

ESF Exploratory Workshop on

**Interplay Between  
Superconductivity and Magnetism  
at Nanometer Scale**

Paestum, Italy, 19-22 June 2008

Convened by Filippo Giubileo, *CNR-INFN Laboratorio Regionale SUPERMAT*

**SCIENTIFIC REPORT**

# 1. Executive summary

The workshop “Interplay between Superconductivity and Magnetism at Nanometer scale” was held in Paestum, at the Congress Room of the MEC Paestum Hotel, where all participants have been also (full-board) accommodated. The 29 Participants were from 11 European countries (one non-ESF country). Almost all participants arrived in the afternoon of 19th June using a direct transfer connection organized by the convenor from the Naples Airport to the workshop site. All the registration activities were done during the evening in order to inform participants about the organization details. A thirtieth participant cancelled his arrival just two days before and there was not enough time to replace him also by another member of his group.

Despite the marvellous scenery of the majestic Doric temples, illuminated by sunlight and the long coastal strip, lined with pine wood and brushed by a sparkling sea, considered by the U.N.E.S.C.O. as a world heritage, the workshop participants enjoyed a tight programme of physics.

The scientific programme of the workshop consisted of 6 sessions over 2 days (20-21 June): two morning sessions separated by a coffee break and one afternoon session per day. Discussion constituted a major part of the Workshop. To this end, each speaker had 20 minutes for presentation and 5 additional minutes for questions and discussion. Coffee breaks during the sessions allowed additional discussion and exchange of ideas in smaller groups in a relaxed atmosphere. Moreover, at the end of each scientific session, the chairs had five minutes for giving their remarks about the topic discussed during the session.

There were also two discussion periods at the end of each of two working days, where the participants summarized what they have agreed and what they still disagree on, as well as identified several aspects that need to be deepened in the future in their own or collaborative work. Both the discussion time after each talk and at the end of the day were really dense and challenging.

Representatives essentially from all European leading groups, involved in the frontier research on the interplay between superconductivity and magnetism, attended the Workshop, thus feeding their latest results in the discussion. Elder scientists, who pioneered the main topics of discussion, were present together with young researchers working on the latest developments.

The presentation of the European Science Foundation (ESF) and of the Standing Committee for Physical and Engineering Sciences (PESC) was given by Prof. Kenneth Ruud, Head of the Centre for Theoretical and Computational Chemistry, Department of Chemistry, University of Tromsø, Norway.

A social activity was organized on Friday afternoon (20th June) for a touristic tour of the archeological site and the national museum which gave the participants the opportunity the chance to get to know each other and/or to plan already their first collaboration.

## 2. Scientific content of the event

Presentations and discussions at the workshop mainly covered the following four areas:

1. Superconductor/Ferromagnet Nanostructures,
2. Spin dynamic in Superconductor/Ferromagnet heterostructures,
3. Superconductivity and (Ferro)magnetism: Ru-based compounds, hybrid structures, etc.

#### 4. Microscopy and Spectroscopy techniques for studying the interplay Superconductivity-Magnetism

One more session was dedicated to further discuss Superconductor/Ferromagnet structures and the last session on Saturday afternoon (21st June) was dedicated to perspectives for industrial applications.

