QuProCS Meeting

6-7/4/2017, IFISC (UIB-CSIC)

6 April	
9:00 9:10	Registration
9:10 9:25	Welcome + Maniscalco
9:25 10:10	**Widera**
10:10 10:30	Buyskikh
10:30 10:50	Foot
10:50 11:10	Lena + Dirkmann
11:10 11:25	Haller
11:25 11:30	Kuhr WP1
11:30 12:00	Coffe break
12:00 12:20	Kropf
12:20 12:40	Galve
12:40 13:00	Breuer WP2
13:00 13:20	Paris WP3
13:20-14:50	lunch+discussions

picture

15:00 15:45	**Marquardt**
15:45 16:05	Vacchini
16:05 16:25	Borrelli
16:25 16:45	Laine+Cabot
16:45 17:05	Giorgi + Nokkala
17:05 17:20	Zambrini WP5
19:00 20:00	Steering + scientific meetings
20:00	Social dinner

7 April	
9:00 9:45	**Parigi**
9:45 10:05	Lyyra
10:05 10:25	Dufour
10:25 10:45	Benedetti
10:45 11:05	Bina
11:05 11:20	Jaksch WP4
11:25 11:45	Coffee break
11:45 12:30	**Maccone**
12:30 12:50	Manzano + Cosco
12:50 13:10	Mur Petit
13:10 13:30	Plastina
13:30-14:20	lunch

14:30 15:10	Bus to Sa Foradada
15:10 17:00	Monastir de Miramar and Son Marroig
	Bus to Bellver castle
18:00 18:50	Bellver Castle
19:15	Back to Palma

European Commission

QuProCS

10 YEARS IFISC

Universitat de les Illes Balears

CSIC

IInd QuProCS Meeting - Extended program

Thursday 6/04/2017

9:00 Registration
9:10 Conference opening
9:15 **S. Maniscalco** QuProCS overview

chair: **Kuhr**

9:25 **A. Widera,** Probing of an ultracold gas through individual neutral atoms
10:10 **A. Buyskikh,** Spin models, probes, and atoms in tilted optical lattices
10:30 **C. Foot**, The development of quantum probes in a multispecies ultracold gas
10:50 **R. G. Lena**, Cooling of impurity atoms in a 2D lattice by a reservoir gas
11:00 **M. Dirkmann**, A Bosonic Josephson Junction with an Impurity
11:10 **E. Haller**, Towards experiments with ultracold cesium atoms in optical lattice potentials
11:25 **S. Kuhr** , *WP1 progress*

11:30-12:00 *coffee break*

chair: **Piilo**

12:00 **C. Kropf**, Master equations for the ensemble averaged dynamics of disordered quantum systems
12:20 **F. Galve**, A 2-ions probe for anomalous heating
12:40 **H. P. Breuer**, *WP2 progress*
13:00 **M. Paris**, *WP3 progress*

13:20-14:50 lunch + discussions

Meeting Photo

chair: **Maniscalco**

15:00 **F. Marquardt,** Topological transport of photons and phonons
15:45 **B. Vacchini**, Memory kernels for collisional models
16:05 **M. Borrelli,** It's all about the bosons
16:25 **E. Laine,** Probing statistical orthogonality catastrophe in a quasi-periodic system
16:35 **A. Cabot**, Spontaneous synchronization and asymptotic entanglement in coupled optomechanical systems dissipating into a common bath
16:45 **G. L. Giorgi,** Synchronization as a local signature of super and subradiance
16:55 **J. Nokkala,** Minimal and maximal access probing of complex quantum networks
17:05 **R. Zambrini,** *WP5 progress*
19:00 Steering + Scientific Meetings
20:00 Social Dinner

Thursday 7/04/2017

chair: **Zambrini**

9:00 **V. Parigi**, Quantum multimode resources based on optical frequency combs and simulation of complex quantum network
9:45 **H. Lyyra,** Progress on optical simulator for generic dephasing
10:05 **G. Dufour**, A two-component bosonic Josephson junction
10:25 **C. Benedetti**, Characterization of qubit chains by Feynman probes
10:45 **M. Bina,** Continuous-variable probing of structured environments
11:05 **D. Jaksch,** *WP4 progress*

