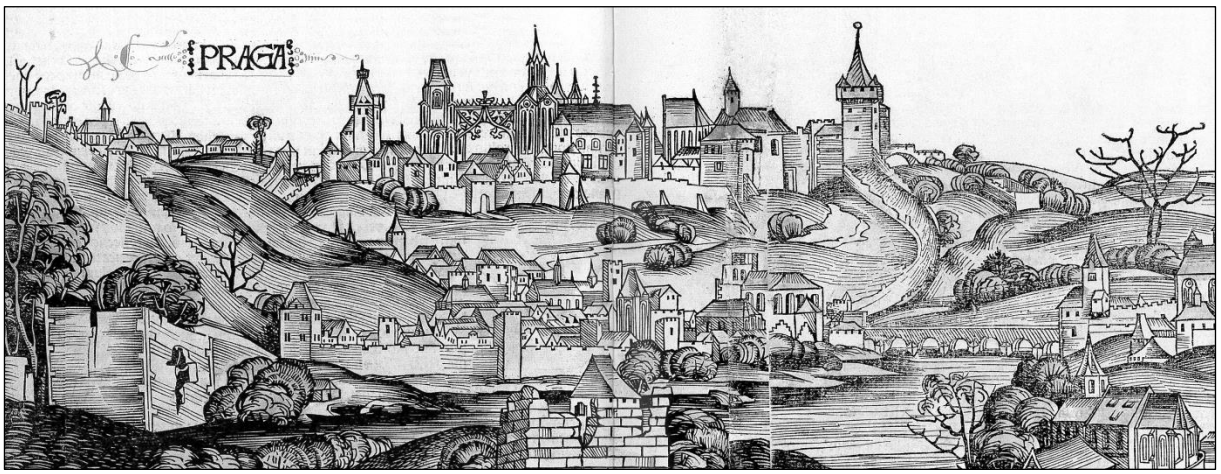
7th multidisciplinary conference

Frontiers of Quantum and Mesoscopic Thermodynamics

FQMT'19

The FQMT'19 is dedicated to Marlan Scully
for his lifetime achievements in physics



Selected topics

Non-equilibrium phenomena
Quantum statistical physics
Foundations of quantum physics
Quantum optics
Astrophysics and cosmology
Mesoscopic and biological systems
Cold atoms and molecules

14 – 20 July 2019, Prague

https://fqmt.fzu.cz/19/

The conference

Frontiers of Quantum and Mesoscopic Thermodynamics (FQMT'19)

is held under the auspices of

Ing. Miloš Zeman

President of the Czech Republic

Jaroslav Kubera

President of the Senate of the Parliament of the Czech Republic

Milan Štěch

Vice-President of the Senate of the Parliament of the Czech Republic

Prof. RNDr. Eva Zažímalová, CSc.

President of the Czech Academy of Sciences

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Archbishop of Prague

The conference is supported by

Committee on Education, Science, Culture, Human Rights and Petitions of the Senate of the Parliament of the Czech Republic

Institute of Physics of the Czech Academy of Sciences

Institute for Theoretical Physics, University of Amsterdam, Netherlands

Department of Physics, Texas A&M University, USA

Quantum Optics Lab at the BRIC, Baylor University, USA

College of Engineering and Science, University of Detroit Mercy, USA

Institut de Physique Théorique, CEA/CNRS Saclay, France

History of the FQMT Conferences

FQMT'19 is a follow-up to the six previous, successful Prague conferences "Frontiers of Quantum and Mesoscopic Thermodynamics" (FQMT'04, FQMT'08, FQMT'11, FQMT'13, FQMT'15, and FQMT'17). For the details of their programs and the history of the FQMT conferences see the www pages: https://fqmt.fzu.cz/. The title of the conference is traditional and reflects main topics of early FQMT conferences. The contributions from the previous conferences have been published in Physica E (vol. 29, issues 1-2, 2005, and vol. 43, issue 3, 2010), Physica Scripta (vol. T151, 2012, and vol. T165, 2015), and Fortschritte der Physik (Progress of Physics), vol. 65, 2017. Contributions from the FQMT'17 will appear in the European Physical Journal Special Topics.