The workshop started with the introduction by the Convenor, Filippo Giubileo, illustrating the basic idea and the aim of this exploratory workshop. Soon after the scientific sessions started with focalizing the attention on the phenomena happening when superconducting and ferromagnetic structures are organized to interact on the nanometer scale. The first talk was given by Prof. Victor V. Moshchalkov, recognized expert in the field, chairman of the ESF Research Networking Programme “Nanoscience and Engineering in Superconductivity (NES)”, Co-Chairman of the Global Research Networking Core-to-Core Programme (Japan-EU-USA) Nanoscience and Engineering in Superconductivity, Director of the Institute for Nanoscale Physics and Chemistry, at the Katholieke Universiteit Leuven, Belgium. He gave a fascinating seminar on “Nucleation of Superconductivity and Vortex Matter in Superconductor/Ferromagnet Hybrid Nanosystems”, illustrating how artificial hybrid superconductor-ferromagnet (S/F) systems have been used to reveal the interplay between competing superconducting and magnetic order parameters, and to verify the existence of new physical phenomena, including the domain-wall superconductivity (DWS) and the reversed domain superconductivity (RDS). Major result is that the critical temperature  $T_c$  of the superconductivity nucleation in Nb/BaFe<sub>2</sub>O<sub>19</sub> hybrids increases with increasing field until it reaches the saturation field of BaFe<sub>2</sub>O<sub>19</sub> and the interesting interpretation is that the compensation of the applied field by the stray fields of the magnetic domains as well as the change in the domain structure induced by the superconducting Nb layer are responsible for the appearance of the DWS and the coexistence of superconductivity and magnetism in the S/F hybrids. The session continued with Alexander Buzdin presenting theoretical aspects of the proximity effect in superconductor-ferromagnet nanostructures. In particular, he pointed out that in the S-F multilayers the critical temperature and Josephson current depend in an oscillatory manner on the exchange field and thickness of ferromagnetic metal. Jose Luis Vicent outlined the different types of ratchet mechanisms and showed that the vortex ratchet in Nanostructured Superconducting-Magnetic Hybrids (superconducting films grow on top of arrays of magnetic nanodefects) is an adiabatic rocking ratchet that strongly depends on the shape and strength of the asymmetric pinning potentials. Victor Petrashov completed the session illustrating direct experiments with S/F/S interferometers made with ferromagnetic Holmium wires, a rare-earth metal with intrinsic helical magnetic structure, testing the presence of the long range proximity effect that results in a coherent transport through F with superconducting phase-periodic conductance oscillations.

The following session on Spin dynamic in S/F heterostructures tried to identify issues related to spintronics, a new branch of electronics where electron spin (in addition to electron charge) is the active element

for information storage and transport. The session was opened by Marco Aprili discussing the Spin and phase dynamics in ferromagnetic Josephson junctions. He showed how the finite magnetization in the mesoscopic Nb/PdNi/Nb junctions induces a shift in the Fraunhofer pattern that is invariant under time reversal. For a voltage such that the Josephson frequency matches the ferromagnetic resonance, he observed a reduction of the critical current due to excitation of spin-waves in the ferromagnetic layer. Moreover, he investigated the effect of an external microwave radiation and of the magnetic field. The resonances appear as satellites at every Shapiro step and they are shifted to

higher energy by applying an external magnetic field as expected. Therefore the imaginary part of the spin susceptibility is directly measured through the current/voltage characteristics. Remarkably, he obtained the real part of the spin susceptibility from the Fiske's steps measured in large area strongly underdamped macroscopic Nb/Al<sub>2</sub>O<sub>3</sub>/PdNi/Nb junctions. The high sensitivity of the ac Josephson effect to a small amount of spins opens up new routes for ESR experiments in nanomagnetism. The session continued with Audrey Cottet reporting about the Spin-Dependence of Interfacial Phase Shifts acquired by electrons upon scattering on superconductor/ferromagnet interfaces that can strongly modify the behaviour of superconducting/ferromagnetic hybrid devices.

Jacob Linder presented a numerical study of the density of states in a ferromagnet/superconductor junction and the Josephson current in a superconductor/ferromagnet/superconductor junction in the diffusive limit by solving the Usadel equation with Nazarov's boundary conditions. In particular, he addressed how the zero-energy peak and minigap observed in experiments may be understood in terms of the interplay between the singlet and triplet anomalous Green's function and their dependence on spin-dependent scattering. He also showed the role of the barrier transparency and spin-flip scattering in a superconductor/ferromagnet/superconductor junction, suggesting that such diffusive Josephson junctions with large residual values of the supercurrent at the 0- $\pi$  transition, where the first harmonic term in the current vanishes, may be used as efficient supercurrent-switching devices. Finally, Takis Kontos presented multi-terminal spin dependent transport experiments in carbon nanotubes by using a four probe geometry with two ferromagnetic and two normal contacts. He reported a regular two-probe gated-controlled tunneling magnetoresistance (TMR) signal and also the so-called "non-local" spin signal.

