magnetization dynamics and at superconductivity at superconductor/ferromagnet interfaces.
The first coupling mechanism is mediated by non-equilibrium spin accumulation produced through spin-pumping. The spin diffusion length and relaxation mechanisms in the superconductor, as well as the effect of spin absorption by the superconductor on the magnetization dynamics, are studied via ferromagnetic resonance (FMR). We find an unusual broadening the FMR peak that indicates a significant coupling of both subsystems.
The second coupling mechanism is mediated by the local magnetic induction (flux quanta), whose dynamics is used to probe spin textures in the ferromagnetic subsystem. This is studied via magneto-transport experiments, which as we will show allow fingerprinting subtle details of the magnetization reversal mechanisms.
Work supported by the ERC grant Nº 64710, French ANR grant ANR-15-CE24-0008-01 and COST “Nanoscale Coherent Hybrid Devices For Superconducting Quantum Technologies” - Action CA16218.

SP 2 Electronic correlations, superconductivity, superconducting spintronics

SP2 - Parallel session 1

SP2.1.03

Electronic nematicity and structure in Co-doped LaFeAsO superconductors

L. Wang, S. Sauerland, F. Scaravaggi, R. Kappenberger, S. Aswartham, S. Wurmehl, A. U. B. Wolter, B. Büchner

Text We report a systematic study on electronic nematicity in LaFe1-xCoxAsO ($0 \leq x \leq 0.2$) by means of shear modulus and thermal expansion measurements of detwinned single crystals. For pure LaFeAsO, the evolution of orthorhombic distortion at TS ~ 150 K is associated with strong uniaxial pressure dependencies in particular along the a- and b-axes as well as sizeable volume effects. At the antiferromagnetic ordering temperature TN ~ 130 K, our data imply much smaller lattice effects. By means of the three-point bending technique in the capacitance dilatometer, we obtain the nematic susceptibility from the shear modulus response in LaFeAsO. The shear modulus softens well above TS implying a Curie-Weiss-like behaviour of the nematic susceptibility. Co-doping suppresses both Ts and TN and the evolution of the nematic phase as well as of nematic fluctuations is mapped out towards the superconducting regime. The relation between the nematic susceptibility and spin, structure and orbital degrees of freedom is discussed.

SP 2 Electronic correlations, superconductivity, superconducting spintronics

SP2 - Parallel session 2

SP2 - Parallel session 2

SP2.2.02

Original phenomena in intermetallics with coexisting 3d magnetism and intermediate valent Yb

T. Mazet, L. Eichenberger, D. Malterre, A. Magnette, M. François, R. Sibille, N. Casati, L. Nataf, F. Baudelet

Text Rare-earth based Kondo systems generally involve Yb or Ce alloyed with non-magnetic elements. These materials may present interesting physical behaviors such as intermediate valency, heavy fermion, non-conventional superconductivity, quantum criticality. We recently evidenced, in the YbMn6Ge6-xSnx series, a new kind of intermetallic systems where intermediate valent Yb coexists with a strongly magnetic 3d sublattice. This yields very unusual behaviors as, inter alia, high temperature magnetic ordering of the Yb sublattice or the stabilization of Yb magnetism up to a high degree of hybridization with band electrons. In our presentation, we shall delineate these original behaviors, thanks to a combined use of experimental methods. In particular, we shall show how chemical or physical pressure allows crossing through the Yb magnetic instability, in the vicinity of which quantum critical phenomena are expected.

SP 2 Electronic correlations, superconductivity, superconducting spintronics

SP2 - Parallel session 2

SP2.2.03

Interface effects in superconductor-ferromagnet heterostructures

A. Stellhorn, A. Sarkar, E. Kentzinger, M. Waschk, P. Schöffmann, Z. Fu, V. Pipich, A. Syed Mohd, T. Brückel

Text Ferromagnetism (F) and superconductivity (S) have long been considered as antagonist phenomena. When the magnetic state of the F-layer is inhomogeneous, magnetic domains can spatially confine the superconductivity in an adjacent S-layer [1]. Our goal is to obtain an understanding of such proximity effects between the two layers. The lateral magnetic depth profile near the S/F-interface and the dependence of the superconductivity on the magnetic configuration still have to be scrutinized.

As a prototype system we use thin film heterostructures of ferromagnetic FePd with a superconducting Nb-toplayer. The heterostructures are grown using molecular beam epitaxy on an MgO (001) substrate. FePd is grown in the L10-ordered phase with a magnetic anisotropy perpendicular to the surface plane [2].

Resistivity measurements as a function of external magnetic field H_{ext} reveal the effect of the magnetic stray fields on the superconducting state. When the superposition of the stray fields and H_{ext} reaches its minimum, superconductivity nucleates over the domain with magnetization direction opposite to H_{ext}. To investigate the depth profile of the lateral magnetization fluctuation Grazing-Incidence-Small-Angle-Neutron-Scattering (GISANS) is performed above and below the superconducting critical temperature.

[1] Z. Yang et al., Nat. Mater. **3**, 793-798 (2004).
[2] V. Gehanno et al., Phys. Rev. B **55**, 12552 (1997).

