

NEWSLETTER N.10, September 2020



The Ion Trap Group established in 1999 by Professor Michael Drewsen at Aarhus University that recently published a PRL paper on Dark Bosons. *Credits: Aarhus University*

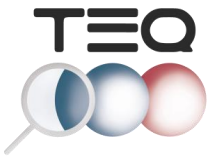


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UPDATES OF WORK DONE

Second TEQ Review Meeting

The TEQ partners have participated in the TEQ's second Review Meeting on September 15, 2020. The meeting was chaired by the PO, Dr Roumen Borissov, and attended by 3 assigned monitors who evaluated the work done within TEQ. As a result, TEQ members were delivered a very positive preliminary assessment: "The contribution to state of the art is significant, mainly to the field of levitating optomechanics, quantum sensing and quantum gravity. In general, TEQ contributes to fundamental physics and quantum technology. The scientific quality of the results from the project is very high. [...] The publication of project results in both theory and experiment in peer-reviewed, high quality research journals attests to their scientific quality. [...] Substantial and excellent dissemination activities have been performed through press articles (including a portrait of Angelo Bassi in the prestigious NY Times Magazine) and events as well as on social media (Facebook, Twitter, LinkedIn). Information and links about these can be found on TEQ website, which is well structured and very accessible. [...] The ongoing work is well aligned with the work plan. [...] All milestones for the period have been achieved and all deliverables are accepted. The use of resources appears to be in line with the DoA, and costs are reasonable given the stated objectives."

Trieste Junior Quantum Days 2020

The Trieste node of TEQ has organized the 4th edition of the Trieste Junior Quantum Days with the aim to gather young researchers working in quantum mechanics and its applications. PhD students and PostDocs are given the opportunity to present their research activity and interact with their colleagues, share motivations, techniques and perspectives, in a friendly and informal environment. Lectures by senior experts provide a perspective on relevant problems in quantum theory. The topics of the workshop include: quantum information, entanglement, open quantum systems, quantum foundations, many-body physics, quantum thermodynamics, equilibrium & non-equilibrium physics, mathematical methods for quantum mechanics.

Due to the Coronavirus outbreak, the workshop has been postponed to 2021.

Scientific Committee

Angelo Bassi (University of Trieste - INFN)

Fabio Benatti (University of Trieste - INFN)

Rosario Fazio (ICTP)

Alessandro Michelangeli (HCM-IAM Bonn)

Andrea Trombettoni (University of Trieste - CNR-IOM Trieste)

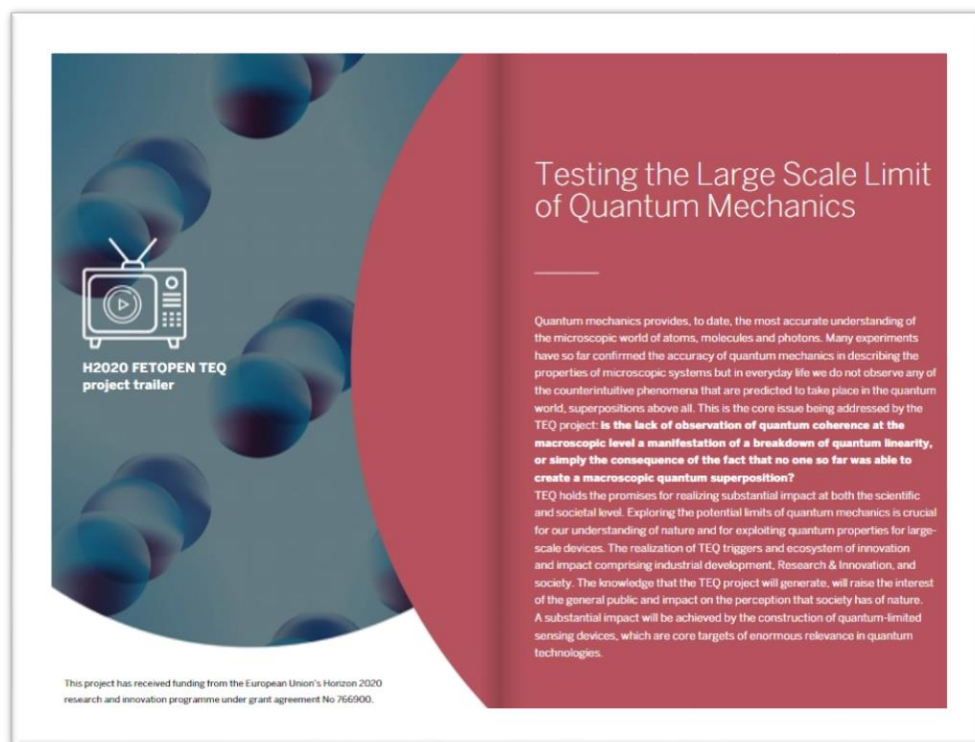
Local Organizers

Matteo Carlesso (University of Trieste - INFN)