After the lunch, the scientific activity restarted with the session dedicated to Superconductivity and (Ferro)magnetism: Ru-based compounds, hybrid structures, etc. The opening talk was given by Andy Mackenzie, with a nice review of the properties of the ruthenate metals as they are known to date, asking whether Sr<sub>2</sub>RuO<sub>4</sub> will prove to be the only superconductor among the series, and suggesting some experiments at the nanoscale that might shed light on this issue. Sebastian Bergeret presented the study of the electronic and transport properties of a diffusive SNS junction in the presence of a perpendicular magnetic field. He showed that the field dependence of the critical current crosses over from the well-known Fraunhofer pattern in wide junctions to a monotonic decay when the width of the normal wire is smaller than the magnetic length. Antonio Vecchione illustrated the recent developments in the natural junctions of eutectic Sr<sub>2</sub>RuO<sub>4</sub>-Sr<sub>3</sub>Ru<sub>2</sub>O<sub>7</sub> crystals, where stacking of the two phases along the c-axis are formed. Structural analysis showed that good quality interface between the superconducting Sr<sub>2</sub>RuO<sub>4</sub> and the normal metal Sr<sub>3</sub>Ru<sub>2</sub>O<sub>7</sub> can be obtained by eutectic solidification using floating zone technique. The investigation of the superconducting behavior across a single Sr<sub>2</sub>RuO<sub>4</sub>-Sr<sub>3</sub>Ru<sub>2</sub>O<sub>7</sub> interface and of a macrodomain of Sr<sub>3</sub>Ru<sub>2</sub>O<sub>7</sub> showed the presence of a superconducting behavior not only in the normal Sr<sub>3</sub>Ru<sub>2</sub>O<sub>7</sub> at a distance of hundreds of microns from the superconducting Sr<sub>2</sub>RuO<sub>4</sub> domain but also in the individual Sr<sub>3</sub>Ru<sub>2</sub>O<sub>7</sub> domain. The results raise new interesting questions about the physics involved in system consisting of the spin-triplet Sr<sub>2</sub>RuO<sub>4</sub> and the metamagnet Sr<sub>3</sub>Ru<sub>2</sub>O<sub>7</sub>. Hans Braun presented a wide review on the Superconductivity and Magnetism in layered ruthenium-based layered cuprates RuSr<sub>2</sub>RECu<sub>2</sub>O<sub>8</sub> and RuSr<sub>2</sub>(RE<sub>1+x</sub>Ce<sub>1-x</sub>)Cu<sub>2</sub>O<sub>10</sub>, compounds that can be considered naturally occurring magnetic and superconducting multilayer systems. For some rare earths, the RuRE1212 is not obtained as a stable phase if prepared under ambient pressure.

Finally, Mario Cuoco discussed the interplay of (un)conventional superconductivity and Stoner- or kinetic- type ferromagnetism within homogeneous systems and hetero-structures. For the hetero-structures, he considered the proximity effect within a junction made of an unconventional superconductor (described by an extended Hubbard model with intersite attractive interaction) and a ferromagnet (assumed to be originated by a relative change in the bandwidths of electrons with

opposite spin) in the limit of high barrier transparency. Starting from the numerical solution of the Bogoliubov-de Gennes equations, he showed that the mechanisms for ferromagnetism lead to different features as concerns the propagation of singlet and triplet superconducting components in the F side of the junction as well as the formation of bound states at the interface. This considerably affects the opening of gap-like structures in the local density of states at the interface for majority and minority spin electrons, leading to distinct effects as one moves towards the half-metallic regime where the density of the minority carriers becomes vanishing.

