

**3<sup>rd</sup> Working Group Meetings of COST Action  
MP1209 “Thermodynamics in the quantum  
regime”**

**Belfast 18-20 August 2014**

**Scientific Report**

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## **Scientific mission of the Meeting**

The goal of the Meeting was to provide a suitable environment for the members of the three Working Groups of the Action to get together and discuss the progress that their respective research stand has made since the last Working Group Meetings in Berlin (January 2014). Such objective was complemented by the presentation of a series of oral/poster contributions, representative of the activity of each Working Group, which gave an overview of the current lines of investigation in the broadest field of quantum thermodynamics.

## **Organising & Technical programme committee**

The local organizing committee comprised Dr. A. Ferraro (Lecturer at Queen's University Belfast), Dr. G. De Chiara (Lecturer at Queen's University Belfast), and Prof. M. Paternostro (Professor at Queen's University Belfast). De Chiara and Paternostro are members of MP1209 (Paternostro is Deputy MC representative for the UK). Valuable help was provided by Mr. M. Brunelli, Dr. S. Campbell, Mr. L. Fusco, and Dr. S. Pigeon, who are all members of the Quantum Technology Group at Queen's University Belfast. Dr. Maurice Macartney provided administrative support and liaised with Mrs. Marion Baxter-Sibley on the financial aspects of the meeting.

The technical programme committee was chaired by Prof. V. Vedral (University of Oxford and National University of Singapore) and comprised Prof. J. Pekola (Aalto University), Dr. A. Auffeves (Institut Neel & CNRS), Dr. Michele Campisi (Scuola Normale Superiore Pisa), Prof. S. Wehner (National University of Singapore), Dr. A. Ferraro (Queen's University Belfast).

Assistance and advice was given by Dr. J. Anders and Prof. R. Renner.

The website of the meeting was

<http://web.am.qub.ac.uk/wp/belfastmp1209/>

## **Location and logistic arrangements**

The meeting was held at the Wellington Park Hotel, Belfast, where three rooms and ample common space have been arranged for the members of the Working Groups to meet and discuss. Accommodation for a limited number of participants (including the invited speakers) was secured within the Wellington Park Hotel or in nearby hotels. Light lunches and tea/coffee breaks were served at the hotel. A social dinner was organized for the delegates at the Cutters Wharf Restaurant, Lockview Road Belfast.

## Structure of the meeting

The meeting was organized in 2 & ½ days of scientific activities comprising 5 plenary sessions and two poster sessions. The final programme of the meeting is presented in **Appendix I** for completeness. Four hours of discussions dedicated to the three Working Groups were secured in the first two days of the meeting. The discussions were conducted in an informal, non-structured way to allow the Groups members to initiate new scientific projects, develop/finalise ongoing ones. The level of engagement of the participants to the discussions was very good across the whole meeting.

Overall, we had 60 participants from 15 different countries (13 European ones). Out of the total number of participants, we had 43 Early Stage Researchers (72% of the total participants); 5 female researchers attended the meeting (accounting for 8% of the total attendance).

The scientific programme consisted of 29 oral presentations (6 invited) and 20 posters. All the participating ESRs presented their work at the meeting (in the form of either an oral contribution or a poster presentation). 16.7% of the invited talks and 13% of the contributed talks were by female researchers. The final distribution of presentations (both oral and poster ones) per Working Group is as follows:

***Working Group 1: 27% of the total***  
***Working Group 2: 47% of the total***  
***Working Group 3: 26% of the total***

The attendance per day was as follows:

Monday 18 August: 58 attendees

Tuesday 19 August: 60 attendees

Wednesday 20 August: 56 attendees

Therefore, 174 people attended over 3 days.