Public Lectures at the FQMT conferences

Public lectures are traditional part of the FQMT conferences. The previous lectures were presented by the following speakers:

FQMT'04		
	Anthony Leggett:	Does the everyday world really obey quantum mechanics?
FQMT'08		
	Georgy Shlyapnikov:	Novel physics with ultracold fermions
	Marlan Scully:	The demon and the quantum: From thermodynamics to quantum mechanics and beyond
	Raymond Chiao:	The Big Bang and the Cosmic Gravitational-wave Background (CGB): Using quantum mechanics to detect the first rumours in the Universe
FQMT'11		
	Martin Rees:	From Big Bang to Biospheres
	Claude Cohen-Tannoudji:	Laser manipulation of atoms
FQMT'13		
	Serge Haroche:	Juggling with photons in a box to explore the quantum world
	Pavel Kroupa:	How astronomers define our world view
FQMT'15		
	Gerard 't Hooft:	The quantum deep down
	Marlan Scully:	The photon sheds light on the quantum
FQMT'17		
	John Pendry:	Metamaterials and the science of invisibility
	Anton Zeilinger:	From quantum puzzles to quantum information technology

Musical program

All the above public lectures were followed by concerts of classical or jazz music. These concerts and other musical events of the FQMT were held in outstanding venues of Prague, namely the St. Vitus Cathedral of the Prague Castle, Dvořák's Hall of the famous Rudolfinum Concert House, National House of Vinohrady, baroque Wallenstein Palace, Břevnov Monastery, and St. Simon and Juda Church. The concerts were performed by world-class musicians from Prague and abroad.

Brief description of concerts during individual FQMT conferences:

FQMT'04

- Classical concert: Main Hall of the Wallenstein Palace, Monday July 26, 2004, Snítil Quartet L. Janáček, A. Dvořák

FQMT'08

- Classical concert – Chamber music: St. Šimon and Juda Church - Wednesday July 30, 2008, J.B. Pergolesi, J.D. Zelenka, G.F. Handel, V. Kramář, A. Dvořák, J. Ježek, and G. Faure
- Jazz concert: Cinema Hall of the Pyramida Hotel, Thursday July 31, 2008 International jazz band
- Classical concert – Organ music: Břevnov Monastery – Friday August 1, 2008, J.S. Bach, Herman of Reichenau, Hildegarda of Bingen, J. Pachelbel, P. Eben

FQMT'11

- Classical concert – Chamber music: St. Šimon and Juda Church - Tuesday July 26, 2011
  J. Clarke, J.S.Bach, P.J. Vejvanovský, F.X. Brixi, D. Buxtehude, G. Faure, J. Somary, Y. Goyzman, J. Weinberger, M. Bruch, Jewish Songs, M. Nyman, D. Shostakovich, G. Mahler, Klezmer music
- Jazz concert: Cinema Hall of the Pyramida Hotel, Wednesday July 27, 2011 Original Prague Syncopated Orchestra
- Classical concert – Chamber and organ music, Dvořák's Hall of Rudolfinum, Thursday July 28, 2011
  L. Boëllmann, G.F. Handel, H.I.F. Biber, M. Duruflé, J.Ch. Pepusch, Y. Waldman, J. Suk, J. Ježek
- Classical concert – Organ, brass, and Gregorian chant music: St. Vitus Cathedral, Friday July 29, 2011
  J. Kšica, J. Suk, J. Burghauser, Hildegarda of Bingen, M. Praetorius, St. Thomas Aquinas, J.S. Bach, O. Messiaen, G.F. Handel