On the second day of the workshop, the first presentation session was devoted to Microscopy and Spectroscopy techniques for studying the interplay Superconductivity-Magnetism. Annamaria Cucolo presented the study of F/S heterostructures  $\text{La}_{0.7}\text{Ca}_{0.3}\text{MnO}_3/\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$  (LCMO/YBCO) both bilayers and trilayers deposited by a multi-target high pressure dc sputtering. In particular, she focalized the attention on the effect of the substrate induced strain in LCMO thin films on STO substrates, inducing a tensile strain, and on compressive LAO substrates by using Frequency Modulation Atomic Force Microscopy and Magnetic Force Microscopy techniques. Dimitri Roditchev showed how to Probe the Superconducting Condensate surrounding Vortices by means of Scanning Tunneling Spectroscopy (STS) with superconducting tips. The STS mapping of the vortices in 2H-NbSe<sub>2</sub> with a superconducting Nb tip reveals both the vortex cores, on the scale of the superconducting coherence length, and the supercurrents, on the scale of the London penetration length, showing a subtle interplay between the superconducting pair potential and the supercurrents at the vortex edge. Ivan Maggio-Aprile outlined that the diversity of phenomena inferred from the vortex-core spectral properties provides significant information on the quest for a microscopic mechanism for unconventional superconductivity: Spatial variations of the zero bias conductance provides valuable estimations of the coherence length, while low bias spectroscopic features are intimately correlated with the symmetry of the superconducting order parameter. Lesley Cohen showed ho to use the Andreev Spectroscopy to interrogate the interplay between Superconductivity and Magnetism at Nanometer scale. First, she did a nice review of the progress made using Andreev spectroscopy to study highly spin polarised systems such as NiMnSb and CrO<sub>2</sub> and the more controversial dilute magnetic ZnO system. Then, she discussed the preliminary experiments using point contact spectroscopy to study the spin spiral MnSi, Andreev properties associated with domain walls and the prospects of using planar Andreev reflection to study spin accumulation in semiconductors such as InAs. The session concluded with Eva Olsson showing examples of functional nanostructures where information about, for example, nanostructure, properties, dynamics and transport properties have been obtained using high resolution analytical TEM. The next session was dedicated again to the S/F structures and it started with Mark Blamire discussing the Superconducting proximity effects with inhomogeneous ferromagnets. In particular, he reported the results of recent experiments in which natural and artificial spin spiral structures have been used to explore the proximity effects associated with inhomogeneous ferromagnets. Anatoli Sidorenko presented the study of Re-entrant behaviour and dimensional crossover in SF bilayers. He reported the first spectacular observation of a double-suppression of the critical temperature in Nb/CuNi bilayers. Carmine attanasio presented the measurements of the upper critical magnetic fields in Nb/PdNi and Nb/CuNi bilayers and trilayers. In the bilayers case the measurements, performed in the parallel configuration, reveal a dependence of the reduced two-dimensional–three-dimensional crossover temperature,  $t_{cr} = T_{cr}/T_c$ , on the different values of the S/F interface transparencies. In the case of the trilayers he observed a non-monotonic behaviour of the anisotropy coefficient  $\frac{H_{c2||}(0)}{H_{c2\perp}(0)}$  as a function of the ferromagnetic layer thickness,  $d_F$ . Ulrich Habermeier concluded the session by giving a talk titled:” Oxide Ferromagnet – Superconductor Interfaces: The Length Scales of Interaction”.

He focalized the attention on heterostructures and superlattices consisting of the half-metal ferromagnet  $\text{La}_{0.67}\text{Ca}_{0.33}\text{MnO}_3$  and superconducting  $\text{YBa}_2\text{Cu}_3\text{O}_7$  layers, fabricated by pulsed laser deposition techniques. He pointed out that at the interface interaction effects are taking place at several different length scales. At a short length scale of  $\sim 3$  nm charge transfer and/or orbital reconstruction takes place – as revealed by resonant X-ray absorption and XMCD measurements, at length scale of  $\sim 10$  nm self-injection of spin-polarized quasiparticles occurs and a scale in the 100 nm range an inverse proximity effect due to spin-polarized quasiparticles is observed.