11:25 – 11:45 *coffee break*

chair: **Buchleitner**

11:45 **L. Maccone**, Entanglement uses in quantum metrology
12:30 **G. Manzano**, Fluctuation theorems for quantum maps
12:40 **F. Cosco**, Non-equilibrium quantum thermodynamics in Coulomb crystals
12:50 **J. Mur Petit,** Quantum fluctuation relations for generalized Gibbs ensembles
13:10 **F. Plastina,** Coherence generation, irreversibility and Non-adiabaticity in out-of-equilibrium quantum processes

13:30 – 14:20 *lunch*

14:30 – 19:15 Excursion

Invited presentations

Probing of an ultracold gas through individual neutral atoms

A. Widera
Technische Universität Kaiserslautern

Manipulation and detection of individual neutral atoms has seen enormous advance in recent years. Exploiting this high level of control by immersion of single neutral atoms into an ultracold gas bears prospects for local, non-destructive probing of, for example, non-equilibrium quantum many-body systems.
I will discuss our experimental system and current status to immerse single laser-cooled Cs atoms into an ultracold Rb cloud and to study their interaction. We have developed tools to independently prepare and detect Cs as well as Rb atoms, and to control their spatial overlap. Cs atoms are trapped in a species selective optical lattice, forming a deep periodic potential for Cs atoms while Rb atoms do not experience a significant potential. We obtain information by position resolved probing of various properties of the Cs atoms after interaction with the Rb cloud, including the Cs atoms' dynamic and their energy distribution within cloud.

Topological transport of photons and phonons

F. Marquardt
Max Planck Institute for the Science of Light

It is an outstanding challenge to create topological transport of phonons at the nanoscale. Here I will describe two alternatives, both of which are based on the so-called 'snowflake crystal' phononic-photonic crystal geometry: (i) breaking time-reversal symmetry using a laser drive with a wave field containing optical vortices, and exploiting the optomechanical interaction; (ii) purely geometrical setups that do not break time-reversal symmetry but exploit the two species of phononic excitations that arise in a Brillouin zone with two Dirac points.

Quantum multimode resources based on optical frequency combs and simulation of complex quantum network

V. Parigi
Laboratoire Kastler Brossel

The Quantum Optics group at Laboratoire Kastler Brossel developed in the last years experimental multimode systems based on parametric processes pumped by optical frequency combs. The spectrum of these lasers is constituted by hundreds of thousands of frequency components. The parametric process in the non-linear crystal couples all these optical frequencies, and generates non-trivial multimode Gaussian quantum states. These can be equally described as a set of different spectral-temporal modes of light, which can be individually addressed and simultaneously occupied by squeezed vacuum. We have demonstrated that by proper control of non-linear crystals, optical cavities and pulse shaping it was possible to embed within an optical frequency comb up to 14 spectral/temporal modes with nonclassical noise properties [1]. Furthermore, dividing the spectrum of this comb into 10 frequency bands, entanglement is certified for all of the 115974 possible nontrivial partitions of this 10-mode state. This is the first demonstration of full multipartite entanglement [2] and this source is shown to be a very promising candidate for scalable measurement based quantum computing [3]. This resource can be pictured as a network where each node is an electromagnetic-field mode and the connection are entanglement relations involving the quadratures of the field. The control on pump shaping combined with multimode homodyne measurements allow to shape the network as a complex structure. It can be used to simulate the dynamics of complex finite quantum environment [4], and to study quantum information and energy transfer in quantum complex network.

[1]. J. Roslund, R. M. De Araujo, S. Jiang, and C. Fabre, Nature Photonics 8, 109 (2014).

[2] S. Gerke, J. Sperling, W. Vogel, Y. Cai, J. Roslund, N. Treps, and C. Fabre, 114, 050501 (2015).
[3] G. Ferrini, J. P. Gazeau, T. Coudreau, C. Fabre, and N. Treps, New J Phys 15, 093015 (2013).
[4] J. Nokkala, F. Galve, R. Zambrini, S. Maniscalco and J. Piilo, Scientific Reports 6, 26861 (2016)

Entanglement uses in quantum metrology

L. Maccone
Dipartimento di Fisica "A. Volta", Universita' di Pavia

I present some recent results detailing the use of entanglement in quantum parameter estimation. First I show that entanglement with external ancillas, which is known to be useless in the noiseless case, is surprisingly useful for quantum metrology in the presence of noise. Then I show how quantum metrology can be secured in a quantum cryptographic fashion through entanglement. Finally I introduce a new approach to quantum metrology and show how entanglement among different probes can be useful also in this scenario.