Luca Ferialdi (University of Trieste - INFN)

TEQ Flipping book

Finally, to further strengthen the communication strategy of the project and approach potential funding agencies for future developments of the research, the TEQ Steering Committee decided to create a project digital booklet. The collection of material and graphic development started in early 2020 and was finalized in June 2020 (Month 30). The booklet includes project description, abstracts and pictures for each project partner, a dissemination section and direct links to websites and digital materials. The TEQ flipping book is digitally available on <http://tequantum.eu/> and ready to print.



PUBLICATIONS

(for more info, please go to www.tequantum.eu → 'Publications')

In the last months there has been a significant amount of papers published, doubling the publications for the same period in 2018.

Here below, the new publications:

Authors	Title	Journal	Volume	Pages	Year
Rossi, Massimiliano, Luca Mancino, Gabriel T. Landi, Mauro Paternostro, Albert Schliesser, and Alessio Belenchia	Experimental Assessment of Entropy Production in a Continuously Measured Mechanical Resonator	Phys. Rev. Lett.	125	080601	2020
Vinante, A., M. Carlesso, A. Bassi, A. Chiasera, S. Varas, P. Falferi, B. Margesin, R. Mezzena, and H. Ulbricht	Narrowing the Parameter Space of Collapse Models with Ultracold Layered Force Sensors	Phys. Rev. Lett.	125	100404	2020
Barbado, Luis C., Esteban Castro-Ruiz, Luca Apadula, and Āaslav Brukner	Unruh effect for detectors in superposition of accelerations	Phys. Rev. D	102	045002	2020
Barbado, Luis C., Ana L. Baez-Camargo, and Ivette Fuentes	Evolution of confined quantum scalar fields in curved spacetime. Part I	Eur. Phys. J. C	80	796	2020
Kull, Ilya, Philippe Allard Guerin, and Frank Verstraete	Uncertainty and trade-offs in quantum multiparameter estimation	Journal of Physics A: Mathematical and Theoretical	53		2020
Solaro, Cyrille, Steffen Meyer, Karin Fisher, Julian C. Berengut, Elina Fuchs, and Michael Drewsen	Improved Isotope-Shift-Based Bounds on Bosons beyond the Standard Model through Measurements of the $2D_{3/2}-2D_{5/2}$ Interval in Ca^+	Phys. Rev. Lett.	125	123003	2020
Mancino, Luca, Marco G. Genoni, Marco Barbieri, and Mauro Paternostro	Nonequilibrium readiness and precision of Gaussian quantum thermometers	Phys. Rev. Research	2	033498	2020

Donadi, Sandro, Kristian Piscicchia, Catalina Curceanu, Lajos Diósi, Matthias Laubenstein, and Angelo Bassi	Underground test of gravity-related wave function collapse	Nature Physics			2020
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DISSEMINATION ACTIVITIES

(for more info, please go to www.tequantum.eu → 'Dissemination')

During the last three months, the dissemination activities held were a total of **14**, addressing around 830 people. 6 talks were given to academic audiences, 1 lecture was given to high-school and school students and teachers while 7 presentations were delivered to the general public.

Due to the Coronavirus restrictive measures, all the dissemination activities were held remotely.

A detailed list of all talks can be found on the TEQ Website.

ANY OTHER RELEVANT INFORMATION

TEQ on the New York Times Magazine

"The rebel physicist trying to fix quantum mechanics" is the title of the profile about one of the PI of the TEQ project, Professor Angelo Bassi, that has been published in the New York Times Magazine. The article covers some of the open questions in foundational quantum mechanics and how TEQ aims to solve them, while describing a personal and intimate side of prof. Bassi's life. Other members of the TEQ Consortium have been interviewed for the piece: Dr Catalina Curceanu (INFN), Prof. Hendrik Ulbricht (UoS), prof. Caslav Brukner (OEAW) and Prof. Mauro Paternostro (QUB) as they have been closely working with prof. Bassi for many years and know him and his work very well.