The last session of the workshop on Saturday afternoon was dedicated to the perspectives for large scale applications. Actually due to the recent discovery of a new class of iron-based superconducting materials two speakers modified their talk to introduce this new and interesting topic. The session was open by Teun Klapwijk, Professor in Physics of Nanoelectronics at Delft University of Technology, discussing the Quasiparticle relaxation in high Q superconducting resonators in the presence of magnetic impurities. In particular, he presented measurements of the quasiparticle relaxation time in superconducting films shaped as planar resonators using the response of the complex conductivity to photon flux. During the talk he showed measurements for both Ta and Al indicating that at high temperatures the relaxation time increases with decreasing temperature, as expected for recombination using electron-phonon interaction, while at low temperatures is observed a saturation in both materials, indicating a second relaxation channel in the films. He has hypothesized that magnetic impurities cause the observed saturation in superconducting films and he showed as confirmation measurements on implanted Ta samples with small concentrations of Mn. The observation of a significant decrease of the relaxation time with increasing Mn concentration, suggests that magnetic impurities affect the low temperature dynamic properties in superconductors. The session continued with Renè Flukiger reporting specific heat measurements at magnetic fields up to 20 T on a polycrystalline sample of  $\text{SmO}_{0.85}\text{F}_{0.15}\text{FeAs}$  with  $T_c = 46$  K. The temperature dependence of  $B_{c2}$  was extracted from the specific heat curves, the corresponding  $B_{c2}(T=0)$  value derived from the Werthamer-Helfand-Hohenberg formula being 150 T. Based on magnetization measurements up to 9 T, he gave a first estimation of the field dependence of the inductive critical current  $J_c$ . Bartek Glowacki illustrated a method of decreasing AC losses and improving critical current density in multifilamentary conductors. He pointed out that magnetic materials can help to improve the performance of practical superconductors on the macro/micro scale as magnetic diverters and also on the nanoscale as effective pinning centres. It was established by numerical modelling that magnetic shielding of the filaments reduces AC losses in self-field conditions due to decoupling of the filaments and, at the same time, it increases the critical current of the composite. This effect is especially beneficial for coated conductors where anisotropic properties of the superconductor are amplified by the conductor architecture. However, ferromagnetic coatings are often chemically incompatible with  $\text{YBa}_2\text{Cu}_3\text{O}_7$  and  $(\text{Pb,Bi})_2\text{Sr}_2\text{Ca}_2\text{Cu}_3\text{O}_9$  conductors, and buffer layers have to be used. Moreover, he evidenced that a possible nanoscale method of improving the critical current density of superconducting conductors is the introduction of nanoscale/sub-micron magnetic pinning centres. However, the volumetric density and chemical compatibility of magnetic inclusions has to be controlled to avoid suppression of the superconducting properties. Rudolf Huebener presented his studies on Nonlinear Effects at High Flux-Flow Electric Fields. In particular, he focalized the attention on the flux-flow voltage in the mixed state of a type-II superconductor. As shown by Larkin and Ovchinnikov in 1975, the energy increase of the quasiparticles in the vortex core due to the electric field generated by vortex motion results in a shrinking of the vortex core, a corresponding reduction of the damping coefficient of vortex motion, and an instability of the flux-flow resistance. On the other hand, at sufficiently low temperatures the energy dependence of the quasiparticle density of states and, hence, of the quasiparticle scattering rate can cause distinct nonlinear effects in the flux-flow resistance. The recent advances in thin-film sample preparation provided new opportunities for

observing nonlinear effects of the latter kind. Janusz Karpinski reported for the first time single crystal growth and investigations of the structure and superconducting properties. Single crystals of  $\text{SmAsFe}_{1-x}\text{O}_x$  and polycrystalline samples of  $\text{RAsFe}_{1-x}\text{O}_x$  (R=Sm, Gd, Nd) have been grown using cubic anvil high-pressure technique. Superconducting critical temperature for single crystals and polycrystalline samples varies between 50 and 53 K. Structure refinement has been performed on single crystals. He also showed measurements of the upper critical field, anisotropy and superconducting gaps. The last talk of the workshop was given by Johannes Eisenmenger. He discussed about the temperature dependent matching field in flux-line lattice interacting with triangular array of pinning centers without long-range order.

After the scientific session, time has been dedicated to “Open Discussion – Planning of follow-up Research”. Participants agreed that the Workshop was a good appointment for exchange on the latest experimental results and theoretical advances in the field of coexistence and interplay of superconductivity and Magnetism. The program has been very much appreciated either for the contents, the high level of the talks and for the large time dedicated to the question time and discussion that allowed very interactive exchange of knowledge. The need for the workshop has been confirmed, due to the fast development of the field - in the last years, a spectrum of new materials with novel properties have been discovered. The participants discussed the European scale networking and collaboration that can produce crucial added value to these important fields in condensed matter physics research. Almost all participants have shown own interest in being involved in building up a wide program of collaborations, in light of reaching the principal goal of the Workshop, that of realizing an European network that can contribute to develop the scientific research .