FQMT'13

- Classical concert – Chamber and organ music, Dvořák's Hall of Rudolfinum, Tuesday July 30, 2013
  Ch. M. Widor, J. Clarke, , J.S. Bach, G.F. Handel, Y. Waldman, V. Trojan, A. Tansman, T. Albinoni, A. Dvořák, M. Reger, J. Ježek, G. Gershwin, H. Arlen, C. François, J. Revaux, P. Anka, J. Kšica
- Jazz concert: Cinema Hall of the Pyramida Hotel, Wednesday July 31, 2013 Original Prague Syncopated Orchestra
- Classical concert – Chamber music: St. Šimon and Juda Church, Thursday August 1, 2013 P.J. Vejvanovský, J. Stanley, G.P. Telemann, F.W. Zachow. J.D. Zelenka, M.A. Charpentier, L. van Beethoven, V.J. Tomášek, V. Hálek, Z. Lukáš, E. Bozza, Jewish Songs, E. Bloch, J. Engel, P. Ben Haim

- Classical concert – Organ, brass, and Gregorian chant music: St. Vitus Cathedral, Friday, August 2, 2013
  J. Pezelius, M. Reger, P. Vejvanovský, Hildegarda of Bingen, J.S. Bach, H.I.F. Biber, F.X. Thuri, J. Bodin de Boismortier, F. Weiss, J. Kšica

FQMT'15

- Classical concert – Chamber music: St. Šimon and Juda Church, Tuesday July 28, 2015
  J. Kšica, G.F. Handel, M. Erdenko, P.A. Levi, M. Weinberg, K. Husa, J. Hlaváč, F. Liszt, D. Milhaud, A. Corelli
- Classical concert – Chamber and organ music, Dvořák's Hall of Rudolfinum, Wednesday July 29, 2015,
  J. Kšica, J.S. Bach, J.B. Loeillet, C.M. Widor, G.F. Handel, V. Trojan, P. Eben, F. Chopin, A. Dvořák, G. Gershwin
- Classical concert – Organ, brass, and chamber music: St. Vitus Cathedral, Thursday, July 30, 2015
  C. Franck , W.A. Mozart, J.B. Pergolesi, J. Burghauser, J.S. Bach, H.I.F. Biber, J. Clarke, M.R. de Lalande
- Classical concert – Organ and chamber music: Břevnov Monastery, Friday, July 31, 2015
  J.S. Bach, G.F. Handel, G. Cavazzoni, J. Massenet, Hildegarda of Bingen

FQMT'17

- Classical concert – Chamber music: National House of Vinohrady, Tuesday July 11, 2017
  J. Kšica, M.A. Charpentier, T. Albinoni, J. D. Zelenka, I. Séquardt, J. Haydn, W.A. Mozart, J. Brahms, A. Dvořák, F. Drdla, F. Chopin, D. Milhaud, G. Gershwin, J. Hlaváč
- Classical concert – Chamber and organ music, Dvořák's Hall of Rudolfinum, Wednesday July 12, 2017
  J. Kšica, J.S. Bach, J. Clarke, G.F. Handel, H. Purcell, A. Vivaldi, A. Dvořák, B.A. Wiedermann, A. Rubinstein, E. Garner, V. Trojan, R. Quilter, L. Bernstein, J. Hlaváč
- Classical concert – Organ and chamber music: St. Vitus Cathedral, Thursday, July 13, 2017
  M. Reger, J.S. Bach, W.A. Mozart, K. Stamic, J. L. Dusík, F. Geminiani, B. Smetana, J. Trneček, G. P. Telemann, A. Corelli, F. Liszt
- Classical concert – Organ and chamber music: Břevnov Monastery, Friday, July 14, 2017
  P. J. Vejvanovský, G. F. Handel, E. Morricone, J. S. Bach, A. Dvořák

The following musicians performed at the above concerts:

Ars Instrumentalis Pragensis: Luboš Hucek (bassoon), Josef Kšica (organ, harpsichord, piano), Pavel Nejtek (double-bass), Liběna Séquardtová (oboe), Ivan Séquardt (oboe, horn)

Prague Castle Trumpeters: Petr Cibulka, Tomáš Hrbáček, František Svejkovský, Jan Verner (trumpets), Martin Homolka, Zdeněk Thuma, Josef Trnka (trombones), Rostislav Pavlík (tuba), Miroslav Turek (kettle-drums)

Snítil Quartet: Roman Hranička, Matěj Polášek (violins), Barbora Veisová (viola), Šimon Veis (cello)

