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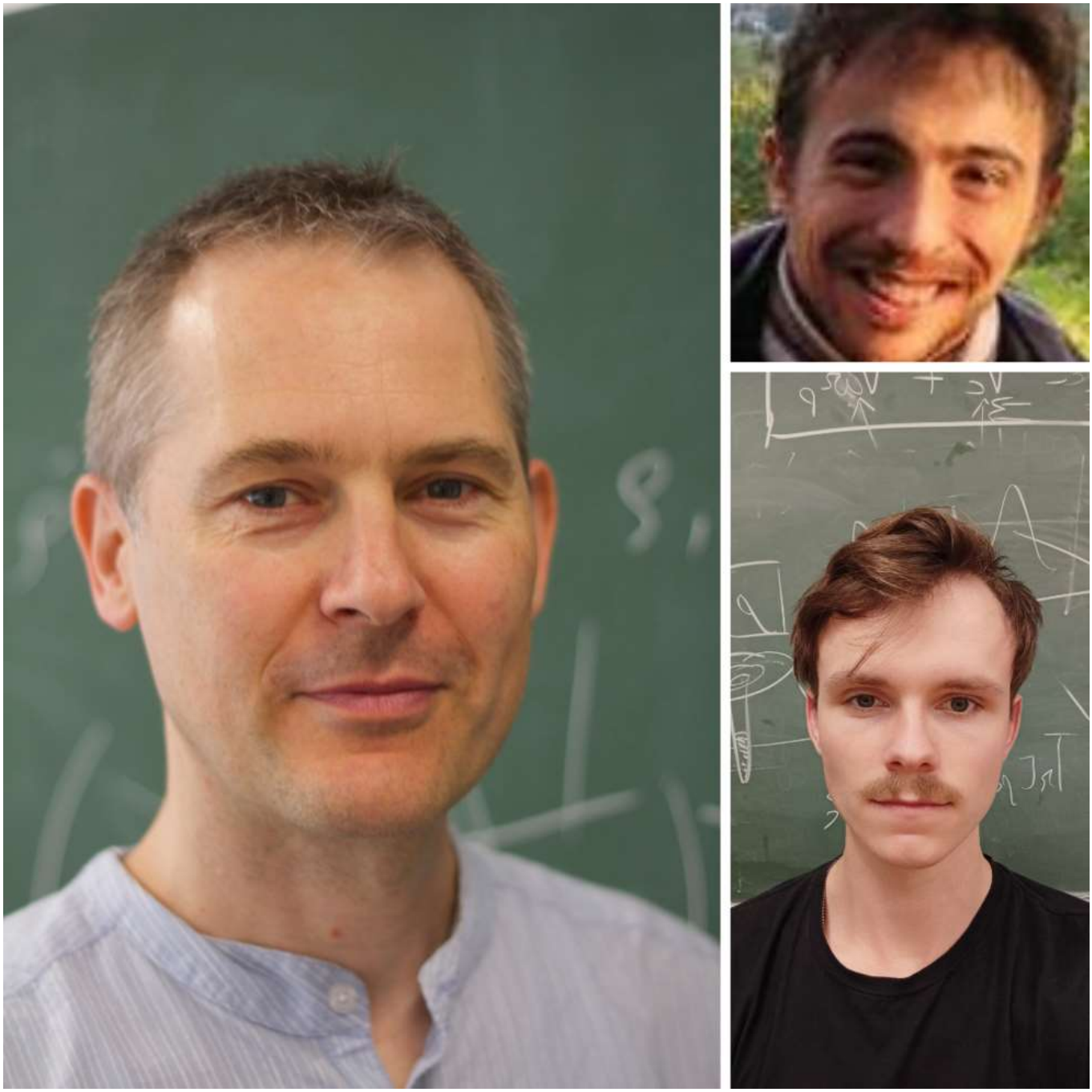
New Horizon 2020-project on quantum-gravity interplay with participation of Tübingen researchers

Quantum Control of Gravity with Levitated Mechanics (QuCoM) is funded by the European Innovation Council (EIC)



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Daniel Braun (left) Alessio Belenchia (above) and Francis Headley

A strong public-private partnership, funded by a 2.3 million euro grant of the European Innovation Council (EIC), has started on October 1, 2022, a 3-year project. The project's aim is to demonstrate the proof of concept of a levitated acceleration sensor and its ability detecting gravity of small masses and in the quantum-controlled regime. Part of the project is also the Theoretical Quantum Optics research group of Professor Daniel Braun, Institute for Theoretical Physics at University of Tübingen.

The quantum-gravity interplay is one of the most fascinating open problems in modern physics. It's known that matter, also in a quantum state, reacts to an external gravitational field as predicted by Newtonian gravity (or its generalization, General Relativity). What's still unknown, is what the gravitational field generated by a quantum superposition looks like: is it the superposition of the gravitational fields generated by the different terms of the superposition, as predicted by theories of Quantum Gravity, or something different? The reason for such a lack of experimental knowledge is that gravity is the weakest of all known forces, therefore it requires relatively large masses to be detectable. On the other

hand, quantum effects are extremely fragile against external perturbations, and the larger the object, the more difficult it is to isolate it from the environment. The regime where an object is large enough to create an appreciable gravitational field, but still controllable in its quantum behaviour, mut be carefully engineered. This is the goal of QuCoM.

QuCoM will explore the interplay between quantum mechanics and gravity in a parameter range accessible for cost-effective table-top experiments. It will suspend sub millimetre-sized particles in optical and magnetic traps and use them to detect gravitational forces in an unprecedented mass regime. Also, it will investigate quantum superpositions where such masses are delocalized in space quantum mechanically. The project will address some of the most popular theoretical proposals combining quantum physics and gravity in a nonstandard fashion, assessing their limits of validity and further constraining the values of their parameters.

The Tübingen subproject together with the subproject at Queens's University of Belfast, is responsible for the theoretical description of the quantum sensor. It will develop optimal quantum control strategies for the quantum sensor as well as attempt to find theoretical descriptions of the gravitational field of quantum mechanical superpositions.

QuCoM puts together five leading European research group and two companies with world-leading expertise in low temperature, low noise measurement systems for Earth Observation. The involvement of private partners will drive the European **opportunities for development of market-ready product based on quantum-technological sensing and metrology** according to the ambitions of EIC as part of Horizon Europe program - the European Supporting Programme for Research and Innovation. The QuCoM project is one of only 56 funded proposals out of 868 evaluated by the Commission under the 2021 EIC Pathfinder call.

QuCoM Consortium

- University of Trieste (Italy)
- Universiteit Leiden (The Netherlands)
- Eberhard Karls Universitaet Tübingen (Germany)
- The Queen's University Belfast (UK)
- University of Southampton (UK)
- Leiden Cryogenics BV (The Netherlands)
- Leiden Spin Imaging BV (The Netherlands)

Zurück