PROGRAM
FRANK HEKKING
MEMORIAL WORKSHOP

28 > 30
JANUARY
2018

École de physique
des Houches

28th January, Sunday

28th January, Sunday

welcome

14:00

Session 1

Chair: *Luigi Amico*

Frank W. J. Hekking, his years as PhD student and postdoc

Gerd Schön,

Karlsruhe Institute of Technology (Germany)

In this short presentation I will review the early scientific life of Frank. He was my first "regular" PhD student, starting to work in my group in Delft in 1988 on various problems of mesoscopic electron transport. In 1991 he and his wife Erika moved with me to Karlsruhe, but Frank still defended his thesis in Delft according to the traditional Dutch rules. While in Karlsruhe the two got their first daughter, Hannah.

Frank had many qualities making him an exceptional physicist. But he was also a very social person, and it was great to have him in the group. I can mention that he organized conference excursions to the Black Forest, and he learned quickly not only good regular German but also mimicking the Karlsruhe dialect. In those years Frank established numerous scientific collaborations, which opened him many further opportunities. As a result he spent postdoc years at the University of Minnesota with Leonid Glazman, at Cambridge with Dima Khmetniskii, and at the University of Bochum with Kostya Efetov, before he was appointed professor in 1999 at the University in Grenoble.

Start - 14:20 • Finish - 14:40
Duration - 00:20

Frank Hekking, Professor at Université Grenoble Alpes

Hervé Courtois,

Institut NÉEL CNRS/UGA (France)

In this talk, I will review the career of Frank Hekking at the Université Joseph Fourier and later Université Grenoble Alpes. This will include a brief overview of the different scientific collaborations Frank had with Grenoble colleagues. I will discuss the various responsibilities he had for the university and the CNRS, including his directorship of his laboratory, the LPMMC. I will mention the creation of the Center for Theoretical Physics Grenoble Alpes and his membership of the Institut Universitaire de France.

Start - 14:40 • Finish - 15:00
Duration - 00:20

Charge and current modulation in superconducting cuprates

Konstantin Efetov,
Ruhr-Universitaet Bochum (Germany)

Several well-known phenomena in the hole-doped cuprates like breaking the rotational invariance, appearance of the pseudogap, charge modulation and d-wave superconductivity occur on a low energy scale of hundreds Kelvin. As it is not quite clear how to obtain these phases in an unified way from microscopic models of cuprates, we consider a low-energy model of fermions interacting with close to critical antiferromagnetic excitations. It is demonstrated in the mean field approximation that a variety of phase transitions are possible depending on the chemical potential and details of the electronic spectrum near the antinodes. In addition to the d-wave superconductivity and charge density wave with the diagonal modulation, we find a nematic transition (Pomeranchuk instability) followed by a transition to a charge density wave with a modulation along the bonds and d-wave formfactor. Further, it is found that an electron-hole pairing with an antiferromagnetic vector of cuprates is also possible. Remarkably, this pairing leads to circulating currents rather than to a charge modulation. Depending on the parameters of the electron spectrum one can also obtain an incommensurate structure of circulating currents. The nematic transition does not lead to formation of the gap but the circulating currents do. This gap is located at the antinodes and we associate this state with the pseudogap state. The results of our theory can serve as an explanation of recent experiments on cuprates performed with the help of STM, NMR, hard and resonant soft X-ray scattering, neutron scattering, sound propagation, and with some other techniques.

Start - 15:00 • Finish - 15:20
Duration - 00:20

Thermoelectric properties of quantum dot-based heat engines

Rosario Fazio,
Scuola Normale Superiore di Pisa (Italy)

Increasing the eciency of thermoelectric materials for heat-work conversion is one of the main challenges of present-days technology. Progress in understanding thermoelectricity at the nanoscale will have important applications for ultra-sensitive all-electric heat and energy transport detectors, energy transduction, heat rectifiers and refrigerators, just to mention a few examples. The search for optimisation of nano-scale heat engines and refrigerators has hence stimulated a large body of activity. I will review our recent activity in this field. I will analyse the efficiency of a thermal engine working in linear response regime in a multiterminal configuration. For the generic three-terminal case, we provide a general definition of local and non-local transport coefficients: electrical and thermal conductances, and thermoelectric powers. Within the Onsager formalism,it is possible to derive analytical expressions for the efficiency at maximum power, which can be written in terms of generalized figures of merit. In a multi-terminal device the (electronic) heat and charge currents can follow dierent paths. I will present a class of multi-terminal devices where this property is pushed to its extreme limits, with charge and heat currents owing in dierent reservoirs. After introducing the main characteristics of such heat-charge current separationregime Ishow how to realise it in a multi-terminal device with normal and superconducting leads. Interestingly this regime allows to control independently heat and charge flows and to greatly enhance thermoelectric performances at low temperatures. Finally I will consider the thermoelectric properties of a multi-level interacting quantum dot in the sequential tunneling regime, in a multi-terminal setup, both in the linear response regime and beyond.

Start - 15:20 • Finish - 15:40
Duration - 00:20

Indistinguishability of quantum states and rotation counting

Christoph Bruder,
University of Basel (Switzerland)

The properties of a quantum system will depend on the underlying configuration space. E.g., it makes a difference whether a particle propagates on an infinite line or on a ring. For angular variables like quantum phase variables, the question arises whether values that differ by a full rotation by 2\pi are identical or not. For real-space rotations, it is well-accepted that states that differ by a full rotation are identical. This fact determines the properties of orbital angular momentum, of the rotational spectra of molecules, and many properties of mesoscopic electronic systems. We describe a system [1] where this periodicity can be controlled by experimental parameters. E.g., the magnetic flux period of the Aharonov-Bohm effect (which is given by the fundamental constant h/e where h is Planck constant and e the electronic charge) can be changed to an integer fraction of h/e.

[1] D.V. Averin and C. Bruder, arXiv:1711.01495

Start - 15:40 • Finish - 16:00
Duration - 00:20

Mesoscopic superconductivity, computation, control and ultrastrong coupling

Giuseppe Falci,
University of Catania (Italy)

Mesoscopic Superconductivity and Quantum Optics have been since decades the two major scenarios where the theoretical ideas about design and control of an open quantum system have stimulated large experimental efforts, leading to several breakthrough discoveries in a fertile meeting point between fundamental and applied physics. After several years of almost independent life, quantum optics and mesoscopic physics merged in the last fifteen years, under the common umbrella of Quantum technologies. I will propose a personal review of some work and some perspective in this new field of quantum optics with mesoscopic superconductors in the regime of ultrastrongly coupling of light and matter.

Start - 16:00 • Finish - 16:20
Duration - 00:20

coffee break

16:20

Music intermezzo in memory of Frank

Session 2

Chair: Wiebke Guichard

V-shape artificial atom based on superconducting quantum circuit

Olivier Buisson,
Institut NÉEL CNRS/UGA (France)

During the last two decades, it has been shown that superconducting electrons dynamics inside superconducting circuits may follow quantum law at very low temperature. These circuits appear as artificial atoms whose properties are not fixed by the number of electrons or atom nucleus but by electronics compounds (capacitance, inductance, Josephson junction). These are adjustable during the nano-fabrication process and many quantum properties can then be reached through this optimization. In my talk I will present how we have built an artificial atom with V-shape energy spectrum. This atom is made of two transmons coupled via a large inductance [1,2]. The resulting circuit presents two modes showing strong non linear couplings between them such as longitudinal coupling or up-and-down energy conversion coupling. This leads to various quantum properties that will be discussed through recent experiments. Moreover such V-shape artificial atom is predicted to realize quantum non-demolition read out on the transmon qubit with a very high fidelity and very short measurement time. This novel readout proposal will be presented as well as its current implementation in a 3D transmon.