### **3. Assessment of the results, contribution to the future direction of the field**

The workshop brought together european experts to discuss the theoretical and experimental aspects concerning the fundamental physics and the application perspectives of the phenomena happening at the nanometer scale due to the interplay between superconductivity and magnetism. The workshop enabled the participants to get an overview of existing research activities in Europe and to establish contacts with other participants. But the workshop also made clear that further coordination actions are needed in order to form a strong European network that can promote the development of the topic on international level. As expected, the workshop had a strong focus on the state of the art and the follow-up research. The wish for similar events to include more participants was also expressed. The workshop highlighted the need to study this topic in a fully integrated way, not just as the sum of its different components. The organizers are therefore convinced that the workshop achieved its goal as an “exploratory workshop” to establish a discussion platform and to initiate novel research in the proposed direction. For the near future the following outcome of this workshop is that we intend to set-up a network structure, where collaboration between different groups is essential. A number of topics have been identified as important areas for future research with increasing prospective potential. Participants will most likely cooperate in drafting a joint proposal for the COST actions on “Interplay between Superconductivity and Magnetism at nanometer scale”. This potential network should also stimulate the activities on this topic in Eastern Europe. We will also explore alternative venues of financing, including the ESF, for further meetings in this area.

## 4. Final programme

### Thursday 19 June 2008

evening

*Arrival (and dinner at hotel)*

### Friday 20 June 2008

08.20-08.30

**Welcome and Introduction**

**Filippo Giubileo** (CNR-INFM SUPERMAT Salerno, IT)

**Session I:**

**Superconductor/Ferromagnet (S/F) Nanostructures**

*Chair: Dimitri Roditchev*

08.30-08.55

**Nucleation of Superconductivity and Vortex Matter in Superconductor/Ferromagnet Hybrid Nanosystems**

**Victor V. Moshchalkov** (Katholieke Universiteit Leuven, BE)

08.55-09.20

**Proximity effect in superconductor-ferromagnet nanostructures**

**Alexander Buzdin** (University Bordeaux I, FR)

09.20-09.45

**Rocking Ratchet in Nanostructured Superconducting-Magnetic Hybrids**

**José Luis Vicent** (Universidad Complutense Madrid, ES)

09.45-10.10

**Experiments with hybrid lateral superconducting/ferromagnetic nanostructures**

**Victor Petrashov** (Royal Holloway, University of London, UK)

10.10-10.15

**Chairman's remarks**

*10.15-10.30*

*Coffee Break*

**Session II:**

**Spin dynamic in S/F heterostructures**

*Chair: Victor V. Moshchalkov*

10.30-10.55

**Spin and phase dynamics in ferromagnetic Josephson junctions**

**Marco Aprili** (Université Paris-Sud, FR)

10.55-11.20

**Spin switching and spin pumping in S/F heterostructures**

**Jan Aarts** (Leiden University, NL)

11.20-11.45

**Superconducting/ferromagnetic hybrid structures with spin-active interfaces**

**Audrey Cottet** (Ecole Normale Supérieure, Paris, FR)

11.45-12.10

**The role of interface transparency and spin-dependent scattering in diffusive ferromagnet/superconductor heterostructures**