Oral presentations

Spin models, probes, and atoms in tilted optical lattices

A. Buyskikh
University of Strathclyde

We study the non-equilibrium dynamics of a one dimensional tilted Bose-Hubbard model, beginning from unit filling in the Mott insulator regime. Studying a quench to the resonance point for tunnelling of the particles over two sites, we show how in the presence of a superlattice, a spin model emerges involving two subchains described by an Ising model that are then coupled by interaction terms. Using this model, we study the behaviour of the system near the quantum critical point in the vicinity of the tunnelling resonance, especially looking at the out-of-equilibrium dynamics after the quench. We compare the dephasing of local observables corresponding to the number of doubly occupied sites, which were measured in recent experiments, to the dynamics expected in the presence of noise and decoherence. These results should be directly measurable in experiments, and provide a diagnostic tool for investigating decoherence in such out-of-equilibrium dynamics.

The development of quantum probes in a multispecies ultracold gas

C. Foot
Oxford University

A report on the work at Oxford towards developing quantum probes.
i) The creation of double-well traps for ultracold atoms using RF-dressed states of atoms in magnetic traps.
ii) The application of species-selective RF-dressed states to the isotopes of rubidium.
iii) A theoretical treatment of the dressed states of atoms with applied fields at three, or more, frequencies.

Cooling of impurity atoms in a 2D lattice by a reservoir gas

R. G. Lena
University of Strathclyde

Within ultracold atoms, there are important experimental challenges both in cooling atoms to lower temperatures and in finding new ways to probe many-body systems. Here we study the experimentally realisable system of neutral atoms in a 2D optical lattice in contact with a superfluid reservoir. Besides the achievement of cooling the trapped atoms to temperature lower than the one of the bath, this kind of system could be extremely useful for the study of impurities in Bose-Einstein Condensates, state engineering and the study of dissipative dynamics in many-body systems. We will give an overview of

our calculations of dynamics inducted for the atoms in the lattice, especially in the context of dual-species experiments currently under development in several places internationally.

A Bosonic Josephson Junction with an Impurity

M. Dirkmann
University of Freiburg

We study the dynamics of a Bose-Einstein condensate in a double-well potential, or bosonic Josephson junction, in the presence of a mobile impurity particle. This allows us to test the practicability of a quantum probe scheme, where measurements are performed on the impurity in order to obtain information about the rest of the system.

The system is described using a two-site Bose-Hubbard Hamiltonian which accounts for tunneling between the wells and on-site interactions between the particles. We observe a variety of dynamical regimes as the relative strength of tunneling and interactions is changed. In particular, we study the entanglement of the impurity particle with the rest of the system. In the weakly interacting regime, we demonstrate that the amplitude of impurity's oscillations between the two wells is related to the purity of its reduced density matrix.

Towards experiments with ultracold cesium atoms in optical lattice potentials

E. Haller
University of Strathclyde

Ultracold atoms in optical lattices offer the possibility to study quantum systems with almost complete control over all system parameters, e.g., such as densities, temperatures and interactions. Especially cesium atoms provide favorable scattering properties and a precise control of the interaction strength by means of broad magnetic Feshbach resonances. I am going to report on the progress of our new experimental setup to implement quantum probes with caesium atoms in optical lattice potentials.

Master equations for the ensemble averaged dynamics of disordered quantum systems

C. Kropf
University of Freiburg

We present our approach to the ensemble averaged dynamics of disordered quantum systems using the framework of quantum master equations. The latter allows for a full characterization of the coherent and incoherent contents of the ensemble averaged dynamics on transient and asymptotic time scales. In the cases of spectral disorder (induced e.g. by slow intensity variations of experimental control fields) and of isotropically disordered eigenvector distributions (e.g. random unitary ensembles), we derive exact master equations which are valid for all times. Furthermore, for the short-time limit, we provide an explicit form valid for any disorder distribution. Finally, with the help of standard perturbation theory, we succeed to derive perturbative disorder master equations for systems with on-site disorder and a weak, disorder-independent, coupling potential. This approach is applicable to a variety of situations, such as finite-size Anderson models, tilted Bose-Hubbard Hamiltonians, frozen Rydberg gases or biology-inspired networks.