SP 2 Electronic correlations, superconductivity, superconducting spintronics

SP2 - Parallel session 2

SP2.2.04

Two-stage Kondo effect in double quantum dots coupled to ferromagnetic and superconducting leads

K. Wójcik, I. Weymann

Text In this contribution the transport properties of a T-shaped double quantum dot proximized by a superconductor and strongly coupled to two ferromagnetic leads are discussed. In particular, the linear response conductance and its spin polarization, calculated by means of the numerical renormalization group method, are analyzed.

We show that even in the absence of direct interactions between the two quantum dots the two-stage Kondo screening is present in the system at the particle-hole symmetry. We explain this phenomenon as a consequence of an effective inter-dot exchange interaction, which is generated by crossed Andreev reflection. Then we analyze the interplay of two-stage Kondo physics with ferromagnets-induced exchange field, which becomes nonzero outside the symmetry point. We argue that the influence of the exchange field is weaker than in the absence of the superconductor. In particular, the spin dependence of the conductance minimum due to Fano-Kondo effect is strongly suppressed even at quite small strength of the coupling to the superconducting lead.

SP 2 Electronic correlations, superconductivity, superconducting spintronics

SP2 - Parallel session 2

SP2.2.05

Tuning the energy of Yu–Shiba–Rusinov states on a superconducting Pb film

L. Malavolti, M. Haenze, M. Briganti, S. Rolf-Pissarczyk, M. Mannini, F. Totti, R. Sessoli, S. Loth

Text Magnetic impurities on a superconductor behave as a scattering potential for the quasi-particles leading to the formation of intra-gap level known as Yu–Shiba–Rusinov states.[1] Chains of magnetic impurities have been indicated to support topological superconductivity and Majorana bound states anticipating application for quantum computing.[2] A key parameter defining the behavior of the impurity-superconductor system is the exchange coupling between the magnetic center and the superconductor.[3]
Here, the capability to tune the exchange coupling of a molecular spin and superconductor film is reported flanked by ab-initio calculations. A low temperature scanning tunneling microscope (STM) has been employed to investigate the behavior of single Vanadyl phthalocyanine molecules (VOPc) deposited on a Pb superconducting film. Unperturbed VOPc molecules, bearing a well-protected spin ½,[4] do not show sizeable magnetic interaction with the superconductor. However, taking advantage of the STM tip, the interaction can be turned on creating Yu–Shiba–Rusinov states whose energy position can be tuned. A direct control over this coupling can open new opportunities for the understanding of topological superconductivity and the formation of Majorana bound states.

(1) Yazdani, A.; et al. Science 1997, 275 (5307), 1767.
(2) Nadj-Perge, S.; et al. Science 2014, 346 (6209), 602.
(3) Heinrich, B. W.; et al. Prog. Surf. Sci. 2018, 93 (1), 1.
(4) Atzori, M.; et al. J. Am. Chem. Soc. 2016, 138 (7), 2154.

SP 2 Electronic correlations, superconductivity, superconducting spintronics

SP2 - Parallel session 2

SP2.2.06

Vortex dynamics in superconductors driven by field-free vector potentials

B. Niedzielski, J. Berakdar

Text The important role of vector potentials in quatum mechanical systems is well known and demonstrated by the famous Aharonov-Bohm effect. We present theoretical predictions how phase-sensitive macroscopoic quantum systems, like superconductors, can be driven and manipulated by phase changes imparted by a field-free vector potential. We discuss a proposal for an experimental realization where such vector potentials are generated and coupled to the superconductor in a realistic set up.
Simulations based on the time dependent Ginzburg-Landau equations reveal the emergence of measurable vortex states that strongly depend on externally imparted phase changes. The proposal offers a way to access the vortex dynamics without applying external electric and magnetic fields.

SP 2 Electronic correlations, superconductivity, superconducting spintronics

SP2 - Parallel session 2

SP2.2.07

Tunable proximity effect in YBCO-graphene junctions

D. Perconte, F. Cuellar, C. Moreau-Luchaire, M. Piquemal-Banci, R. Galceran, P. Kidambi, M.-B. Martin, S. Hoffmann, R. Bernard, C. Ulysse, B. Dlubak, P. Seneor, J. Villegas

Text Superconductivity induced by proximity effect is particularly interesting in graphene because graphene Fermi's energy and the electron's wavenumber can be modulated by an external gate. We have fabricated YBCO/Au/graphene planar junctions using a combination of lithography, ion irradiation and CVD graphene transfer techniques. The conductance measurements show that the interfaces are transparent such that the electrical transport is governed by the Andreev reflection. We evidence a superconducting electron interference effects that constitute an analogue of Klein tunneling for superconducting pairs. The interference effects periodically modulate the conductance across the junction. We compare the superconductor graphene interface conductance calculated numerically to the experimental conductance. We will also present recent work on nanometric cuprate superconductor/Au/graphene junctions where we observe conductance oscillations with bias voltage. These oscillation period decrease when increasing the graphene channel length which indicates that the interferences happen inside the graphene channel.