Start - 17:10 • Finish - 17:30
Duration - 00:20

Unveiling the bosonic nature in an ultrafast single electron pulse

Christopher Bauerle,
Institut NÉEL CNRS/UGA (France)

G. Roussely[1], E. Arrighi[1], S. Takada1, G. Georgiou[1], M. Schalk[1], A. Ludwig[2], A.D. Wieck[2], P. Armagnat[3], T. Kloss[3], X. Waintal[3], F. W. J. Hekking[4], T. Meunier[1] & C. Bäuerle[1]

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[2] Department of Applied Physics, University of Bochum, 44780 Bochum, Germany
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Quantum dynamics is very sensitive to dimensionality. While two-dimensional electronic systems form Fermi liquids, one-dimensional systems - Luttinger liquids - are described by purely bosonic excitations even though they are initially made of fermions. With the advent of coherent single electron sources, the quantum dynamics of such a liquid is now accessible at the single electron level. Here, we report on time-of-flight measurements of ultra-short single electron charge pulses injected into a quasi one-dimensional quantum conductor. We change the confinement potential from the one-dimensional Luttinger limit to the multi-channel Fermi liquid. Our measurements show that the plasmon velocity can be varied over almost an order of magnitude, even in the quantum regime where the pulses carry one or less electrons.

These results are in quantitative agreement with a parameter-free theory and demonstrate a powerful new probe for directly investigating the real-time dynamics of fractionalisation phenomena in low-dimensional conductors.

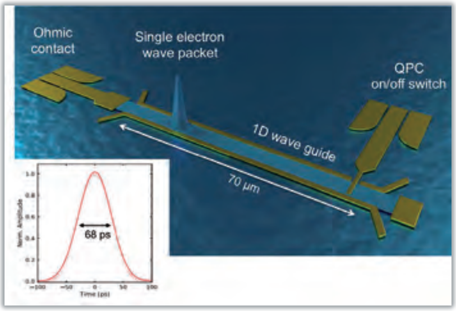


Fig 1: A single electron pulse is injected into the left ohmic contact and propagates through a 70 µm long quasi one-dimensional quantum conductor defined by electrostatic gates in a two-dimensional electron gas. The QPC to the right allows for time resolved detection of the electron wave packet.
Lower left panel: time resolved measurement of the electron wave packet.

Start - 17:30 • Finish - 17:50
Duration - 00:20

Non-equilibrium quasi-particles in disordered superconductors

Julia Meyer,
INAC/PHELIQS (France)

Experimentally, the concentration of quasiparticles in gapped superconductors always largely exceeds the equilibrium one at low temperatures. Since these quasiparticles are detrimental for many applications, it is important to understand the origin of the excess. We demonstrate that the dynamics of quasiparticles localized at spatial fluctuations of the gap edge becomes exponentially slow. This may give rise to the observed excess quasiparticles in the presence of a vanishingly weak nonequilibrium agent.

Start - 17:50 • Finish - 18:10
Duration - 00:20

Young researchers,
5 minutes each

Start - 18:10

Dinner
19:30

Music in memory of Frank: self-organized concert
21:00

29th January, Monday

Session 3

Chair: Anna Minguzzi

A simple implementation of an open system strongly coupled to radiation

Daniel Estève,

Quantronics, Service de Physique de l'Etat Condensé, CEA-Paris-Saclay (France)

I will first explain how a voltage biased Josephson junction connected in series with one (two,...) microwave resonator(s) provides a model situation for investigating the physics of an open system strongly coupled to radiation. I will describe in this talk a few phenomena we have investigated with this system.

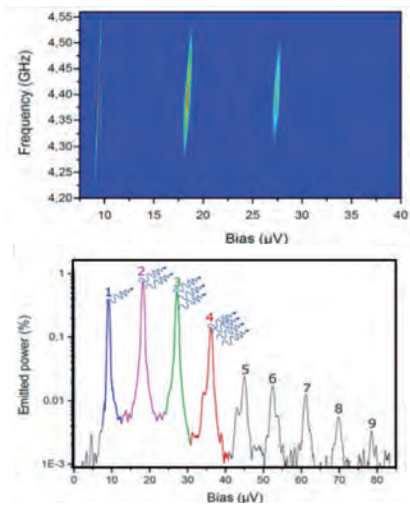
Here, the effective coupling constant between Cooper pair transfer across the Josephson junction and radiation can be made large by increasing the resonator characteristic impedance. In this regime that corresponds to the dynamical Coulomb blockade of Cooper pair tunneling [1], the transfer of a single Cooper pair only occurs when its electrostatic energy 2eV can be transformed in 1,2,..n photonic excitations in the resonator, that leak afterwards in the measuring line (see figure below).

We have also identified a recently predicted regime in which the presence of a single photon in the resonator blocks the creation of a second one, which forces the resonator to emit a single photon in the external circuit before another Cooper pair can pass and re-excite it: Cooper pair transfer and photon emission are locked.

Using a two-mode resonator circuit with different frequencies, we have investigated the regime where the transfer of a single Cooper pair simultaneously excites a single photonic excitation in each mode. We show that the quantum state of the emitted radiation is non-classical [2], and that the photons leaking out of the two resonators are entangled.

[1] Hofheinz et al., Phys. Rev. Lett. 106, 217005 (2011).

[2] Westig et al., Phys. Rev. Lett. 119, 137001 (2017).



Above: Emitted microwave power (false colors) of a voltage biased Josephson junction in series with a high impedance microwave resonator.

Below: The microwave power integrated over the resonator bandwidth shows many photon processes.

Start - 8:30 • Finish - 8:50
Duration - 00:20

Universal theory for out-of-equilibrium transport: application to driven Josephson junctions

Ines Safi,
Laboratoire de Physique des Solides
Université Paris-Saclay (France)

Universal theory for out-of-equilibrium transport: application to driven Josephson junctions. We aim to present some aspects and applications of a universal out-of-equilibrium perturbative theory [1] with respect to a Hamiltonian whose time-dependence (TD) can be periodic [2] or not, and controlled through external TD or fluctuating fields. The Hamiltonian terms are all arbitrary, and are required to ensure merely one condition. Such a theory covers a large domain of physical problems, and has been useful in numerous theoretical and experimental works, [3] some of which have tested directly some of the theorems it led too.[4] It has also allowed us to revisit the implementation of minimal excitations in non-linear systems. [5] In the stationary regime, it generalizes to a large extent the Rogovin-Scalapino formula for out-of-equilibrium noise, and provides its version in case the current average is not symmetric. We will focus on its relevance to Josephson junctions (JJs) coupled strongly to an electromagnetic environment in both dual limits : EJ<>E_c, where E_J and E_c are the Josephson and charging energies. A recent work by A. Di Marco, F. Hekking with G. Rastelli, modelling the regime E_J>>E_c through « phase particle » tunneling, has recovered our theorem for the average voltage, through its explicit calculation. We show that the theory alllows us to go further : it provides the out-of-equilibrium admittance and voltage fluctuations at zero or finite frequencies. In particular, the expression of zero-frequency voltage noise, having a quadratic behavior at low bias, has been tested experimentally in Ref.8. ■■■

■■■ References:

[1]-I. Safi, «Time-dependent Transport in arbitrary extended driven tunnel junctions» arXiv:1401.5950. I. Safi, « Universal perturbative theory for periodic or non-periodic driving. Part I: Probing ratchet effects and using them as probes. », submitted to Phys. Rev. B.

