

JOB OFFER

Position in the project:	PhD Student
Scientific discipline:	Quantum physics
Job type (employment contract/stipend):	stipend
Number of positions offered:	2
Remuneration/stipend amount/month:	Monthly stipend 5000,00 PLN (gross stipend, tax included)
Position starts on:	Starting date: 01.10.2022 (for candidates who already have MSc degree (or equivalent) and candidates who plan to defend their MSc thesis no later than July 31, 2022) For candidates who are already doctoral students the starting date is negotiable.
Maximum period of contract/stipend agreement:	Until 30.09.2025
Institution:	International Centre for Theory of Quantum Technologies at the University of Gdańsk, Poland
Project leader:	Michał Horodecki
Project title:	The OPUS 21 project entitled “Quantum open systems and thermodynamical resource theory (Polish: Kwantowe układy otwarte i termodynamiczna teoria zasobów)”. The project is financed by the National Science Centre (NCN).
Project description:	<p>We are looking for two PhD students to work in the International Centre for Theory of Quantum Technologies (ICTQT), funded by the Foundation for Polish Science, and hosted by the University of Gdańsk (UG) - pioneering and leading center of quantum information research in Poland.</p> <p>ICTQT aim is to find new solutions and protocols for basic aspects of fundamental quantum physics, from new non-classical phenomena, measures of non-classicality, structural aspects of quantum theory, theory of quantum measurement, up to theory of open systems and quantum thermodynamics, and bring them into quantum technologies.</p> <p>The ICTQT activity is focused on the scientific research in quantum foundations, quantum communication, quantum information, and development of quantum technologies with an emphasis on quantum communication and new computing techniques.</p> <p>The Centre consists of 6 groups: Multiphoton Quantum Optics for Quantum Information (leader Marek Żukowski); New Quantum Resources (leader Paweł Horodecki); Foundational Underpinnings of Quantum Technologies (leader Ana Belen Sainz); New Quantum Resources and Thermodynamics (leader Michał Horodecki); Quantum Cybersecurity and Communication (leader Marcin Pawłowski); Quantum Open Systems in Relation to Quantum Optics (leader Łukasz Rudnicki).</p> <p>More about the research groups please find at you will find here: https://ictqt.ug.edu.pl/</p>

About the OPUS 21 project

The project aims at developing dynamical and kinematic approach to quantum thermal machines. In dynamical approach, evolution is described by Hamiltonian (or derived from it evolution equations) while in kinematic approach the processes are described by discrete unitary transformations, or completely positive maps executed by external agent, belonging to a suitable (thermodynamically motivated) class. I.e. by kinematic approach we mean resource theoretic approach to quantum thermodynamics. The two approaches are complementary. The dynamical approach is close to the physical realm of quantum thermal machines, but often requires numerics, and usually does not allow for proving general statements – one has to usually confine to specific models. The kinematic approach – inheriting methods from quantum information - although often does not refer to common experimental situations, allows to obtain analytical results, especially concerning limitations as well as optimization over possible processes. Thus is it important to develop both approaches and possible interconnections. The main objectives will be contained in the following tasks: dynamics, kinematics and interconnections.

Dynamics. We plan to re-examine the present results on thermodynamics of microscopic systems in the weak coupling non-Markovian regime. Our main tool is newly developed weak coupling non-Markovian dynamical equation (regularized cumulant equation). In particular, we want to solve an open problem of a description of heat flow for two systems coupled to two baths, so that it is consistent with thermodynamics (e.g. reproducing the known truth that heat flows from the hot bath to cold bath) for full range of coupling between the systems. Our working hypothesis is that the regularized cumulant equation will properly describe the thermodynamics of such scenario. Another topic is to analyse two systems operating as a heat engine, again, for parameters, for which no description consistent with thermodynamics is known. One of basic challenges will be to find proper description of heat currents in the non-Markovian weak coupling regime.

Kinematics. We plan to develop understanding of thermodynamical processes within the resource-theoretic approach. This includes: the relations between fluctuations and dissipation in the second order asymptotic limit; the problem of definition of work for explicit work reservoir possessing ground state; the long standing unsolved problem of embezzling (related to Planck-Kelvin formulation of the Second Law). Selected working hypotheses are:

- (i) the resource-theoretic fluctuation-dissipation relation identified recently by PI and coworkers holds for general states
- (ii) for states of work reservoir flat enough far from ground state average energy change give appropriate description work; while this hypothesis is implicitly assumed, apart from initial study by PI and coworkers no quantitative results are known – our main task will be to provide ones
- (iii) for suitable scaling of catalyst error, the catalytic processes with small error on catalyst, will obey near identical laws as without error on catalyst at all.

