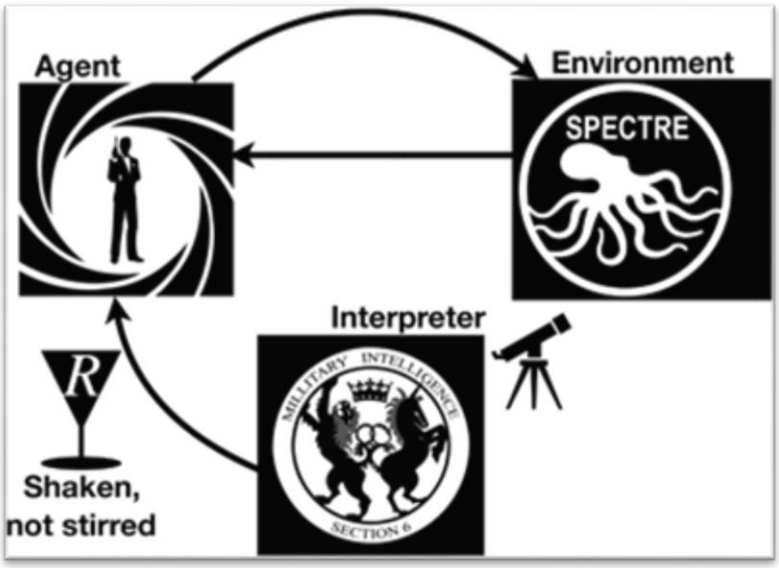
NEWSLETTER N.12, March 2021



The cover image of Phys. Rev. Lett. 126, 020601 (2021) featuring the article "Reinforcement Learning Approach to Nonequilibrium Quantum Thermodynamics" by Pierpaolo Sgroi, G. Massimo Palma, and Mauro Paternostro. *Image by Mauro Paternostro.*

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UPDATE OF WORK DONE

TEQ meeting for experimentalists

TEQ experimentalists have met to update on developments of setting up the low-noise electronics, update on particle loading experiments at UCL & AU, and evidence for decision on details for realization of the ultimate experiment at Southampton. This is the follow up meeting after November 2020 on TEQ experiments.
Covid-19 is slowing done all experiments at UCL, AU, Delft and UoS. Labs are open, but operate at reduced capacity and experiments.

Agenda

14:00	UCL team update on trapping experiments, use of electronics from INFN, YLF particles from Delft and trapping experiments
14:30	Au team update on tests with low noise electronics
15:00	UoS team on magnetic trapping and experiments
15:30	Particle loading and suggestions for experiment at Soton (magnetic or Paul trap, based on experience of all partners)
16:00	Discussion on next steps with electronics and input for INFN, next version of electronics
16:30	End of the meeting

Participants

UCL: Peter Barker, Thomas Penny, Jonthan Gosling
UoS: Antonio Pontin, Andrea Vinante, Hendrik Ulbricht
INFN: Catalina Curceanu, Massimiliano Bazzi
AU: Michael Drewsen, Steffen Meyer

Conclusions

Final decision on Paul or magnetic trap at Soton has to be taken in mid-2021 (gives 6 months to assemble the experiment and perform the first tests at 300 mK) based on more information on particle loading in Paul trap and the lowest mass particle possible in magnetic trap.
H. Ulbricht (UoS), P. Barker (UCL) and M. Drewsen (AU) to meet in late March 2021 to discuss further the topics of magnetic vs Paul trap and the measurement protocol.

Paper by Mauro Paternostro on PRL cover

The control of quantum dynamics is key at both the fundamental and technological level. Over the years, various techniques have been devised to reach the important goal of controlling the fundamental processes that are responsible for the evolution of a quantum system, from optimal control to shortcuts to adiabaticity. In a visionary manner, the development of such techniques will leads us to the design of controlled dynamics able to showcase quantum features all the way up to mesoscopic and macroscopic size-scales.
A very promising approach to controlled quantum dynamics is built on the merging of methods of machine learning with the fundamental building blocks of quantum dynamics. The application of such techniques is finding a growing interest in the community working on quantum technologies and open quantum systems in light of their potential and promises.

The work by TEQ member Mauro Paternostro (Queen's University Belfast) with PhD student Pierpaolo Sgroi and in collaboration with Prof G Massimo Palma (University of Palermo) demonstrates the successful application of reinforcement learning techniques to the control and engineering of energy-exchange processes occurring at the quantum level, showing the possibility to control energy dissipation and irreversibility resulting from non-equilibrium quantum dynamics. This work paves the way to the design of energy-efficient protocols able to harness closed and open quantum evolution and will impact in fields such as quantum computation and quantum transport. The paper made it to the cover of Physical Review Letters.