[2]-I. Safi and E. Sukhorukov, «Determination of tunneling charge via current measurements», Eur. Phys. Lett. 91, 67008 (2010). B. Roussel, P. Degiovanni et I. Safi, « Perturbative fluctuation dissipation relation for non-equilibrium finite frequency noise in quantum circuits » Phys. Rev. B 93, 045102 (2016)

[3]-M. Hofheinz et al., « The bright side of Coulomb Blockade », Phys. Rev. Lett. 106, 217005 (2011). S. Jebari et al, arXiv:1704.04432 (2017).

[4]-C. Altimiras et al. "Dynamical Coulomb Blockade of Shot Noise" Phys. Rev. Lett. 112, 236803 (2014). O. Parlavecchio, C. Altimiras, J.-R. Souquet, P. Simon, I. Safi, P. Joyez, D. Vion, P. Roche, D. Estève, and F. Portier, "Fluctuation-dissipation relations of a tunnel junction driven by a quantum circuit", Phys. Rev. Lett. 114, 126801 (2015)

[5]-J. Keeling et al, Phys. Rev. Lett. 97,116403 (2006). J. Dubois et al. Nature 502, 659 (2013).

[6]-A. Di Marco, F. W. J. Hekking, and G. Rastelli, Phys. Rev. B 91, 184512 (2015).

[7]-I. Safi, in "Noise and Fluctuations", AIP Conference Proceedings of XX Int. Conf. on Noise and Fluctuations (Pisa 2009), 1129, ed. M. Macucci and G. Basso (AIP, Melville, New York, 2009). I. Safi and P. Joyez, Phys. Rev. B 84, 205129 (2011).

[8]-J-Y Wang, T-H Chung, T-H Lee, and C-D Chen, « Quadratic Characteristics of Environment Induced Voltage Shot Noise in Josephson Junctions », Scientific Reports 7 :3567 (2017).

Start - 8:50 • Finish - 9:10
Duration - 00:20

Dynamics of quasiparticles in Andreev quantum dots

Hugues Pothier,
SPEC, CEA-Saclay (France)

In contrast with a bulk superconductor, a single-channel phase-biased superconducting weak link hosts a discrete subgap quasiparticle state, called « Andreev state ».
As such, it can be seen as a sort of quantum dot in quasiparticles can be trapped, not due to electrostatic barriers, but to the phase drop. I will present vey recent experiments in which, by coupling Andreev quantum dots obtained at one-atom contacts between aluminum electrodes to a microwave resonator (circuit-QED setup), we probe the transitions between states with 0, 1 and 2 quasiparticles.

Start - 9:10 • Finish - 9:30
Duration - 00:20

Revealing topological edge states in Bismuth nanowires by proximity induced superconductivity

Hélène Bouchiat,
Laboratoire de Physique des Solides, Orsay (France)

We provide a direct signature of ballistic 1D transport along the topological surfaces of a monocrystalline bismuth nanowire connected to superconducting electrodes in an asymmetrical SQUID geometry The measurement of the Current Phase Relation is an exquisite tool to discriminate between different transport regimes (ballistic, diffusive, tunnel,...). The sharp sawtooth-shaped CPR we find demonstrates that transport of Cooper pairs occurs ballistically along two edges of the nanowire, whose positions can be deduced from experiments in different magnetic field orientations. In order to investigate the topological nature of these edge states we have also inductively coupled the NS loop to a multimode superconducting resonator, with eigen-frequencies ranging from 300 MHz up to 6 GHz. We have measured sharp absorbtion peaks around odd multiples of pi. The frequency and temperature evolution of this phase dependent absorption spectrum can be analyzed using a simple low energy model taking into the nearly perfect crossing of Andreev bound states at phase pi.

Start - 9:30 • Finish - 9:50
Duration - 00:20

Microscopic model of quantum butterfly effect: out-of-time-order correlators and traveling combustion waves

Lara Faoro,
LPTHE (France)

In a chaotic classical system a small perturbation leads to the exponential divergence of trajectories characterized by Lyapunov time. As a result, the observables in two copies of the system experiencing different perturbations quickly become uncorrelated. In a many body system a local perturbation initially destroys the correlations locally, then the region where the correlations are destroyed quickly grows with time. This phenomena is known as butterfly effect.
The concept of butterfly effect can be generalized to a closed chaotic quantum system even though such generic system does not necessarily have a direct analogue of Lyapunov divergence of trajectories because quantum mechanics prohibits the infinitesimal shift of the trajectory. The convenient measure of the butterfly effect is provided by the out-of-time-order correlator (OTOC) .
In this work, we extend the Keldysh technique to enable the computation of OTOC. We show that the behavior of these correlators is described by equations that display initially an exponential instability which is followed by a linear propagation of the decoherence between two initially identically copies of the quantum many body systems with interactions. At large times the decoherence propagation (quantum butterfly effect) is described by a diffusion equation with non-linear dissipation known in the theory of combustion waves. The solution of this equation is a propagating non-linear wave moving with constant velocity despite the diffusive character of the underlying dynamics. ■■■

■■■ Our general conclusions are illustrated by the detailed computations for the specific models describing the electrons interacting with bosonic degrees of freedom (phonons, two-level-systems etc.) or with each other.

Ref: I. Aleiner, L. Faoro and L. Ioffe, Annals of Physics 375, 378-406 (2016)

Start - 9:50 • Finish - 10:10
Duration - 00:20

coffee break
10:10

FRANK HEKKING

Session 4

Chair: Hervé Courtois

Reconstructing Nonlinearity with Intermodulation Spectroscopy

David Haviland,

Royal Institute of Technology (Sweden)

This talk will describe the use of frequency combs to probe nonlinear oscillations. High Q resonators are frequently applied in precision measurement, where the system of interest is probed by measuring how it perturbs the dynamics of the resonator. Often this perturbation is nonlinear. Driving the nonlinear resonator with two our more pure tones creates many high-order intermodulation (frequency mixing) products near resonance, where this nonlinear response can be measured with high signal-to-noise ratio. A remarkably simple method exists for extraction of the parameters the nonlinear perturbation, from a phase-coherent measurement of many intermodulation products. A key aspect of the multi-frequency lock-in measurement technique is the 'tuning' of the multiple drive tones. The intermodulation spectral method will be discussed in the context of two applications: Dynamic AFM and measurement of surface forces, and cluster-state generation in nonlinear superconducting circuits.

Start - 10:40 • Finish - 11:00
Duration - 00:20

Thermal drag in capacitively-coupled metallic islands

Fabio Taddei,

Istituto Nanoscienze-CNR (Italy)

Two electrically isolated conductors placed close together can still be coupled via Coulomb interaction. As a result, when a bias is only applied to one conductor, electronic currents can be generated in the other unbiased one, thus inducing a dragged charge current. Here we study the drag of heat in a capacitively-coupled system composed of two Coulomb blockaded metallic islands. They are placed in the two branches (the driver and the drag) of a four-electrode setup. The system is biased, either by a voltage or by a temperature difference, on the driver branch, while no biases are present on the drag branch. We study the general properties of the dragged heat current, also accounting for co-tunnelling contributions, making use of the master equation. Analytic results are obtained in the sequential tunnelling regime for small biases. In particular, we find that the dragged heat current is quadratic in the applied voltage or temperature bias, even when co-tunnelling processes are included. We also analyse the dragged heat current for arbitrary values of voltage and temperature bias and find that it is non-monotonous as a function the coupling between the islands. Finally, we consider the presence of a superconducting electrode in the drag branch which, in addition to the dragged heat current, gives rise to a finite dragged charge current.