Interconnections. We plan to seek for a connection between resource theoretic and dynamical models of quantum thermal machines. This includes seeking for a mapping from discrete models of thermal machines to autonomous ones. We want also to seek for a connection between fluctuation-dissipation theorem in open systems and the resource theoretic fluctuation dissipation relations. We shall also aim at developing foundations for definition of work within resource-theoretic picture, and apply the results in dynamical picture.

Keywords: quantum thermodynamics, open systems, quantum heat engines, thermal operations, resource theory, quantum batteries.

	<p>If you would like any further details about the project, the advertised positions, or life in Gdańsk then please feel free to get in contact michal.horodecki@ug.edu.pl for a chat.</p> <p>PhD students positions are offered by the International Centre for Theory of Quantum Technologies of the University of Gdansk within the implementation of the OPUS 21 project entitled “Quantum open systems and thermodynamical resource theory (Polish: Kwantowe układy otwarte i termodynamiczna teoria zasobów)”. The project is financed by the National Science Centre (NCN).</p>
Key responsibilities include:	<ol style="list-style-type: none"> 1. Active scientific research. 2. Discussion and presentation of ideas and results with a diverse audience at ICTQT and at external events. 3. Participation in seminars, group meetings, and other activities of scientific exchange. 4. Participation in activities organized by ICTQT.
Profile of candidates/requirements:	<ol style="list-style-type: none"> 1. The candidate should hold a MSc degree in physics, computer science or mathematics. 2. The candidate should be interested in mathematical and conceptual foundations of quantum mechanics and quantum information, and related topics, especially those which are within the research agenda of ICTQT (visit https://ictqt.ug.edu.pl/). 3. The candidate should be committed to working collaboratively within an inclusive and diverse environment. 4. Basic knowledge of quantum theory is appreciated. 5. Experience in numerical simulations of physical systems is appreciated.
Required documents:	<p>All required documents should be prepared in English:</p> <ol style="list-style-type: none"> 1. filled-in recruitment form; 2. curriculum vitae; 3. motivation letter (including statement of current scientific interests) – up to 2 pages; 4. Optional: a research resume with a list of research projects in which the candidate took part (with specification of the role); PDF files of publications; list of talks at conferences and workshops, list of prizes and awards; 5. documents confirming scientific degrees (copy of diploma); 6. name and contact details (e-mail addresses) to two researchers who may provide reference for the candidate (the candidate is expected to contact the referees and ask them to send reference letters directly to ictqt@ug.edu.pl. The letters must be sent before the deadline). ICTQT may also contact the referees directly to request the letters or to send reminders. <p>General rules of the recruitment process:</p> <ol style="list-style-type: none"> 1. The recruitment procedure has three stages: <ul style="list-style-type: none"> ○ Pre-selection candidates by the Selection Commission (SC), based on sent documents; ○ Interview of pre-selected candidates by SC; ○ Recruitment to the UG Doctoral School of Natural Sciences (a formal UG procedure). 2. PhD student positions are offered to candidates who have received a MSc degree (or equivalent) or who are already PhD students at other Universities/Institutions in Poland 3. PhD student positions are also offered to candidates who plan to defend their MSc thesis no later than July 2022. 4. The decision will be made by the SC within 3 months from the date of recruitment completion. 5. SC reserves the right to invite for the interview only pre-selected candidates. 6. SC’s decision is final and is not subject to appeal.

	<ol style="list-style-type: none"> 7. In the event of resignation from accepting the position of the selected candidate, the SC has the right to send the offer to the person placed on the reserve list, and in the absence of such a list, the SC has the right to reconsider the applications submitted to the competition and to indicate a new candidate. 8. SC reserves the right to close the competition without selecting the candidate.
We offer:	<ol style="list-style-type: none"> 1. Monthly stipend; 2. Work in a rapidly developing, world class research centre; 3. Scientific and organizational support; 4. Basic equipment and core facilities; 5. Friendly, inspiring, interdisciplinary environment, including “entanglement” with National Centre for Quantum Information (KCIK: https://kcik.ug.edu.pl/) and Institute for Theoretical Physics and Astrophysics (IFTiA) at UG.
Please submit the documents to:	ictqt@ug.edu.pl
Application deadline:	July 13, 2022
Offer available at EURAXESS portal:	https://euraxess.ec.europa.eu/jobs/805177