A 2-ions probe for anomalous heating

F. Galve
IFISC (CSIC-UIB)

We investigate the scenario of anomalous heating in ion traps, a major promising platform for quantum information processing, where this limiting factor in the rush for miniaturization is believed to be caused by a yet unknown source of dipole fluctuations in the electrodes' surfaces. A geometric crossover between Common Bath and Separate Baths, and back to anti-common bath (a common bath which dissipates the relative motion instead of the center of mass) is predicted which strongly depends on spatial correlations between

dipoles, and also on their orientation. We propose a protocol to measure this peculiar effect in recent state of the art segmented Paul traps, allowing for a better insight into the microscopic origin of this elusive phenomenon.

Memory kernels for collisional models

B. Vacchini
Unimi & INFN

We consider how to construct memory kernels leading to well-defined evolution equations for an open quantum system featuring memory effects. It turns out that a large class of memory kernel master equations are naturally related to so-called collisional models, which thus provide a possibly controlled way to engineer non-Markovian dynamics. In this relationship, a fundamental role is played by the issue of operator ordering, which in the quantum setting brings in a wide variety of behaviours with respect to a classical description.

It's all about the bosons

M. Borrelli
University of Turku

In this talk I will present recent findings on the physics of atomic impurities embedded in bosonic gases. Several many-body models will be analyzed and it will be shown how some of their distinctive features can be mapped onto the impurity dynamics. Connections to critical and non-equilibrium behavior will also be discussed.

Probing statistical orthogonality catastrophe in a quasi-periodic system

E. Laine
University of Turku

We study the dynamics of an impurity probe locally coupled to a cold atomic gas in a quasi-periodic structure. The model (Aubry-André model, AA) is known to exhibit a transition from a delocalized to a localized regime, in which all of the wave functions simultaneously turn from an extended (metallic like) to a localized (insulating like) character. The impurity atom introduces a local perturbation (quench), which influences the dynamics of the atoms in the lattice. Scanning the lattice through the probe position (keeping the phase of the potential fixed) we show how the Loschmidt echo is affected by the delocalized-localized transition in the ground state.We study the probe dynamics for the three characteristic phases of the non-interacting fermionic problem: the metallic, band insulating and Anderson insulating phases. In the the Anderson insulating phase scanning the lattice through the probe position reveals an inhomogeneous response to the impurity, which can be associated with the emergence of statistical orthogonality catastrophe (StOC) in the system.

Spontaneous synchronization and asymptotic entanglement in coupled optomechanical systems dissipating into a common bath

A. Cabot
IFISC (CSIC-UIB)

In this work we consider two mechanically coupled optomechanical systems. Dissipative couplings induced by collective dissipation can arise due to the elastic radiation propagating in the surrounding crystal and have not been characterized so far. Here we analyze the effects of common dissipation onto two different physical phenomena. Firstly, we study the emergence of synchronization between the mechanical oscillators, and we compare the results with the ones of previous studies in which separate mechanical dissipation was considered. In particular we show that collective mechanical dissipation enlarges the region in which spontaneous synchronization can be found. Secondly, we study the presence of entanglement between the mechanical modes in the asymptotic state, below the threshold of self-sustained oscillations. Asymptotic entanglement between the mechanical mode and the optical one is known to arise in single optomechanical systems. Here we study the novel cases of mechanically coupled devices dissipating both in common and separate mechanical baths. We

report asymptotic entangled states in both cases, and we analyze the strong relation between the presence of entanglement and the degree of optomechanical cooling of the oscillators. Again we find that collective dissipation enhances the presence of asymptotic entanglement in the studied parameter region.