Start - 11:00 • Finish - 11:20
Duration - 00:20

Fractional quantum Hall effect and Wigner crystallization in suspended graphene

Pertti Hakonen,
Aalto University (Finland)

The structure of the many-body ground state of a 2D electron gas has been under intense theoretical and experimental investigation over the past 40 years. Many unexpected findings, e.g. such as the fractional quantum Hall effect, have made this research area as one of the most fascinating of modern condensed matter physics. As for the present aspirations, fractional elementary excitations and their possible non-Abelian statistics have raised hopes for unconventional applications of these systems in future quantum technologies. Suspended monolayer graphene forms an excellent, new platform to investigate these many-body phenomena. Suspended graphene provides a system where the Coulomb energy is maximized owing to the small dielectric constant of its environment, much lower than obtained in the regular semiconductor heterostructures. This favors crystallization of the electrons into a Wigner crystal phase as well as it enhances the energy gaps of the incompressible fractional quantum Hall (FQH) liquid states. Hence, an unprecedentedly rich sequence of ordered phases can be expected. We have investigated the Wigner crystal order and the FQH liquid phases of suspended graphene in Corbino geometry. Our results indicate an unconventional sequence of FQH phases, which is consistent with the composite fermion theory including weak residual interactions. With lowering electron density, the sequence of FQH states is interrupted by Wigner crystal order at Landau level filling factors $\nu = 1/7 \dots 1/5$. In my talk, besides the basic 2D electron gas many-body correlations, I will discuss the basic experimental results giving rise to the above conclusions.

Start - 11:20 • Finish - 11:40
Duration - 00:20

Coherence in thermal transport in Josephson circuits

Francesco Giazotto,
NEST, Istituto Nanoscienze-CNR (Italy)

The emerging field of phase-coherent caloritronics (from the Latin word calor, heat) [1] is based on the possibility of controlling heat currents by using the phase difference of the superconducting order parameter. The goal is to design and implement thermal devices that can control energy transfer with a degree of accuracy approaching that reached for charge transport by contemporary electronic components. This can be done by making use of the macroscopic quantum coherence intrinsic to superconducting condensates, which manifests itself through the Josephson effect and the proximity effect. Here, I will initially report the first experimental realization of a heat interferometer [2-4]. We investigate heat exchange between two normal metal electrodes kept at different temperatures and tunnel-coupled to each other through a thermal device in the form of a DC-SQUID. Heat transport in the system is found to be phase dependent, in agreement with the original prediction. After this initial demonstration, we have extended the concept of heat interferometry to various other devices, implementing the first quantum `diffractor' for thermal fluxes [5, 6], realizing the first balanced Josephson heat modulator [7], and the first tunable 0-pi thermal Josephson junction [8].

Finally, I will conclude by showing the realization of the first phase-tunable thermal router [9] which is able to control the heat transferred between two terminals residing at different temperatures. Thanks to the Josephson effect, our structure allows to regulate the thermal gradient between the output electrodes until reaching its inversion, and represents an important step towards the realization of caloritronic logic components. ■■■

References:

[1] A. Fornieri and F. Giazotto, Nat. Nanotechnol. 12, 944 (2017).
[2] B. D. Josephson, Phys. Lett. 1, 251 (1962).
[3] K. Maki and A. Griffin, Phys. Rev. Lett. 15, 921 (1965).
[4] F. Giazotto and M. J. Martínez-Pérez, Nature 492, 401 (2012).
[5] F. Giazotto, M. J. Martínez-Pérez, and P. Solinas, Phys. Rev B 88, 094506 (2013).
[6] M. J. Martínez-Pérez and F. Giazotto, Nat. Commun. 5, 3579 (2014).
[7] A. Fornieri, C. Blanc, R. Bosisio, S. D'Ambrosio, and F. Giazotto, Nat. Nanotechnol. 11, 258 (2016).
[8] A. Fornieri, G. Timossi, P. Virtanen, P. Solinas, and F. Giazotto, Nat. Nanotechnol. 12, 425 (2017).
[9] G. Timossi, A. Fornieri, F. Paolucci, C. Puglia, and F. Giazotto, arXiv:1710.04606v1 (submitted 2017).

Start - 11:40 • Finish - 12:00
Duration - 00:20

Lunch

12:00

Session 5

Chair: Jukka Pekola

Non-ergodicity in many body systems and disordered random graphs; application to the phase diagram Josephson junction chain

Lev Ioffe,
LPTHE (France)

At very high disorder a generic closed quantum systems becomes completely localized. I argue that this (many body) localization is preempted by a wide regime of non-ergodic behavior that displays a number of unusual properties. A good system to study these effects are Josephson junction arrays in a somewhat unusual regime.

The toy model of disordered many body systems that capture the physics of many body systems is provided by random regular graphs. I will sketch a simplified analytical theory of the non-ergodic phase in this models, compare the results with the direct numerical simulations and summarize the conclusions relevant for physical many body systems.

Start - 14:00 • Finish - 14:20
Duration - 00:20

A conducting fixed point in quantum wires with backscattering

Alexander Altland,
Institute for theoretical physics (Germany)

According to conventional wisdom the presence of impurities in single channel repulsively interacting quantum wires (Luttinger liquids) leads to insulating behavior at low temperatures. This has been established both for the coherent scattering off localized potential and the fully incoherent scattering off cavities or quantum dots. However generic imperfections support both both coherent and incoherent scattering. In this talk we argue that the simultaneous presence of both channels leads to the formation of a highly universal attractive low temperature fixed point characterized by a reflection and transmission probability of 1/2 each - a beam splitter. We will discuss the mechanisms behind this phenomenon and its signatures in low temperature quantum transport. The work is inspired by an earlier one with Frank, PRL 83, 1203 (1999)

Start - 14:20 • Finish - 14:40
Duration - 00:20

Topologically protected Landau level in the vortex lattice of a Weyl superconductor

Carlo Beenakker,
Instituut-Lorentz (The Netherlands)

The question whether the mixed phase of a gapless superconductor can support a Landau level is a celebrated problem in the context of d-wave superconductivity, with a negative answer: The scattering of the subgap excitations (massless Dirac fermions) by the vortex lattice destroys any signs of Landau level quantization in the spectrum. Here we show that the same question has a positive answer for a Weyl superconductor: The chirality of the Weyl fermions protects the zeroth Landau level by means of a topological index theorem. As a result, the heat conductance parallel to the magnetic field has the universal value of one-half the thermal conductance quantum per vortex.