**Jacob Linder** (Norwegian University of Science and Technology, NO)

12.10-12.35

**Quantum coherent spintronics with carbon nanotubes**

**Takis Kontos** (Ecole Normale Supérieure, Paris, FR)

12.35-12.40

**Chairman's remarks**

*12.40-14.00*

*Lunch*

**Session III:**

**Superconductivity and (Ferro)magnetism: Ru-based compounds, hybrid structures, etc.**

*Chair: Alexander Buzdin*

14.00-14.25

**Ruthenate magnetism and superconductivity**

**Andy Mackenzie** (University of St Andrews, UK)



14.25-14.50	<b>The Vortex State and Josephson Critical Current of a Diffusive SNS junction</b> <b>Sebastian Bergeret</b> (Universidad Autonoma de Madrid, ES)
14.50-15.15	<b>Recent developments in the natural junctions of Sr<sub>2</sub>RuO<sub>4</sub>-Sr<sub>3</sub>Ru<sub>2</sub>O<sub>7</sub> crystals</b> <b>Antonio Vecchione</b> (CNR-INFN SuperMAT Salerno, IT)
15.15-15.40	<b>Superconductivity and Magnetism in layered Ruthenocuprates</b> <b>Hans Braun</b> (University of Bayreuth, DE)
15.40-16.05	<b>Interplay of (un)conventional superconductivity and Stoner- or kinetic- type ferromagnetism within homogeneous systems and hetero-structures</b> <b>Mario Cuoco</b> (CNR-INFN SuperMAT Salerno, IT)
16.05-16.10	<b>Chairman's remarks</b>
16.10-16.25	<b>Presentation of the European Science Foundation (ESF)</b> <b>Kenneth Ruud</b> (Standing Committee for Physical and Engineering Sciences)
16.25-17.00	<b>Free Discussion - Coffee Break</b>
17.00	<i>Free time (visit to Archaeological site)</i>
	20.00 Dinner at hotel

## Saturday 21 June 2008

### Session IV: **Microscopy and Spectroscopy techniques for studying the interplay Superconductivity-Magnetism**

*Chair: Bartek A. Glowacki*

08.30-08.55	<b>Scanning Probe Microscopy on superconducting and magnetic materials</b> <b>Annamaria Cucolo</b> (University of Salerno, IT)
08.55-09.20	<b>Probing the Superconducting Condensate surrounding Vortices</b> <b>Dimitri Roditchev</b> (University Bordeaux I)
09.20-09.45	<b>Unveiling the vortex cores of superconductors with Scanning Tunneling Spectroscopy</b> <b>Ivan Maggio-Aprile</b> (University of Geneva, CH)
09.45-10.10	<b>Using Andreev Spectroscopy to interrogate the interplay between Superconductivity and Magnetism at Nanometer scale</b> <b>Lesley Cohen</b> (Imperial College London, UK)
10.10-10.35	<b>Functional Nanostructures and Interplay of Superconductivity and Magnetism</b> <b>Eva Olsson</b> (Chalmers University of Technology, SE)
10.35-10.40	<b>Chairman's remarks</b>
	10.40-11.00 Coffee Break

### Session V: **S/F structures**

*Chair: Andy Mackenzie*

11.00-11.25	<b>Superconducting proximity effects with Inhomogeneous ferromagnets</b> <b>Mark Blamire</b> (University of Cambridge, UK)
11.25-11.50	<b>Re-entrant behaviour and dimensional crossover in SF bilayers</b> <b>Anatoli Sidorenko</b> (Institute of Applied Physics Academy of Sciences of Moldova)
11.50-12.15	<b>Critical fields in Superconductor/Ferromagnet hybrids</b> <b>Carmine Attanasio</b> (University of Salerno, IT)

12.15-12.40	<b>Oxide Ferromagnet – Superconductor Interfaces: The Length Scales of Interaction</b> <b>Ulrich Habermeier</b> (Max Planck Institute Stuttgart, DE)
12.40-12.45	<b>Chairman's remarks</b>
	12.45-14.30 <i>Lunch</i>
<b>Session VI:</b>	<b>Towards Applications</b> <i>Chair: Ulrich Habermeier</i>
14.30-14.55	<b>Quasiparticle relaxation in high Q superconducting resonators in the presence of magnetic impurities</b> <b>Teun Klapwijk</b> (Delft University of Technology, NL)
14.55-15.20	<b>Upper critical fields well above 100 T for the superconductor <math>\text{SmO}_{0.85}\text{F}_{0.15}\text{FeAs}</math></b> <b>René Flukiger</b> (University of Geneva, CH)
15.20-15.45	<b>Superconducting-magnetic heterostructures: a method of decreasing AC losses and improving critical current density in multifilamentary conductors</b> <b>Bartek Glowacki</b> (University of Cambridge, UK)
15.45-16.10	<b>Nonlinear Effects at High Flux-Flow Electric Fields</b> <b>Rudolf Huebener</b> (Universitat Tübingen, DE)
16.10-16.35	<b>High pressure growth, structure refinement and superconducting properties of <math>\text{SmAsFeO}_{1-x}\text{F}_x</math> single crystals and polycrystalline samples</b> <b>Janusz Karpinski</b> (ETH Zurich, CH)
16.35-17.00	<b>Temperature dependent matching field in flux-line lattice interacting with triangular array of pinning centers without long-range order</b> <b>Johannes Eisenmenger</b> (University of Ulm, DE)
17.00-17.05	<b>Chairman's remarks</b>
	17.05-17.15 <i>Coffee Break</i>
17.15-18.30	<b>Open Discussion – Planning of follow-up Research</b>
18.30-18.40	<b>Concluding remarks</b>
18.40	<i>Free time</i>
	20.00 <i>Conference Dinner</i>