Synchronization as a local signature of super and subradiance

G. L. Giorgi
IFISC (CSIC-UIB)

The relationship between the collective phenomena of super and subradiance and spontaneous synchronization of quantum systems is studied revisiting the case of two detuned qubits interacting through a pure dissipative bosonic environment. By using the Liouville formalism, we are able to find analytically the ultimate connection between these phenomena. Indeed, dynamical synchronization is shown to be due to the presence of long standing coherence between the ground state of the system and the subradiant state. Finally, under pure dissipation, the emergence of spontaneous synchronization and of subradiant emission occur on the same time scale.

Minimal and maximal access probing of complex quantum networks

J. Nokkala
University of Turku

Quantities that are difficult to determine directly can sometimes be indirectly determined via a probe system. In some cases one can sacrifice accuracy for less resources required and vice versa. I will discuss and contrast the probing of a complex network of quantum harmonic oscillators with opposite approaches. It will be seen that while one can even determine the network completely by sequentially coupling the probe to each oscillator, much can be learned by coupling to just one of them.

Progress on optical simulator for generic dephasing

H. Lyyra
University of Turku

We describe the progress of the theoretical and experimental work on developing an optical simulator for generic dephasing dynamics. The simulator system is the polarization of a single photon and its dynamics is induced by interaction with the frequency degree of freedom of the photon [1]. The total polarization-frequency system is prepared in specific correlated states to induce the desired dynamics. As an example dynamics to be simulated, we use the well-studied Loschmidt echo of a central spin coupled to an Ising chain in a transverse field [2]. To illustrate the versatility of the simulator, we have chosen to simulate the Loschmidt echo in three fundamentally different cases: below, above, and exactly at the critical value of the strength of the transverse field.

[1] B.-H. Liu, L. Li, Y.-F. Huang, C.-F. Li, G.-C. Guo, E.-M. Laine, H.-P. Breuer & J. Piilo, Nat. Phys. 7, 931 (2011)
[2] P. Haikka, J. Goold, S. McEndoo, F. Plastina, and S. Maniscalco Phys. Rev. A 85, 060101(R) (2012)

A two-component bosonic Josephson junction

G. Dufour
University of Freiburg

We study the dynamics of a Bose-Einstein condensate in a double-well potential, or bosonic Josephson junction, when the condensed atoms can be in two distinct internal states. On the one hand, this allows us to investigate the effect of many-body interference on the dynamics by tuning the distinguishability of the atoms. On the other hand, it provides a toy model for quantum probe schemes, where one component is used to probe the other. In this perspective, we consider a system with a single impurity and we study its entanglement with the rest of the system. In the weakly interacting regime, we demonstrate that the amplitude of impurity's oscillations between the two wells is directly related to the purity of its reduced density matrix.

Characterization of qubit chains by Feynman probes

C. Benedetti
Università degli Studi di Milano

We address the characterization of qubit chains and assess the performances of local measurements compared to those provided by Feynman probes, i.e., nonlocal measurements realized by coupling a single-qubit register to the chain. We show that local measurements are suitable to estimate small values of the coupling and that a Bayesian strategy may be successfully exploited to achieve optimal precision. For larger values of the coupling Bayesian local strategies do not lead to a consistent estimate. In this regime, Feynman probes may be exploited to build a consistent Bayesian estimator that saturates the Cramér-Rao bound, thus providing an effective characterization of the chain. Finally, we show that ultimate bounds to precision, i.e., saturation of the quantum Cramér-Rao bound, may be achieved by a two-step scheme employing Feynman probes followed by local measurements.

Continuous-variable probing of structured environments

M. Bina
Università degli Studi di Milano

We address the problem of estimating the parameters of structured environments by means of continuous variables quantum probes. Considering a very general master equation describing the interaction of a thermal reservoir with one or two quantum harmonic oscillators, we derive the ultimate bounds to the estimability of the cutoff frequency of Ohmic, sub-Ohmic and super-Ohmic environments. In particular, we derive interesting scaling laws for the quantum Fisher information in terms of the environment temperature, of the initial state parameters and of time evolution. Moreover, we investigate the role of entanglement in the quantum probing process and compare the results with implementable quantum measurements.