Start - 14:40 • Finish - 15:00
Duration - 00:20

Quantum dots coupled to superconducting reservoirs

Benoit Douçot,
CNRS and Université Pierre et Marie Curie, Sorbonne Universités (France)

The physics of quantum dots coupled to superconducting reservoirs offers a very interesting example of discrete energy levels with a tunable coupling to a macroscopic environment. Indeed, the sharp Andreev boundstates present in equilibrium are broadened at finite voltage bias into resonances as the result of multiple Andreev reflections (MAR). I will focuss on voltage configurations such that the resulting Hamiltonian is a periodic function of time. A specially interesting example is provided by a three terminal system biased at Va=-Vb and Vc=0. On top of the usual ac Josephson effect, dc quartet currents are expected, due to coherent processes involving two incoming Cooper from the c terminal recombining into one Cooper pair on terminal a and another one on terminal b. I will show how a simple physical picture, based on Floquet-Wannier-Stark ladders and semi-classical ideas, sheds light on this quartet physics. I will apply it also to discuss the onset of long-range correlations between two dots, mediated by non-local MAR processes.

Start - 15:00 • Finish - 15:20
Duration - 00:20

Quantum phase slips in superconducting wires and Josephson junction chains with periodic spatial modulations

Denis Basko,
LPMMC (France)

We study coherent quantum phase-slips, which lift the ground state degeneracy in a superconducting loop made of a thin metallic wire or a Josephson junction chain, pierced by a magnetic flux, whose magnitude is equal to half of a flux quantum. The quantum phase-slip amplitude is sensitive to the normal mode structure of superconducting phase oscillations in the loop (Mooij-Schoen modes). These, in turn are affected by long-range spatial inhomogeneities in the loop. We analyze the case of weak periodic modulations of the system parameters and calculate the corresponding modification of the quantum phase-slip amplitude.

Start - 15:20 • Finish - 15:40
Duration - 00:20

coffee break
15:40

Session 6

Chair: Anna Minguzzi

Exploring Interacting Topological Insulators with Ultracold Atoms: the Synthetic Creutz-Hubbard Model

Matteo Rizzi,
Institut für Physik (Germany)

Understanding the robustness of topological phases of matter in the presence of strong interactions, and synthesising novel strongly-correlated topological materials, lie among the most important and difficult challenges of modern theoretical and experimental physics. The synthetic Creutz-Hubbard ladder is a paradigmatic model that provides a neat playground to address these challenges, including the generation of flat bands as well as of non-doubled Dirac dispersion relations.
In [1], we present a theoretical analysis of the competition between correlated topological phases and orbital quantum magnetism in the regime of strong interactions at half-filling.
We predict topological quantum phase transitions for weak and intermediate interactions with different underlying conformal field theories (CFTs), i.e. Dirac versus Majorana CFTs.
In [2], we study the response of an interacting system of Dirac-Weyl fermions confined in a one-dimensional (1D) ring: we show that tuning of interactions leads to a unique many-body system that displays either a suppression or an enhancement of the Drude weight-the zero-frequency peak in the ac conductivity-with respect to the non-interacting value. ■■■

■■■ Both studies are furthermore confirmed and extended by extensive numerical simulations based on matrix product states (MPS) and binary Tree Tensor Networks (bTTN).
Moreover we propose how to experimentally realize this model in a synthetic ladder, made of two internal states of ultracold fermionic atoms in a one-dimensional optical lattice.

References:

[1] J. Jünemann, et al., PRX 7, 031057 (2017)
[2] M. Bischoff, et al., arXiv:1706.02679.

Start - 16:10 • Finish - 16:30
Duration - 00:20

An annular quantum gas - towards an atomic SQUID

Hélène Perrin,
Laboratoire de Physique des Lasers (France)

In my talk I will present experimental results obtained within the ANR project `SuperRing' to which Frank participated. The aim of the project is to take advantage of the ring geometry to study superfluidity, through the existence of persistent currents (or equivalently persistent atomic flows) in this geometry. We have conceived and build a ring trap for ultra cold atoms to this purpose. The ring trap is a paradigm for an atomic version of a SQUID, in which junctions will be obtained by adding barriers (with focused laser spots) and the magnetic field is equivalent to inducing a rotation of the neutral particles. I will report on the status of the experiment, showing the annular gas and the different tools developed to match the solid state case.

Start - 16:30 • Finish - 16:50
Duration - 00:20

Entanglement and visibility in Bose-Bose mixtures of cold trapped atoms

Dominique Spehner,
Facultad de Ciencias Físicas y Matemáticas, Universidad de Concepción (Chile)

We study the dynamics of mixtures of two species of bosonic atoms trapped in a 1-dimensional ring. The two atomic gases, initially in their ground states, are put into contact at time t=0, so that atoms of the first species (A) start interacting with atoms of the second species (B). We focus in particular on the A-B entanglement at large times for stong A-B interactions, and relate it to the initial visibility.

Start - 16:50 • Finish - 17:10
Duration - 00:20

Quantum stirring of an interacting one dimensional Bose gas

Roberta Citro,
University of Salerno (Italy)

Quantum stirring with a laser beam is shown to be a probe of superfluidlike behavior for a strongly interacting one-dimensional Bose gas confined to a ring. Within the Luttinger liquid theory framework, we have calculated the fraction of stirred particles per period as a function of the stirring velocity, the interaction strength, and the coupling between the stirring beam and the bosons. We have shown that the stirred fraction is never zero due to the presence of strong quantum fluctuations in one dimension, implying imperfect superfluid behavior under transport. Some experimental issues on quantum stirring in ring-trapped condensates are also discussed.

Start - 17:10 • Finish - 17:30
Duration - 00:20

Energy transport in out-of-equilibrium parafermionic models

Davide Rossini,
University of Pisa (Italy)

We study the energy transport in a basic quantum quench protocol of interacting parafermions. Namely, we consider a lattice system of two half-infinite parafermionic Hamiltonians, initially kept separated at different temperatures, and later connected and let free to evolve unitarily. Through dephasing, at late times the state becomes locally equivalent to a stationary state which explicitly depends on position and time. At low energies, the model is described by a conformal field theory with a fractional charge, and it is possible to analytically calculate the stationary current through a scattering approach. At higher energies, we employ a kinetic theory of elementary excitations and derive a continuity equation which is able to characterize the thermodynamics of the model. We benchmark our predictions with the help of numerical simulations based on time-dependent matrix product states.

Start - 17:30 • Finish - 17:50
Duration - 00:20

Free time
17:50

Dinner
19:30

Young researchers,
poster session

Enrico Compagno
Angelo Di Marco
Nicolas Didier
Michele Filippone
Juan Polo-Gomez
Hamza Jirari
Etienne Jussiau
Piero Naldesi
Ioan Pop
Gianluca Rastelli
Jacopo Settino
Aleksandr Svetogorov
Andrei Vasenko
Nicolas Victorin

Start - 21:30 • Finish - 22:30
Duration - 1:00

NOON states via a quantum walk of bound particles

Enrico Compagno,
Labex Laboratoire d'Alliances Nanosciences-Energies du Futur et Institut NÉEL (France)

The possibility of designing schemes useful for developing quantum technology devices of practical value necessitates exploiting quantum coherence effects in a feasible way. Tight-binding lattice models allow the creation of bound composite objects which, in the strong-interacting regime, are protected against dissociation. How to harness their natural evolution in a many-site lattice for applications is still an open question. We show that in a 1D finite lattice a coherent split of an incoming bound particle wave-packet can be triggered through the introduction of a local impurity in the lattice potential which consequently produces a NOON state between the endpoints. This is non-trivial because when finite lattices are involved, edge-localisation effects make their use for non-classical state generation and information transfer challenging. We derive an effective model for describing the dynamics of bound state in a Bose-Hubbard model chain. Via few local impurities in the lattice potential we inhibit localisation effects and split the propagating bound particle wave-packet, thus enabling the generation of distant NOON states. Finally, we analyse how minimal engineering transfer schemes improve the transfer fidelity and we quantify the robustness to typical decoherence effects in optical lattice implementations. Our scheme potentially has an impact on quantum-enhanced atomic interferometry in a lattice.