Gregorian Chant Singers: Jan Baťa, Pavla Bušová, Zbyněk Šír, Radim Vondráček, Eva Zbytovská

Original Prague Syncopated Orchestra: Pavel Klikar (trumpet), Ladislav Kokeš (trumpet, violin), Jan Šimůnek (violin), Tomáš Černý, Tomáš Jirák (clarinet, saxophone), Vojtěch Pospíšil, Jakub Šnýdl (clarinet), Matěj Černý (double bass), Zbyněk Dobrohruška (banjo), Antonín Dlapa, Antonín Šturma (guitar), Jiří Gilík (piano), Alice Bauer, Adéla Zejfartová (vocal)

International jazz band: Al Hermann (trombone), Bob Montgomery (trumpet), František Uhlíř (double-bass), David Vrobel (saxophone), Adam Tvrdý (guitar), Jaromír Helešic (drums), Jiří Hlaváč (clarinet), Tomáš Víšek (piano)

Jiří Hlaváč (clarinet), Luboš Hucek (bassoon), Josef Kšica (organ, harpsichord, piano), Přemysl Kšica (organ), Pavla Bušová-Kšicová (mezzosoprano), Tomáš Jindra (bass), Jan Kvapil (violin), Pavel Nejtek (double-bass), Ivan Sequardt (oboe, horn), Liběna Sequardtová (oboe), Jan Thuri (oboe), Tomáš Víšek (piano), Jindra Nečasová Nardelli (piano), Marek Zvolánek (trompet), Václav Eichler (clarinet, tarogato), Miroslav Kejmar (trumpet), František Svejkovský (trumpet), Zdeněk Šedivý (trumpet), Yuval Waldman (violin), Iva Fleischhansová-Butler (violin), Jiří Lukeš (accordion), Kristina Švábová (quitar), Yasuko Tanaka (trumpet), Jan Fišer (trumpet), Martin Misár (trumpet), Hana Müllerová (harp)

Conference overview

Frontiers of Quantum and Mesoscopic Thermodynamics (FQMT'19)

14 July (Sunday) – 20 July (Saturday) 2019, Prague, Czech Republic

https://fqmt.fzu.cz/19/

Scope of the Conference

The main goal of the conference is to contribute to a better understanding of the behavior of quantum systems out of equilibrium. To reach this aim we also need to improve our knowledge of systems in equilibrium and steady state situations. The conference will thus address foundations of quantum physics, quantum many body physics, statistical physics, and thermodynamics relying on the theoretical and experimental methods of condensed matter physics and quantum optics. The systems considered will be mainly on the order of mesoscopic (nanoscale) size, and include those of both natural and artificial origin. Special attention will be given to non-equilibrium quantum systems, physics of quantum information and manifestation of quantum effects in biological systems. Subjects from astrophysics, gravitation or cosmology related to the above scope will also be included.

Topics

Non-equilibrium quantum phenomena
Foundations of quantum physics
Quantum measurement, entanglement and coherence
Dissipation, dephasing, noise and decoherence
Many body physics, quantum field theory
Quantum statistical physics and thermodynamics
Quantum optics
Quantum simulations
Physics of quantum information and computing
Topological states of quantum matter, quantum phase transitions
Macroscopic quantum behavior
Cold atoms and molecules, Bose-Einstein condensates
Mesoscopic, nano-electromechanical and nano-optical systems
Biological systems, molecular motors and quantum biology
Cosmology, gravitation and astrophysics

Multidisciplinary Character of the Conference

The aim of FQMT'19 is to create a bridge between the fields of non-equilibrium statistical physics, quantum many body physics, foundations of quantum physics, quantum thermodynamics, quantum optics, physics of quantum information, astrophysics, condensed matter physics, physics of mesoscopic systems, chemical physics and biophysics.