Fluctuation theorems for quantum maps

G. Manzano
Universidad Complutense de Madrid and IFISC (CSIC-UIB)

When considering small systems, quantum fluctuations, in addition to thermal ones, come into play. Furthermore, there is a wide range of phenomena without classical counterpart that cannot be neglected, such as coherence, squeezing or entanglement, in both single and many-body systems. A promising route to the understanding of thermodynamics in quantum systems are the fluctuation theorems, which establish exact statements about the fluctuations of thermodynamic quantities such as work, heat or entropy production, in systems arbitrarily far from equilibrium [1].
Work fluctuation theorems have been extensively investigated in the quantum regime under an inclusive Hamiltonian approach. Also fluctuation theorems for the exchange of heat and particles in transient and steady-state regimes has have been established within the so-called two-measurements-protocol [2,3]. This framework has provided important results, but its rigid assumptions restrict possible extensions to more general situations, apart from being impractical in most physical situations.
On the other hand, an alternative approach recently considered is the derivation of fluctuation theorems for arbitrary completely-positive and trace-preserving (CTPT) maps, as they provide a compact description of general physical processes condensing the main effects of the environmental action in a set of few relevant variables.
Here we present a novel fluctuation theorem valid for a broad class of quantum CPTP maps [4]. It is based in the concept of a nonequilibrium potential, an intrinsic fluctuating property of the map which allows the thermodynamic description at the single trajectory level in most situations of interest. Our theorem goes beyond previous results for specific classes such as unital maps --maps preserving the identity operator-- [5, 6], or theorems limited by efficacy (correction) terms [7, 8].

[1] U. Seifert, Rep. Prog. Phys. 75, 126001 (2012).

[2] M. Campisi, P. Hänggi, and P. Talkner, Rev. Mod. Phys. 83, 771791 (2011).
[3] M. Esposito, U. Harbola, and S. Mukamel, Rev. Mod. Phys. 81, 16651702 (2009).
[4] G. Manzano, J. M. Horowitz, and J. M. R. Parrondo, Phys. Rev. E 92, 032129 (2015).
[5] M. Campisi, P. Talkner, and P. Hänggi, Phys. Rev. Lett. 105, 140601 (2010).
[6] A. E. Rastegin, J. Stat. Mech.: Theor. Exp., P06016 (2013).
[7] D. Kafri and S. Deffner, Phys. Rev. A 86, 044302 (2012).
[8] T. Albash, D. A. Lidar, M. Marvian, and P. Zanardi, Phys. Rev. E 88, 032146 (2013).

Non-equilibrium quantum thermodynamics in Coulomb crystals

F. Cosco
University of Turku

We present a thorough study of the non-equilibrium statistics of the irreversible work produced during sudden quenches in proximity of the structural linear-zigzag transition of ion Coulomb crystals in 1+1 dimensions. We employ both an analytical approximation approach and a numerical method and study scaling properties as well as universality features.

Quantum fluctuation relations for generalized Gibbs ensembles

J. Mur Petit
University of Oxford

The non-equilibrium dynamics of a strongly-correlated quantum system is one of the most fascinating problems in physics, with open questions such as whether and how the system will relax to an equilibrium state. Unusual phenomena are observed when the system exhibits conserved quantities that constrain its evolution in phase-space, invalidating the predictions of standard quantum thermodynamics.
I will present a set of new exact results that relate out-of-equilibrium fluctuations in the energy and other observables with equilibrium properties in such systems, and show how they enable to detect the existence of unknown conserved quantities of difficult experimental access.
I will further discuss an experimental proposal to test our findings with existing trapped-ion technology, and explore implications on maximum work-extraction efficiency with quantum machines that rely on quantum and thermal fluctuations.

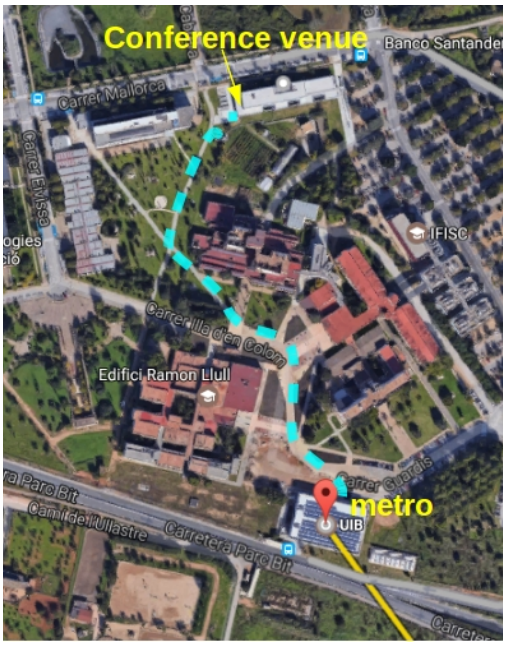
Coherence generation, irreversibility and non-adiabaticity in out-of-equilibrium quantum processes