Photon emission of a Josephson junction in the over-bias regime

Angelo Di Marco,
Chalmers University (Sweden)

We study the dynamics of a voltage-biased Josephson junction connected to a microwave cavity and to an external (dissipative) electromagnetic environment, characterized by an impedance with a finite thermal noise. In this system, generally, single-photon and two-photon emission can occur due to the tunneling of one and two Cooper pairs, respectively. Moreover, the statistics of the (microwave) photons, collected into the QED cavity, can be non-classical due to the quantum nature of the source. In our work, we focus on the yet unexplored over-bias regime in which we can have the emission of a single photon due to the coherent tunneling of two Cooper pairs. In particular, we investigate how the environment affects the occurrence of this process as well as the statistics of the corresponding emitted photons. We address this issue by calculating the Cooper pair current, the average photon occupation of the cavity and the corresponding Fano factor beyond perturbation theory in the Josephson energy and by taking into account non gaussian fluctuations. Our findings are of interest for the understanding of the physics of photon-charge interaction in nanoscale devices, of importance for future technological applications based on the use of non-classical light.

Parametric entangling gates

Nicolas Didier,
Rigetti Quantum Computing (United States)

The theory and experimental realization of parametric entangling gates for transmon qubits is presented. I have not felt such enthusiam to collaborate closely with experimentalists since the realization of a phase qubit with Frank and the group of Olivier Buisson.

Controlled parity switch of persistent currents in quantum ladders

Michele Filippone,
University of Geneva (Switzerland)

We investigate the behavior of persistent currents for a fixed number of noninteracting fermions in a periodic quantum ladder threaded by Aharonov-Bohm and transverse magnetic fluxes Φ and χ. We show that the coupling between ladder legs provides a way to effectively change the ground-state fermion-number parity, by varying χ. Specifically, we demonstrate that varying χ by 2π (one flux quantum) leads to an apparent fermion-number parity switch. We find that persistent currents exhibit a robust 4π periodicity as a function of χ, despite the fact that $\chi \to \chi + 2\pi$ leads to modifications of order $1/N$ of the energy spectrum, where N is the number of sites in each ladder leg. We show that these parity-switch and 4π periodicity effects are robust with respect to temperature and disorder. We provide explicit connections between this mesoscopic effect and more conventional quantum Hall effects and also outline potential physical realizations using cold atomic gases and, for bosonic analogs of the effects, photonic lattices.

Josephson oscillations in strongly correlated one-dimensional atomic gases

Juan Polo Gomez,
LPMMC Grenoble (France)

We study the Josephson oscillations of two strongly correlated one-dimensional bosonic clouds separated by a localized barrier. Using a quantum-Langevin approach and the exact Tonks-Girardeau solution in the impenetrable-boson limit, we determine the dynamical evolution of the particle-number imbalance, displaying an effective damping of the Josephson oscillations which depends on barrier height and interaction strength. The damping rate originates from quantum and thermal fluctuations intrinsically present in the strongly correlated gas and can be understood in the fermionized limit as due to dephasing of multiple particle-hole excitations. Thanks to the density-phase duality of the model, the same results apply to angular-momentum oscillations in a one-dimensional ring where a weak barrier couples different angular momentum states.

Quantum Brachistochrone

Hamza Jirari

The main objective of my presentation is optimal control of decoherence and dissipation in a system of interacting qubit. First, we use the Bloch-Redfield formalism to derive the master equation describing the evolution of a dissipative multi-qubit systems in the presence of a time-dependent external control field. Then optimal control theory is considered as a methodology to calculate the field that generates a quantum logical gate in minimum time (Quantum Brachistochrone).

Transport properties in the Fano-Anderson model

Etienne Jussiau,
LPMMC Grenoble (France)

In order to understand open quantum systems in the strong coupling regime, we study an exactly solvable model: the Fano-Anderson model. The presence of a bound state with infinite lifetime in this model has been studied on several occasions. We highlight here the effects of the latter on the transport properties of a quantum thermoelectric.

Scattering of solitons from a potential barrier in lattice systems

Piero Naldesi,
LPMMC Grenoble (France)

Attractive interactions in one dimensional Bose fluids give rise to very peculiar features. For instance they lead to the creation of bright solitons: localized wave-packets of particles that propagate without dispersion. Solitons, on the other hand can be the fundamental elements for fabricating mesoscopic Schrödinger cat states or for building a Sagnac interferometer in Atomtronics circuits. These two applications rely on the ability to split a soliton, for instance making it scatter with a potential barrier. Thus, we start analyzing the fundamental aspects of attractive bosons in a lattice, to then focus on the study of the fragmentation of a solitonic state in presence of a barrier.

Fluxon-Based Quantum Simulation in circuit QED

Ioan Pop,
Karlsruhe Institute of Technology (Germany)

I will present an idea of trapping long lived fluxon excitations in a highly inductive network of Josephson junctions, and use the resulting fluxon quantum dynamics to perform quantum simulations of tight binding models.

Dissipative phase transition with quantum frustration

Gianluca Rastelli,
University of Konstanz (Germany)

We study the quantum phase transition of the one dimensional phase model in presence of quantum frustration, provided by a dissipative interaction of the system with the environment through two non-commuting operators. Such a model can be realized in Josephson junction chains (1DJJ) with shunt resistances and resistances between the chain and the ground. Using a selfconsistent harmonic approximation (SCHA), we determine the phase diagram at zero temperature which exhibits a quantum phase transition between a long-range ordered phase, corresponding to the superconducting state, and a disordered phase, corresponding to the insulator of the pristine 1DJJ. Interestingly, we find that the critical line separating the two phases has a nonmonotonic behavior as a function of the dissipative coupling strength. This result is a consequence of the frustration between (i) the first dissipative coupling that quenches the quantum phase fluctuations favoring the ordered phase and (ii) the second one that quenches the quantum charge fluctuations leading to a vanishing of the phase coherence. Moreover, within the SCHA, we analyse the cross-over between between a first order and a second order phase transition as increasing the dissipative coupling showing that quantum frustration increase the range where the phase transition is second order. This behavior is reflected also in the purity of the system that quantifies the degree of correlation between the system and the environment, and the logarithmic negativity as entanglement measure that encodes the internal quantum correlations in the system.

Signatures of the single-particle mobility edge in the ground-state properties of Tonks-Girardeau and noninteracting Fermi gases in a bichromatic potential

Jacopo Settino,
Università Della Calabria (Italy)

We explore the ground-state properties of cold atomic gases focusing on the cases of noninteracting fermions and hard-core (Tonks-Girardeau) bosons, trapped by the combination of two potentials (bichromatic lattice) with incommensurate periods. For such systems, two limiting cases have been thoroughly established. In the tight-binding limit, the single-particle states in the lowest occupied band show a localization transition, as the strength of the second potential is increased above a certain threshold. In the continuous limit, when the tight-binding approximation does not hold, a mobility edge is found, instead, whose position in energy depends upon the strength of the second potential. Here, we study how the crossover from the discrete to the continuum behavior occurs, and prove that signatures of the localization transition and mobility edge clearly appear in the generic many-body properties of the systems. Specifically, we evaluate the momentum distribution, which is a routinely measured quantity in experiments with cold atoms, and demonstrate that, even in the presence of strong boson-boson interactions (infinite in the Tonks-Girardeau limit), the single-particle mobility edge can be observed in the ground-state properties.