TEQ's Angelo Bassi and Catalina Curceanu publish paper on Nature Physics

TEQ's members Professor Angelo Bassi (UniTS) and Dr Catalina Curceanu (INFN), alongside with other colleagues, reach today, September 7, 2020, an important goal: the scientific journal Nature Physics publishes their paper "Underground test of gravity-related wave function collapse".

While preparing the TEQ final experiment, this study represents a very important preliminary outcome, ruling out the natural parameter-free version of the Diósi–Penrose model.

The news of the publication has been picked up by several media. For details see the TEQ Website "Press articles" on the "Dissemination" page.

TEQ's PI Angelo Bassi coordinates demonstration of Quantum Communication

The closing ceremony of ESOF2020 — EuroScience Open Forum featured the first Italian public demonstration of encrypted communication using Italian-made optical-fibre quantum technology. The presentation was carried out by the “Quantum Communications” group of the National Research Council (CNR) of Florence, Italy, thanks to the “Quantum FVG” Project, financed by the Friuli Venezia Giulia Region and coordinated by the University of Trieste, in the person of Professor Angelo Bassi. This communication consisted of an encrypted video call between Italian Prime Minister Giuseppe Conte, who was on-location at ESOF at Trieste's Old Port, and the Rector of the University of Trieste Roberto Di Lenarda.



This communication highlights both the impact of quantum technology on security in communication and Italy's contribution to the development of this new technology in Europe.

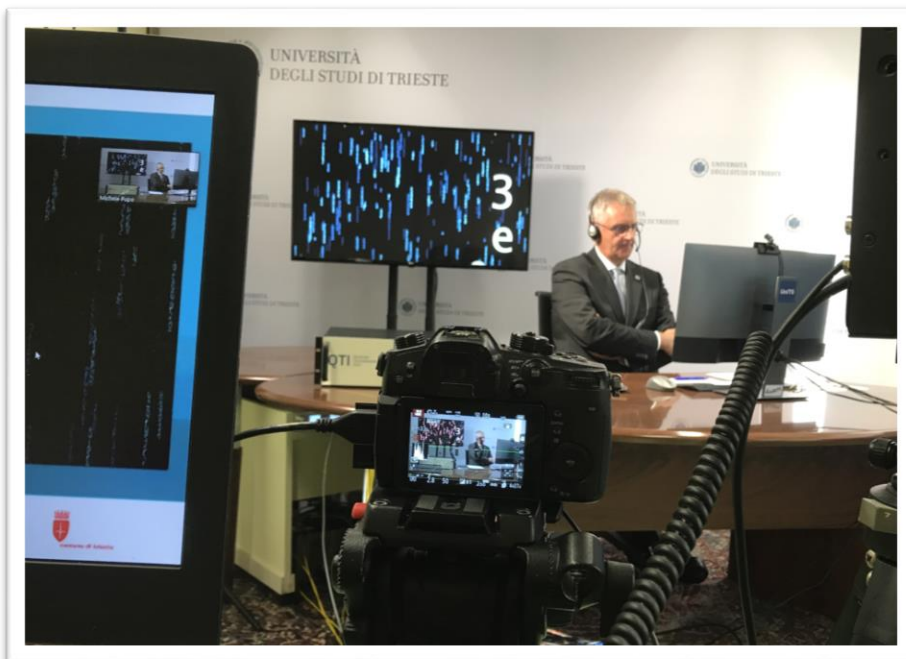


Fig 1,2: The Rector of the University of Trieste Roberto Di Lenarda during the demonstration of quantum communication at ESOF2020 (Trieste, 6th September 2020). Credits: Divulgando Srl

"Narrowing the Parameter Space of Collapse Models with Ultracold Layered Force Sensors" on PRL

On the path to the TEQ final experiments, TEQ's members Dr Vinante, Dr Carlesso, Prof Bassi and Prof Ulbricht, alongside with other colleagues, implemented the experiment proposed in [Physical Review A 98, 022122 (2018), <http://tequantum.eu/?q=node/206>], where an ultracold multi-layered force sensor probes the CSL noise. Their work, which improves the bounds of previous experiments and challenges the well-motivated region of the CSL parameter space proposed by Adler, has been published on Physical Review Letters.