## Scientific summary

The meeting covered the most pressing research activities within each Working Group, focusing on the most recent progresses accomplished in the formulation of a resource-theory approach to quantum thermodynamics, the application of many-body techniques to finite-time out-of-equilibrium thermodynamics of quantum systems, the design of efficient micro and nano-scale engines and the implementation of archetypal devices for the investigation of thermodynamics at the quantum scale. Very interesting problems on equilibration in closed quantum system and the appropriate definition of thermodynamic quantities in open

system dynamics were at the centre of the discussions that took place during both the plenary sessions and the Working Group-oriented discussion times. The breadth of different topics covered at the meeting is best presented by inspecting the “Booklet of Abstract” that can be downloaded from [here](#).

## **Financial aspects**

Financial support from the Action was secured for 28 COST members and Prof. Mikko Mottonen, who gave an invited talk at the meeting and, despite not being a member of MP1209, comes from a COST Country.

The Local Organiser Support claim was for € 6142.67. A participation fee of € 60 was asked to participants (waived to the invited speakers), which helped covering the costs of the social dinner. The fees were collected and managed by the local organizing committee.

# Appendix I: Final programme of the meeting

Program of the 3 <sup>rd</sup> Working Group Meeting of Cost Action MP1209				
18 August		19 August		20 August
08:30--08:50 Registrations	08:50--09:00 Introduction			
09:00--09:45 Ahsan Nazir	09:00--09:45 Ferdinand Schmidt-Kaler	09:00--09:45 Antonio Acin		
09:45--10:10 Maxime Clusel	09:45--10:15 Gabriele De Chiara	09:45--10:00 Philippe Faist		
10:10--10:25 Raam Uzdin	10:15--10:40 Laura Mancinska	10:00--10:25 Tony Short		
10:25--10:40 Mathis Friesdorf	10:40--10:55 Piotr Cwiklinski	10:25--10:50 Tony J G Apollaro		
10:40--11:05 Robert Whitney	10:55--11:20 Alberto Imparato	10:50--11:05 Lea Kraemer		
		11:05--11:45 Coffee		
11:05--13:05 Coffee & WGs discussions	11:20--13:00 Coffee & WGs discussions	11:45--12:10 Beatriz Olmos		
		12:10--12:25 Luis A. Correa		
		12:25--12:50 Nikolai Kiesel		
		12:50--13:05 Marco Pezutto		
13:05--14:30 Lunch	13:00--14:30 Lunch	13:05--14:45 Lunch		
14:30--15:15 Lidia del Rio	14:30--15:15 Mikko Mottonen	14:45--15:00 Closing remarks		
15:15--15:30 Karen Hovhannisyan	15:15--15:30 Giovanni Vacanti	Free time for discussions & Departures		
15:30--15:55 John Goold	15:30--15:55 Luis Masanes			
15:55--16:10 Felix Binder	15:55--16:10 Artur Malabarba			
16:10--16:35 James Millen	16:10--16:35 Francesco Plastina			
16:35--18:35 Coffee & WGs discussions based around posters	16:35--18:35 Coffee & WGs discussions based around posters			
	19:00-- Social dinner			

## Appendix II: Titles of the invited and contributed presentations

### Invited Talks

**1. Antonio Acin:**

*Work and correlations*

**2. Gabriele De Chiara:**

*Quantum work distribution in many body systems*

**3. Lidia del Rio:**

*Thermodynamics as a resource: foils and clocks*

**4. Mikko Mottonen:**

*Experimental studies of fluctuation relations in single-electron boxes*

**5. Ahsan Nazir:**

*Environmental dynamics, correlations, and the emergence of non-canonical equilibrium states in open quantum systems*

**6. Ferdinand Schmidt-Kaler:**

*Non-equilibrium statistics and thermodynamic machines with trapped ions*

### Contributed Talks

**1. Tony J. G. Apollaro:**

*Quantum thermodynamics of global and local quenches performed on a spin chain*

**2. Felix Binder:**

*Operational Thermodynamics of Open Quantum Systems*

**3. Maxime Clusel:**

*Stochastic thermodynamics for driven quantum open systems*

**4. Luis A. Correa:**

*COP at maximum cooling power for strongly coupled quantum fridges*

**5. Piotr Cwiklinski:**

*Ultimate power of thermal operations: limitations for thermodynamical processing of coherences*