Theory of coherent quantum phase-slips in ingomogeneous superconducting wires or Josephson junction chains

Aleksandr Svetogorov,
LPMMC, Grenoble (France)

We study coherent quantum phase-slips, which lift the ground state degeneracy in a superconducting loop made of a thin metallic wire or a Josephson junction chain, pierced by a magnetic flux, whose magnitude is equal to half of a flux quantum. The quantum phase-slip amplitude is sensitive to the normal mode structure of superconducting phase oscillations in the loop (Mooij-Schön modes). These, in turn, are afected by long-range spatial inhomogeneities in the loop. We analyze the case of weak periodic modulations of the system parameters, and derive the corresponding modication of the quantum phase-slip amplitude

Hexagonal warping effects in the surface states of topological insulators

Andrei Vasenko,
National Research University Higher School of Economics (Russia)

We study the effect of the Fermi surface anisotropy (hexagonal warping) in the surface states of three-dimensional topological insulators (TIs) and TI-based superconducting hybrids. First, we show that the hexagonal warping imposes a specific pattern of a quasiparticle interference image in TI. Second, we study the symmetry of the superconducting pair potential, induced in TI by proximity with an s-wave superconductor (S) in presence of a magnetic moment of a nearby ferromagnetic insulator (FI). We show that a very exotic pair potential is induced on the topological insulator surface. Based on the symmetry arguments we also discuss the possibility of a supercurrent flowing along the S/FI interface, when an S/FI hybrid structure is formed on the TI surface.

Particle Production in a Waveguide Ultra-Strongly Coupled to a Qubit

Serge Florens,
Institut NÉEL CNRS/UGA (France)

Superconducting metamaterials such as Josephson junction waveguides constitute a promising platform for non-linear quantum optics, due to an enhanced light-matter interaction that can reach values of order one. This ultra-strong coupling regime allows physical effects beyond standard quantum optics, such as multi-photon emission at vanishingly small driving power. We study a single two-level artificial atom coupled ultra-strongly to an ohmic waveguide, using a controlled numerical many-body scattering method based on multi-mode coherent states, and a comparison to input-output theory and perturbative calculations. Surprisingly, we find that off-resonant emission is dominated by broadband non-rotating-wave contributions, due to the large phase space associated with particle production. Such frequency conversion processes lead also to strong signatures in time-correlations among the reflected photons, such as incomplete anti-bunching at zero delay, and bunching at times larger than the inverse decay rate. This detailed study should be useful in guiding experiments aiming at probing non-linear emission processes in waveguide quantum electrodynamics.

Authors: Nicolas Gheeraert, Xin Zhang, Soumya Bera, Nicolas Roch, Harold U. Baranger, and Serge Florens

Double lattice ring under a gauge field

Nicolas Victorin,
LPMMC, Grenoble (France)

In a recent experiment, a gas of bosons on a flux ladder exhibited a Meissner and a vortex current state. We investigate bosonic currents in a mesoscopic double lattice ring geometry with a gauge field. We reveal parity effect of the total flux on the number of vortices and propose a way to see them by time-of-flight images. The stability of the vortex phase is also studied via a Bogoliubov analysis.

30th January, Tuesday

Session 7

Chair: Wiebke Guichard

From crossed Andreev reflection to electronic quartets

Denis Feinberg,
Institut NÉEL- CNRS (France)

Crossed (nonlocal) Andreev reflection at a N-S-N three-terminal junction has been discussed long ago by Frank Hekking and collaborators (G. Falci, D. Feinberg, F. Hekking, Europhys. Lett. 2001) and is a source of entangled pairs of electrons. Recently, in an all-superconducting biased S-S-S three-terminal junction, it has been shown that two nonlocal Andreev reflections lead to electronic quartets crossing the junction, entangling pair numbers in all three terminals. The quartets appear as a phase-coherent DC mode due to an Andreev resonance in an otherwise nonequilibrium superconducting system.

Start - 8:50 • Finish - 9:10
Duration - 00:20

Quantum dynamics of a driven three-level Josephson-atom maser

Yaroslav Blanter,
Delft University of Technology (Netherlands)

A lasing effect has been observed in a superconducting nano-circuit where a Cooper pair box, acting as an artificial three-level atom, was coupled to a resonator. Motivated by this experiment, we analyze the quantum dynamics of a three-level atom coupled to a quantum-mechanical resonator in the presence of a driving on the cavity within the framework of the Lindblad master equation. As a result, we have access to the dynamics of the atomic level populations and the photon number in the cavity as well as to the output spectrum. The results of our quantum approach agree with the experimental findings. The presence of a fluctuator in the circuit is also analyzed. Finally, we compare our results with those obtained within a semiclassical approximation.

Start - 9:10 • Finish - 9:30
Duration - 00:20

Nonequilibrium I-V Curve at a Quantum Critical Point

Harold Baranger,
Duke University (United States)

Many-body systems that are driven far from equilibrium exhibit a complex interplay between the many-body correlations and the driven degrees of freedom. I shall discuss a system that is particularly advantageous for studying these effects: it exhibits impurity quantum criticality, it is amenable to detailed experimental study,, and it is simple enough theoretically that analytical results can be obtained. First, I present the experimental system: it consists of a spin-polarized carbon nanotube quantum dot connected to resistive leads via tunable tunnel barriers (see figure). A quantum critical point (QCP) occurs when a level in the dot is resonant with the leads and the dot is symmetrically coupled to them. Second, I present a summary of our theoretical results for the nonlinear I-V curve, both as the system flows into the QCP and for the crossover away the QCP. These results have a simple interpretation as an environmental blockade, albeit one involving a strange barrier and a strange environment. The theory and experiment are compared in a parameter free way, and the agreement is excellent.

Start - 9:30 • Finish - 9:50
Duration - 00:20

The bistability transition induced by a strong nano-electromechanical coupling

Fabio Pistolesi,
University of Bordeaux and CNRS (France)

I will discuss the mechanical bistability transition induced in a nano electromechanical oscillator coupled capacitively to quantum dot. We have recently shown that at the transition the mechanical mode becomes soft, and the mechanical response presents several peculiarities. The most striking one is an important broadening of the resonance with a universal quality factor at the transition. These results have been obtained in the limit of slow classical oscillator with respect to the tunneling rate of electrons. In this talk I will discuss also the opposite case, of fast quantum mechanical mode in the tunneling limit, and show that the displacement correlation function presents also remarkable features.

References for the published part of the presentation:

G. Micchi, R. Avriller, F.P., Phys. Rev. B, (2016). G. Micchi, R. Avriller, F.P., Phys. Rev. Lett. (2015).

Start - 9:50 • Finish - 10:10
Duration - 00:20

coffee break
10:10

Session 8

Chair: Luigi Amico

Yu-Shiba-Rusinov bands in superconductors in contact with a magnetic insulator

Wolfgang Belzig,
University of Konstanz (Germany)

Superconductor-Ferromagnet (SF) heterostructures are of interest due to numerous phenomena related to the spin-dependent interaction of Cooper pairs with the magnetization. Here we address the effects of a magnetic insulator on the density of states of a superconductor based on a recently developed boundary condition for strongly spin-dependent interfaces. We show that the boundary to a magnetic insulator has a similar eect like the presence of magnetic impurities. In particular we find that the impurity effects of strongly scattering localized spins leading to the formation of Shiba bands can be mapped onto the boundary problem.