Seminar series on optomechanics

TEQ member Professor Hendrik Ulbricht is involved in setting up and running the UniKORN online seminar series on optomechanics, which is strongly linked to the TEQ project. The goal of UniKORN is to bring together researchers working on all sorts of optomechanics theory and experiments within the United Kingdom, as part of the British Optomechanics Research Network (BORN) and beyond. BORN aims to strengthen the strategic role of optomechanics amongst the emerging quantum technologies (QT), but is not limited to the quantum side of optomechanics. UniKORN particularly fosters and supports early career researchers and give a platform for them to present their latest research results. UniKORN is open and inviting to everyone to join for the weekly seminars, registration can be found on the UniKORN webpage: https://www.optomechanics.net/?page_id=83

UniKORN has been adapted to have scientific interactions under covid-19 by holding online events, but will hopefully soon be able to organize also in-person scientific workshops and events.

Do light Dark Bosons exist? A PRL publication

Very light and feebly interacting bosons could potentially contribute significantly to the dark matter sector of our universe without being detectable at high-energy collider experiments. The TEQ partner at Aarhus University has in a collaboration with researchers from the University of New South Wales in Sydney and Fermilab/University of Chicago applied a very different method to seek detection of such hypothetical bosons, namely, high-precision measurements of isotope shifts of electronic transitions in the Ca^+ ion. This method is specifically sensitive to very light bosons interacting with neutrons and electrons through minute changes in the electronic energy levels. The unprecedented accuracy obtained in the isotope-shift measurements allowed the TEQ partner to improve the previous bound on the coupling of such bosons by almost two orders of magnitude. These results were reported, back-to-back with similar results obtained with Yb^+ ions at MIT in [Physical Review Letters](#) and featured in a [Synopsis](#) on the online site Physics by the American Physical Society.

The research has been also picked up by Scientific American in an in-depth article by Daniel Garisto at <https://www.scientificamerican.com/article/possibility-of-dark-bosons-entices-physicists/>.

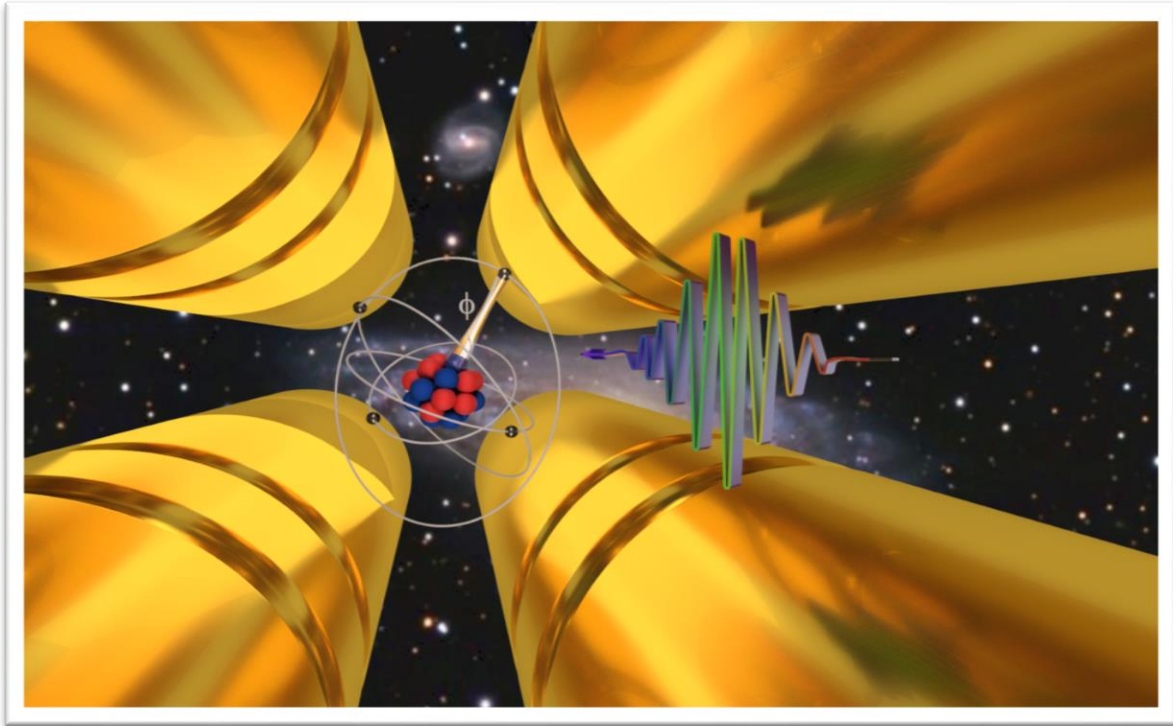


Fig 3: An image illustrating the research on dark bosons. *Credits: Aarhus University*