## Sunday 22 June 2008

morning          *departure*

# 5. Statistical information on participants

29 Participants (included the Convenor) –

Males: 25  
Females: 4

Age distribution:

# of Participants	age interval
8	< 40 years old
11	> 40 and < 50
10	> 50 years old

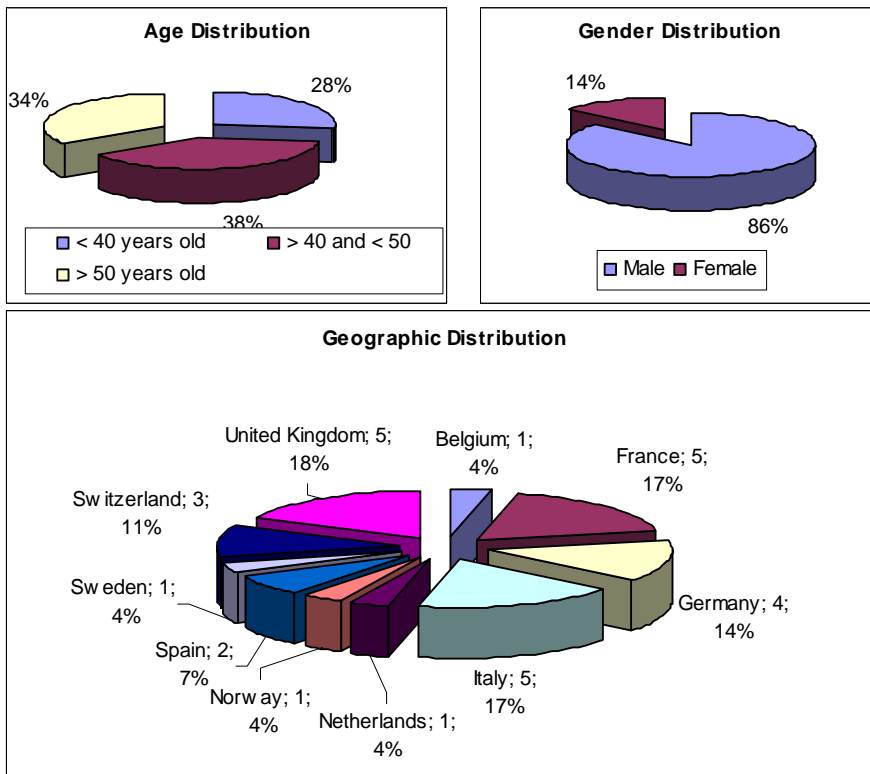
Geographic distribution:

1 Participant from non-ESF country

Republic of Moldova: 1

28 Participants from 10 ESF countries:

Belgium: 1  
 France: 5  
 Germany: 4  
 Italy: 5  
 Netherlands: 1  
 Norway: 1  
 Spain: 2  
 Sweden: 1  
 Switzerland: 3  
 United Kingdom: 5



## 6. The Final list of participants (full name and affiliation)

### Convenor:

1. **Filippo GIUBILEO**  
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### ESF Representative:

2. **Kenneth RUUD**  
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### Participants:

3. **Marco APRILI**  
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