Start - 10:40 • Finish - 11:00
Duration - 00:20

Spin-polarized transmission through correlated heterostructures

Ulrich Eckern,
University of Konstanz (Germany)

A novel method for computing the transmission through correlated heterostructures is proposed, by combining density functional and many-body dynamical mean field theory (DFT and DMFT, respectively). The heart of this combination consists in porting the many-body self-energy from an all electron basis into a pseudopotential localized atomic basis set. Using this combination we study the effects of local electronic interactions and finite temperatures on the transmission across a Cu-Co-Cu metallic heterostructure (1). As another prototypical case, we investigate the ballistic conduction through a half-metallic (NiMnSb)n layer coupled to Au leads (2). For n = 1, and within DFT-LSDA, the transmission function displays a spin polarization of around 50% in a window of 1 eV around the Fermi level. By increasing n an almost complete transmission spin polarization is achieved. Supplementing the DFT-LSDA calculations with local electronic interactions of Hubbard-type on the Mn sites, we find a strong hybridization between interface and many-body states. ■■■

The significant reduction of the spin polarization seen in the density of states is not apparent in the spin polarization of the conduction electron transmission, which suggests that the hybridized interface and many-body induced states are localized. (1) L. Chioncel, C. Morari, A. Ostlin, W. H. Appelt, A. Droghetti, M. M. Radonjic, I. Rungger, L. Vitos, U. Eckern, and A. V. Postnikov, Transmission through correlated Cu-Co-Cu heterostructures, Phys. Rev. B 92, 054431 (2015) (2) C. Morari, W. H. Appelt, A. Prinz-Zwick, U. Eckern, U. Schwingenschlogl, A. Ostlin, and L. Chioncel, Spin-polarized ballistic conduction through correlated Au-NiMnSb-Au heterostructures, arXiv:1709.00983 (4 Sep 2017)

Start - 11:00 • Finish - 11:20
Duration - 00:20

Landauer's Principle for Trajectories of Repeated Interaction Systems

Alain Joye,
Institut Fourier (France)

We analyze Landauer's principle for repeated interaction systems consisting of a reference quantum system S in contact with a environment E made of a chain of independent quantum probes. The system S interacts with each probe sequentially, for a given duration, and the Landauer principle relates the energy variation of E and the decrease of entropy of S by the entropy production of the dynamical process. We consider refinements of the Landauer bound at the level of the full statistics associated to a two-time measurement protocol of, essentially, the energy of E. The emphasis is put on the adiabatic regime where the environment, consisting of T>>1 probes, displays variations of order 1/T between the successive probes, and the measurements take place initially and after T interactions. Joint work with E.P. Hanson, Y. Pautrat and R. Raquépas.

Start - 11:20 • Finish - 11:40
Duration - 00:20

Energy fluctuations and quantum jump based thermodynamics in superconducting hybrid circuits

Jukka Pekola,
Aalto University School of Science (Finland)

I present the idea, basic theory, and on-going experiments to investigate energy fluctuations in mesoscopic electronic circuits. Heat current noise can be measured using fast thermometry on mesoscopic baths, and non-equilibrium fluctuation relations of a qubit can be ultimately tested by observing single photon absorption and emission events by a nanocalorimeter.

Start - 11:40 • Finish - 12:00
Duration - 00:20

Closure of the workshop

12:00

Lunch

12:15

List of participants

Ahufinger Veronica
Altland Alexander
Amico Luigi
Baranger Harold
Basko Denis
Bauerle Christopher
Beenakker Carlo
Belzig Wolfgang
Blanter Yaroslav
Borsje-Hekking Erika
Bouchiat Helene
Bruder Christoph
Buisson Olivier
Champel Thierry
Citro Roberta
Compagno Enrico
Courtois Hervé
Didier Nicolas
Di Marco Angelo
Doucot Benoit
Eckern Ulrich
Efetov Konstantin
Esteve Daniel
Falci Giuseppe
Faoro Lara
Fazio Rosario
Feinberg Denis
Filippone Michele
Florens Serge
Fontaine Alain
Giazotto Francesco
Golovach Vitaly
Guichard Wiebke
Hakonen Pertti
Haviland David
Hippert Françoise
Holzmann Markus
Ioffe Lev
Jirari Hamza
Joye Alain
Jussiau Etienne
Melin Regis
Meyer Julia
Mingo Natalio
Minguzzi Anna
Naldesi Piero
Pascal Laetitia
Pekola Jukka
Perrin Hélène
Pistolesi Fabio
Polo Gomez Juan
Pop Ioan M.
Pothier Hugues
Rastelli Gianluca
Rizzi Matteo
Rossini Davide
Safi Ines
Schoen Gerd
Settino Jacopo
Spehner Dominique
Svetogorov Aleksandr
Taddei Fabio
Vasenko Andrey
Victorin Nicolas
Weissl Thomas
Whitney Robert
Winkelmann Clemens

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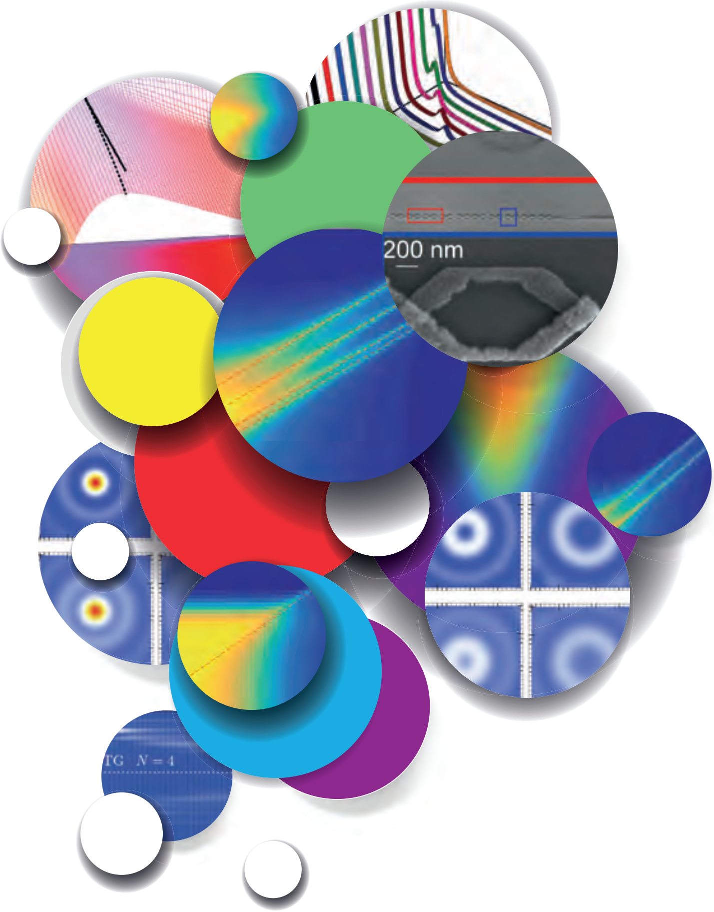
NOTE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