**6. Philippe Faist:**

*Gibbs-preserving maps outperform thermal operations in the quantum regime*

**7. Mathis Friesdorf:**

*Emergence of coherence and the dynamics of quantum phase transitions*

**8. John Goold:**

*Steps towards exploring the quantum Landauer principle experimentally*

**9. Karen Hovhannisyan:**

*Tightening the second law of thermodynamics for restricted baths*

**10. Alberto Imparato:**

*Fluctuation theorems in systems in contact with several baths: theory and experiments*

**11. Nikolai Kiesel:**

*Cavity-Optomechanics meets Thermodynamics*

**12. Lea Kraemer:**

*Timing in Quantum Thermodynamics*

**13. Artur Malabarba:**

*Quantum Systems Equilibrate Rapidly for Most Observables*

**14. Laura Mancinska:**

*Limits to catalysis in quantum thermodynamics*

**15. Lluís Masanes:**

*derivation and quantification of the third law of thermodynamics*

**16. James Millen:**

*Thermodynamics with nanospheres levitated in a vacuum*

**17. Beatriz Olmos:**

*Relaxation of interacting many-body systems under purely dissipative quantum dynamics*

**18. Marco Pezzutto:**

*Complete positivity and the second law in a driven open quantum circuit*

**19. Francesco Plastina:**

*Irreversible work and inner friction in quantum thermodynamic processes*

**20. Tony Short:**

*Thermodynamics for individual Quantum Systems*

**21. Raam Uzdin:**

*Equivalence of Reciprocating Quantum Heat Engines*

**22. Giovanni Vacanti:**

*Housekeeping heat and work in out of equilibrium quantum systems*

**23. Robert Whitney:**

*Most efficient quantum thermoelectric at finite power output*

**Posters**

**1. Ivan Balog**

*Hysteresis, in and out of equilibrium*

**2. Zachary BlundenCodd**

*Multipolaron Ground State Ansatz for the Spin-Boson Model*

**3. Matteo Brunelli**

*Non-equilibrium Quantum Thermodynamics of an Ideal Optomechanical System*

**4. Steve Campbell**

*Shortcuts to adiabaticity in genuinely many-body interacting Hamiltonians*

**5. Andrew Carlisle**

*Out of equilibrium thermodynamics of quantum harmonic chains*

**6. Lorenzo Fusco**

*Assessing the non-equilibrium thermodynamics in a quenched quantum many-body system via single projective measurements*

**7. Luis Pedro Garcia-Pintos**

*On the equilibration time scales for small subsystems of a closed quantum system*

**8. Marcel Goihl**

*Matrix-Product operators as a numerical tool for transport*

**9. Jake Iles-Smith**

*Environmental dynamics, correlations, and the emergence of noncanonical equilibrium states in open quantum systems*

**10. Philipp Kammerlander**

*Autonomous work extraction within a Szilard engine model*

**11. Ruari McCloskey**

*Landauer's principle and non-Markovianity in two-body open quantum systems*

**12. James Millen**

*Thermodynamics of levitated nanospheres*



**13. Michael Moeckel**

*Synchronizing a single-electron shuttle to an external drive*

**14. Hamed Mohammady**

*Minimising heat dissipation of bit erasure by controlling a finite-size quantum reservoir*

**15. Mariona Moreno**

*Quantum Thermometry of Strongly Correlated Systems*

**16. Fernando Nicacio**

*Thermal Transport on a Chain of Oscillators coupled to Individual Baths*

**17. Christian Nietner**

*Non-equilibrium relaxation transport of ultracold atoms*

**18. Simon Pigeon**

*Dynamical symmetries and phase transitions in a three-spin system*

**19. Matthew Power**

*Entanglement and correlations of thermal states of the cluster-Ising model*

**20. Andre' Xuereb**

*Reconfigurable long-range phonon dynamics in optomechanical arrays*