Following the tradition of the FQMT conferences, FQMT'19 will again bring together a unique combination of both young and experienced scientists across a disciplinary spectrum covering the above mentioned topics. The interdisciplinary character of the conference will be supported by the choice of key speakers who, apart from their specializations, are not only able to report specific results within their fields, but are also able to discuss the state of the art of their fields from the standpoint of a broader perspective of overlap with other fields. It is an objective to gather important scientists from overlapping branches of physics who can mutually benefit from the exchange of different views and ideas, experiences from studies of many different systems and various theoretical and experimental approaches to the study of current problems in physics. It is intended that this arrangement of the scientific program of the conference will again significantly contribute to the formulation of challenging questions and problems, as well as their related answers that are nowadays essential to improve the understanding of the foundations of quantum physics, many body physics, quantum statistical physics of systems far from equilibrium, the physics of nanoscale and biological systems, and further, will motivate new collaboration and intensive discussions between experts from differing fields of physics, chemistry, and biology.

Public Lectures

Following the tradition of FQMT conferences, the FQMT'19 program will include several public lectures which will present interesting topics in the form attractive for both the conference participants and general audience. The following lecturers are preliminary confirmed:

- Wolfgang Ketterle (Massachusetts Institute of Technology)
- William Phillips (NIST and University of Maryland, Gaithersburg)
- Rainer Weiss (Massachusetts Institute of Technology)

These lectures will be held at special venues and accompanied by concerts.

Musical, Art and Social Programs

An encompassing social program includes the number of social events and tours in order that participants may enjoy not only physics but also Prague during the conference, sometimes in a way, which is hardly available to common visitors of Prague. Hence for accompanying persons this is an opportunity of rare quality to visit to this city.

Participants of FQMT'19 conference will have an exceptional opportunity to spend some time in the Wallenstein Palace. The participants and their partners could enjoy the large baroque Garden of the Wallenstein Palace with its nice Sala Terrena for discussions during the evening welcome party. A guided tour will be organized through the huge baroque complex of the Wallenstein Palace. This would be a unique experience by itself since it is difficult to see all these places under ordinary circumstances.

In keeping with the multidisciplinary character of the scientific program, the cultural richness of the city of Prague and the tradition of the previous FQMT conferences, the FQMT'19 program will feature concerts performed by world-class musicians, held at outstanding venues of the city. The list of these places will likely include, e.g., the St. Simon and Juda Church (seat of the Prague Symphonic orchestra FOK), Dvořák's Hall of the Rudolfinum (the seat of the Czech Philharmonic Orchestra and famous by concerts of Prague Spring Festival), the gothic Cathedral of St. Vitus at Prague Castle (one of the symbols of the Czech lands), and the baroque St. Margaret Church at the Břevnov Monastery.

The scientific, the fine arts, and the musical programs are intended as a complement to one another, where scientists, historians of the arts and musicians are encouraged to mingle and share their knowledge and experience. An encompassing social program is planned which will include tours and a number of very special events unavailable to the general tourist.

The conference is organized by

- Institute of Physics, the Czech Academy of Sciences
- Committee on Education, Science, Culture, Human Rights and Petitions of the Senate of the Parliament of the Czech Republic

Organizing Committee

Conference chair: Václav Špička (*Institute of Physics, Czech Academy of Sciences, Prague*)
Jiří Bok (*Charles University, Prague*)
Howard Brubaker (*Detroit*)
Pavla Bušová (*Prague*)
Barbora Chudíčková (*Institute of Physics, Czech Academy of Sciences, Prague*)
Soňa Fialová (*Prague*)
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Peter D. Keefe (*University of Detroit Mercy*)
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Yuval Waldman (*Music Bridge International, New York*)

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Rainer Blatt (*Innsbruck University*)
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Dudley Herschbach (*Harvard University*)
Gregg Jaeger (*Boston University*)
Christopher Jarzynski (*University of Maryland, College Park*)

Wolfgang Ketterle (*Massachusetts Institute of Technology, Cambridge*)

Andrei Khrennikov (*Linnaeus University, Växjö*)

Norbert Kroo (*Hungarian Academy of Sciences, Budapest*)

Pavel Kroupa (*University of Bonn, Charles University, Prague*)

Anthony J. Leggett (*University of Illinois at Urbana - Champaign*)

Igor Lerner (*University of Birmingham*)