Link to the publication: Phys. Rev. Lett. 126, 020601 (2021) - Reinforcement Learning Approach to Nonequilibrium Quantum Thermodynamics (aps.org)

PUBLICATIONS

Authors	Title	Journal	Volume	Pages	Year
Giulia Rubino, Lee A. Rozema, Daniel Ebler, Hlér Kristjánsson, Sina Salek, Philippe Allard Guérin, Alastair A. Abbott, Cyril Branciard, Časlav Brukner, Giulio Chiribella, and Philip Walther	Experimental quantum communication enhancement by superposing trajectories	Phys. Rev. Research	3	013093	2021
Adler, Stephen L., Angelo Bassi, and Matteo Carlesso	The continuous spontaneous localization layering effect from a lattice perspective	Journal of Physics A: Mathematical and Theoretical	54	085303	2021

Giulio Gasbarri, Alessio Belenchia, Mauro Paternostro, and Hendrik Ulbricht	Prospects for near-field interferometric tests of collapse models	Phys. Rev. A	103	022214	2021
Pierpaolo Sgroi, G. Massimo Palma, and Mauro Paternostro	Reinforcement Learning Approach to Nonequilibrium Quantum Thermodynamics	Phys. Rev. Lett.	126	020601	2021
Marchese, Marta Maria, Alessio Belenchia, Stefano Pirandola, and Mauro Paternostro	An Optomechanical Platform for Quantum Hypothesis Testing for Collapse Models	New Journal of Physics			2021

To explore the latest publications, visit Publications | TeQuantum.

DISSEMINATION ACTIVITIES

In the first quarter of 2021, TEQ members delivered online seminars and talks to a total of 1.500 people in audience!

Who	What	Where	When
Matteo Carlesso	*Witnessing the Quantum Nature of Linearised Gravity: Challenges in table-top experiments*	UNIKORN Seminars, British Optomechanical Research Network	February, 2021
Angelo Bassi	*Spooky Action at a Distance*	Invited Seminar	February, 2021
Angelo Bassi	Optomechanical interfaces of quantum mechanics and gravity	UNIKORN Seminars, British Optomechanical Research Network	February, 2021
Marta Maria Marchese	*Quantum Hypothesis Testing for Fundamental Physics*	CTP Quantum Information Days QID2020(+1)	February, 2021
Fabrizio Napolitano	*Searches for Pauli exclusion principle violation with the VIP-2 experiment at LNGS*	CTP Quantum Information Days	February, 2021
Catalina Curceanu	*Meccanica quantistica, atomi kaonici*	Meet Science event (on twitch.tv) Fisica della particelle	February, 2021
Catalina Curceanu	*Alla scoperta del computer quantistico*	Le Vie Della Scienza (Velletri 2030)	March, 2021

Alessio Belenchia	*Quantum Superposition of Massive Objects and the Quantization of Gravity*	ZARM Bremen seminars	March, 2021
Catalina Curceanu	*Quantum (r)evolution: dal problema della misura e dal gatto di Schroedinger ai computer quantistici*	Scuola di Storia della Fisica, AIF	March, 2021
Catalina Curceanu	*Quantum Mechanics tested in the cosmic silence of the Gran Sasso underground laboratory*	Fachbereich Physik und Astronomie, Bern Physics Colloquium	March, 2021
Catalina Curceanu	*Da Dracula al gatto di Schroedinger: Ma che avventura la Fisica!*	International Day of Women and Girls in Science, STEM	March, 2021

A detailed list of all talks can be found at Talks | TeQuantum.

ANY OTHER RELEVANT INFORMATION

TEQ paper within the Science best news of 2020

"Scientists have long known that a particle can be in two places at once—yet we only ever see it here or there because the act of observing the particle collapses it. Now, one of the most plausible mechanisms for this collapse—gravity—has suffered a setback." With these words, Science gives the silver medal of the 2020 best science news to the researches resulted in the article "Underground test of gravity-related wave function collapse".
The paper, written by TEQ members Angelo Bassi and Catalina Curceanu with fellow scientists, was published by Nature Physics in September 2020 and has so far received great interest being cited by the most important scientific sources.
The study presents the results of theoretical models and a dedicated experiment at the Gran Sasso underground laboratory to verify the wave function collapse model proposed by the Nobel Laureate Sir Roger Penrose, the Diósi–Penrose model.

Another TEQ innovation on the EU Commission Innovation Radar

The TEQ team is proud to announce that another innovation developed in the project has been analyzed by the European Commission's Innovation Radar and published on the European Commission's Innovation Radar platform joining TEQ's another innovations already showcased on the platform.

The newly introduced innovation is developed by the University of Southampton and is "Levitated mechanical system for acceleration and force sensing (f.e. gravimetry or magnetometry)".