F. Plastina
Università della Callabria

We prove some general relationships between the amount of coherence generated in a quantum process and the irreversible work performed on the system. Furthermore, we introduce an entropic quantifier of the nonadiabaticity of a given process and connect it to both the produced coherence and the ergotropy; i.e. the optimal work extraction in a cyclic transformation.

USEFUL INFORMATION

- **Venue**: the meeting will take place at the Universitat de les Illes Balears (UIB) Campus. Lectures will be given in the “salón de grados” of Antoni Maria Alcover i Sureda building (top level). It can be reached from the Metro station or from the bus station.
  You should take the metro from Plaza de España at 8:35 to be at UIB at 8:48.



- **Social dinner** will take place at Club de Mar [Restaurant Taronja Negre Mar, Muelle Pelaires, Palma] **on Tuesday 6/4/2017 at 20:00 (19:00 for management and steering committees).** The restaurant can be reached by bus lines 1, 102, 104 and 111. A taxi from plaza de España will cost 8-10€.

- The **tour of Friday afternoon**, for conference participants that have booked it, will start at the UIB campus and end near to plaza de España in Palma by 19:15.
  We will reach by bus Serra de Tramuntana and have a guided visit to Miramar monastery, Son Marroig, and then to the Bellver Castle, back to Palma. Further information here:
  http://www.serradetramuntana.net/en/
  http://www.sonmarroig.com/miramar.html
  http://castelldebellver.palma.cat

- You should have received the **INVOICE** of you registration fee from UIB congress. Contact: info@uibcongres.org

- If you need **attendance certificate** you can request it to:
  marta@ifisc.uib-csic.es

- WIFI access information

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2. Enter with the password "uib@events2016".
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- ## Transport

How to go from Palma Airport to Palma downtown

The international "Son Sant Joan" airport (airport code PMI), is located 8 km east of Palma.

At the Airport take the Bus Line 1 to Plaza España (or Plaça d'Espanya; this is Palma's downtown). The stop is outside the Airport Arrivals' Hall. There is one bus every 12-15 minutes. Ticket price: 5 EUR. Tickets can be purchased from the bus driver (only bills up to 10 EUR are accepted). Line 1 bus route and schedule can be found here. Please pay attention to the number of the bus stop (in front of the name) as it might be different for the go and back. For more information on buses visit the EMT web page. A map with all the bus lines can be dowloaded from here.

Alternativelly you can also take a Taxi from the Airport to Palma. Taxis can be found just outside the Airport Arrivals Hall. Typical fares are between 20 and 25 euros depending on destination and number of suitcases. The are suplemental fares for night and holiday services.

How to go from Palma downtown to the UIB campus

- Metro (subway)

Take **line M1** which starts in Plaza España (marked as *Estació Intermodal* in ticket machines) and ends in the UIB campus. Travel time is 13 min. Ticket price is 1.60 EUR. Tickets can be purchased at the ticker machines located in the station hall (bills larger than 20 EUR are not accepted). Keep the ticket until the end, since it is needed to leave the station. A map and the schedule of the M1 line can be download from this page.

- Bus

You can also take the **bus line 19** (labelled as "Universitat") to go to the UIB campus (ticket price 1.50 EUR). Bus frequency is about one every 15 minutes. To get to the building the bus stop number is 571 and is called "Edifici Beatriu de Pinós". To go back to Palma downtown the bus stop is in front of the building (number 1140 "edifici Jovellanos") Trip time is about 30 minutes. Tickets can be purchased from the bus driver (oly bills up to 10 EUR are accepted). Bus line 19 route can be found here.