Heiner Linke (*Lund University*)

Reinhard Lipowsky (*MPI of Colloids and Interfaces, Potsdam*)

Angus MacKinnon (*Imperial College, London*)

Yigal Meir (*Ben Gurion University, Beer Sheva*)

Franco Nori (*RIKEN, Wako-shi, and University of Michigan, Ann Arbor*)

Henri Orland (*CEA-Saclay*)

Giorgio Parisi (*Università di Roma I. La sapienza*)

William Daniel Phillips (*NIST and University of Maryland, Gaithersburg*)

Jean Michel Raimond (*École Normale Supérieure, Paris*)

Christophe Salomon (*Laboratoire Kastler Brossel, Paris*)

Marlan Scully (*Texas A&M University, Baylor University and Princeton University*)

Georgy Shlyapnikov (*Université Paris Sud*)

Wolfgang Schleich (*University of Ulm*)

Ady Stern (*Weizmann Institute, Rehovot*)

Jan van Ruitenbeek (*Leiden University, Kamerlingh Onnes Laboratory*)

Rainer Weiss (*Massachusetts Institute of Technology, Cambridge*)

Anton Zeilinger (*University of Vienna*)

Peter Zoller (*Institute for Quantum Optics and Quantum Information, Innsbruck*)

FQMT'19 Scientific Background

Recent advances in technologies have led to enormous improvements of measurement, imaging and observation techniques at microscopic, mesoscopic and macroscopic scales. At the same time, various methods allow us to investigate not only equilibrium features, but also time evolution of classical and quantum systems (which are in general far from equilibrium) at different time scales. This increasing ability to study subtle details of the dynamics of systems yields new versions of old questions and creates new challenges in many fields of physics.

A good understanding of the time evolution of both classical and quantum systems is essential for an explanation of many observations and experiments of contemporary physics. Observed systems must be often treated as non-equilibrium, open systems in which their behavior is influenced not only by their inner parameters, but also by properties of their environment and time dependent external fields. The theory of non-equilibrium behavior of quantum many-body systems is, however, far from complete. Important problems include such questions as irreversible behavior of real systems in comparison with reversible microscopic laws, emergence of classical macroscopic behavior from microscopic quantum behavior, charge (electron), spin and heat transport, limits to "phenomenological" thermodynamic descriptions, and the problem of how to describe properly open quantum systems far from equilibrium, especially in the case of strong interaction between a small system and reservoirs. Thus, further experimental as well as theoretical studies of short to long time dynamics (via transport as well as optical properties) and the influence of initial and boundary conditions (e.g. in quenched or annealed systems) are needed.

Mesoscopic systems are of special importance for these studies. Various systems, of natural and artificial origin, can exhibit mesoscopic features depending on inherent inner parameters and interactions with their environment. Typical mesoscopic systems are of nanometer size, enabling fast developing nanoscale technologies for the preparation of structures with well defined inner parameters, providing an enormous diversity of systems subject to interaction with the external environment. Nanoscale structures include not only very small artificially prepared structures, but also structures occurring in living cells, as for example complex molecules, proteins and molecular motors.

Such systems are on the borderline between different disciplines (i.e., physics, chemistry, and biology) where the dynamic behavior of these systems and corresponding various methods of their description (individual and statistical, microscopic and macroscopic, classical and quantum) meet. These (often open) systems are commonly dominated by quantum effects, by topology of their structures and states, and by strong interactions with their environment. Due to their position between the macro and micro world, these systems exhibit many surprising phenomena which can lead to a better understanding of quantum mechanics, many-body physics, and the relation between classical and quantum behaviors by sensitive choice of parameters. The development of theoretical concepts for their description and reliable experimental methods is of great importance for investigating these systems, testing theories and designing new nanostructures with well defined, desired behavior. They can be studied by methods of condensed matter physics and quantum optics in such detail that

affords a deeper understanding of quantum physics, as represented by quantum interferences, entanglement, the uncertainty principle and quantum measurement processes.