This innovation joins the following:
- Spectroscopy and characterisation of an isolated single particle held in vacuum (UoS, UCL);
- Nanoparticles emitting in the near-infrared with high quantum yield for e.g. luminescent solar concentrators (TUDelft);
- Low-noise digitally controlled DC-voltage source for high-precision (quantum) technologies like trap based quantum technologies or charged particle optics (INFN, AU)

Detailed information on all TEQ's innovations can be found here.

TEQ Coordinator becomes EIC National Champion

TEQ coordinator Professor Angelo Bassi has been invited by the EU Commission's newly established European Innovation Council to become EIC National Champion. This proposal is justified by the outstanding work and contribution to the success of the EIC Pilot under Horizon 2020 that the TEQ project has been giving so far.

Professor Bassi was asked to contribute to the communication efforts of the EIC launch and first steps by being ready to speak to media, being invited to speak at EIC events, using own social media to raise awareness.

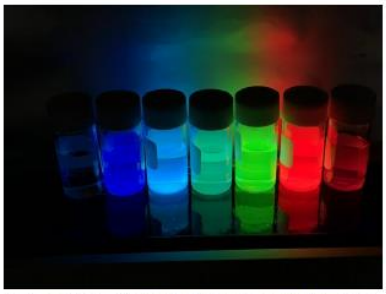
The European Innovation Council under Horizon Europe is a one-stop-shop for innovators, providing support from the idea to the market. The EIC covers the two key dimensions of the innovation process: the early advanced research and the commercialisation and scale-up phase. With a budget of over € 10 billion earmarked in the proposal for the next EU Framework Programme for research and innovation, the fully-fledged European Innovation Council is the most ambitious innovation programme that Europe has ever taken. The EIC is unique in the world in combining an advanced technology programme with an accelerator programme for startups.

Watch the video-message: (1) Angelo Bassi EIC National Champion - EIC launch message - YouTube
More info on the European Innovation Council on European Innovation Council (europa.eu)

Getting to know TEQ members: the interviews

Behind TEQ's theories and experiments, there are scientists: from early career researchers in their 20's to experienced world-known professors. All of them are people who are often outshined by their own work. We decided to ask them a few questions to get to know them better.
So far, 6 interviews to early career researchers were collected and published. The information was used to feed the TEQ social media accounts and had a satisfactory success in terms of persons reached (450) and total interactions (28) on TEQ Facebook page. The interview can be found on the TEQ website: Getting to know TEQ members: the interviews | TeQuantum

Can you briefly introduce yourself and your work?



Some cesium lead halide (CsPbX3) nanocrystal dispersions made during my internship at IIT Genova, where the halide goes from chloride (left) to bromide (middle) to iodide (right) and mixtures thereof. *Credits: J. Mulder.*

I'm Jence Mulder, I'm Dutch and currently, I am working as a PhD candidate for the TEQ-project at TU Delft (and hopefully soon at IIT Genova again). My main research is aimed at synthesizing, optically analyzing and improving a variety of nanomaterials, including ytterbium-doped YLF. This material is studied further by, for example UCL.
Outside of working hours, I love to play the oboe and English horn (especially in a symphony orchestra), as well as occasionally attend techno parties.

Can you briefly introduce yourself and your work?

I am an experimental physicist from the United Kingdom, currently working as a post-doctoral researcher at the University of Southampton in the group of Hendrik Ulbricht. I also completed my undergraduate and post-graduate studies at Southampton. Primarily, my work is focused on levitation of ferromagnetic particles with type-I superconductors. These levitated magnets behave as very well isolated harmonic oscillators and can be used for sensing as well as for probing fundamental physics questions.

Chris Timberlake pictured atop the famous Duomo di Milano

What do you mostly like about your research? What are the challenges?

The side I love the most in the research is the interaction and the exchange of ideas between people from both my research group and all over the world. I also really appreciate the freedom you have in organizing and planning your work, following your personal interests. At the same time this is for me one of the hardest challenges to face, that in my opinion makes the research different from other equally demanding jobs: you have to constantly motivate yourself, especially when you do not get the expected results and it seems like you failed and wasted a lot of time; or you might go through less creative periods and it could be frustrating feeling like you do not have a direction. There are of course other challenges, related to the practical difficulties of staying in academy, like for example the search for grants and the flexibility you must have to move places quite often. However, I think that all the challenges are manageable with a little of effort and overall, they give an extra spark of excitement to the job.

Can you briefly introduce yourself and your work?

I grew up in southern Germany where I also studied physics at the University of Freiburg. After my PhD in the Ion Trap Group of Michael Drewsen in Aarhus, I decided to stay in Denmark as a post-doctoral researcher.
Within TEQ, I'm working on a new cryogenically cooled ion trap, in which we will trap large molecules, like proteins, to explore an intermediate regime between the single atom and trapped nano-particles.