Another challenging problem is stochastic behavior of such systems caused either by innate features of the systems or by noise related to the studied systems being open. Studies of quantum and temperature fluctuations, as well as quantum noise, dephasing and dissipation are of key importance, since these phenomena are closely related to the performance and the reliability of both artificially created nano-devices as well as natural “engines”, as are for example molecular motors and processes in cells in general.

Non-equilibrium processes and the system’s environment play a decisive role in living organisms and there are many questions to be answered before we fully understand the laws which govern the performance of the nanometer structures which are essential for life. In this regard, it appears one of the necessary conditions for the proper performance of cells is that their dynamics be based on far from equilibrium states and related nonlinear, non-equilibrium transport. There are also questions about the role of quantum physics in the behavior of various systems which are essential for living organisms, i.e., under which circumstances quantum effects, coherence, fluctuations and noise can influence a cell’s functions.

Behavior of molecular motors is associated with more general considerations related to thermodynamics and the use of various mesoscopic structures. Among the central themes of classical thermodynamics are the concepts of “temperature”, “system”, “reservoir”, and “engine”. Due to quantum features of mesoscopic systems, it is necessary to deal with quantum thermodynamics to discuss possible quantum pumps, heat engines or refrigerators based on features of mesoscopic (molecular) systems. The task of quantum thermodynamics is to provide a good “phenomenological” frame for the “macroscopic” description of open mesoscopic systems coming from more detailed studies of non-equilibrium quantum statistical physics of open systems and the foundations of quantum mechanics.

In general, the above problems arise in dissipation, dephasing and decoherence processes, and, on a very basic level, the foundations of quantum mechanics and related theories of quantum measurement. A better knowledge and insight into the foundations of quantum physics is essential for a proper formulation of the fundamental laws of physics. It is also essential for developing a suitable description of small quantum systems and their applications. This applies particularly to quantum optics and physics of quantum information and computing, where questions of quantum interference, entanglement and decoherence processes, together with knowledge of time scales governing the dynamics of the studied systems, are essential and mutually beneficial.

The above subjects can be well documented by various examples from the physics of quantum computing, information and metrology and the physics of cold atoms and molecules. Various quantum (two states) systems are nowadays intensively studied in a hope that their parameters and related dynamics will be suitable for quantum computers.

Many of the above mentioned problems are also important for such seemingly distant fields as cosmology, gravitation and astrophysics, for the reason that these areas of investigation are strongly related to non-equilibrium statistical physics, many body physics, foundations of quantum physics, physics of quantum measurement, macroscopic quantum phenomena (e.g.,

magnetization) and also, mainly due to measurement methods used for observation and detection, to quantum optics, condensed matter physics, and physics of mesoscopic systems.

Thus, the FQMT'19 program will be focused on conceptual and experimental challenges of non-equilibrium statistical physics, quantum many body physics, quantum thermodynamics, foundations of quantum mechanics, and quantum field theory. Further development of all these fields is needed to deal with an increasing requirement for more detailed understanding and use of such phenomena as quantum correlations, entanglement and their dynamics; decoherence and dissipation; light−matter interactions; behavior of closed and open quantum systems far from equilibrium; equilibration and thermalization of systems; roles of initial and boundary conditions; influences of environment, reservoirs and external fields on the time evolution of systems; quantum to classical transitions; dynamics of quantum phase transitions; and topological states of systems. As for systems which enable study of various related questions, the conference will deal mainly with mesoscopic systems. The program will concentrate on discussions of phenomena which are observed in structures and materials such as carbon allotropes, quantum wires and dots, microcavities, single molecule nanomagnets, molecular motors and active gels, various structures in living cells, as well as specific arrangements featuring cold atoms and molecules which can exhibit macroscopic quantum effects and which can also be used for testing methods of quantum many-body theory. The above mentioned phenomena, related problems and challenges occur in many fields of physics, astrophysics, chemistry, and biology. Both theoretical and experimental experiences from such seemingly different, but in fact strongly correlated, fields as condensed matter physics, quantum optics, plasma physics, nuclear physics, physics of quantum information and computing, chemistry, biophysics and astrophysics, will be discussed during the conference program.