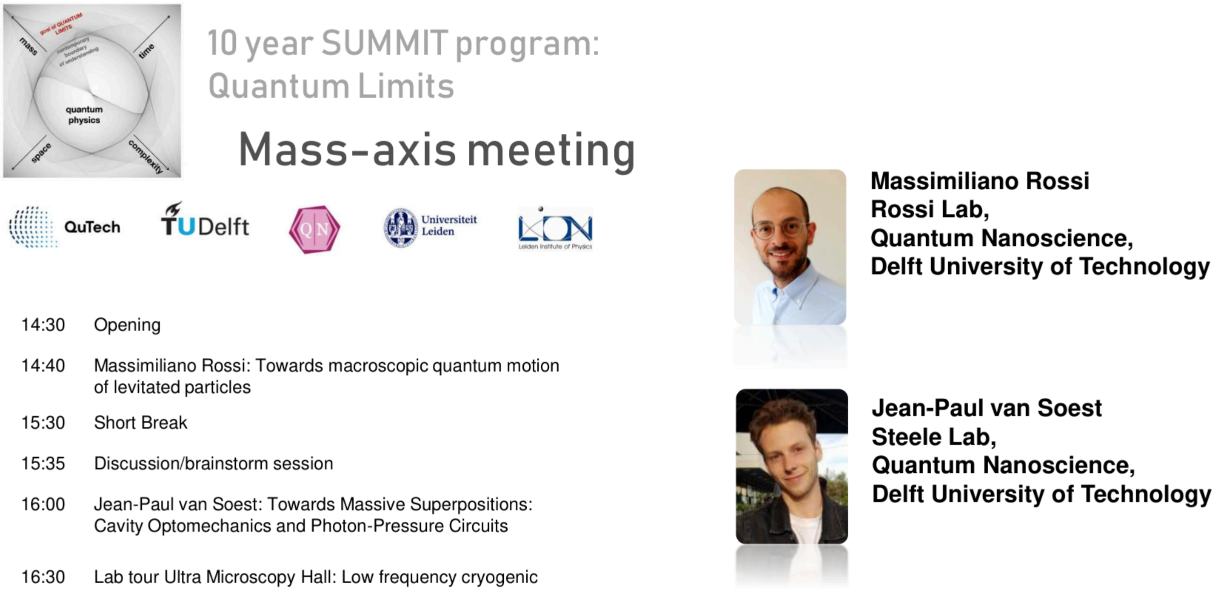
Quantum Limits Mass-axis Meeting 1

Aantal deelnemers: 27



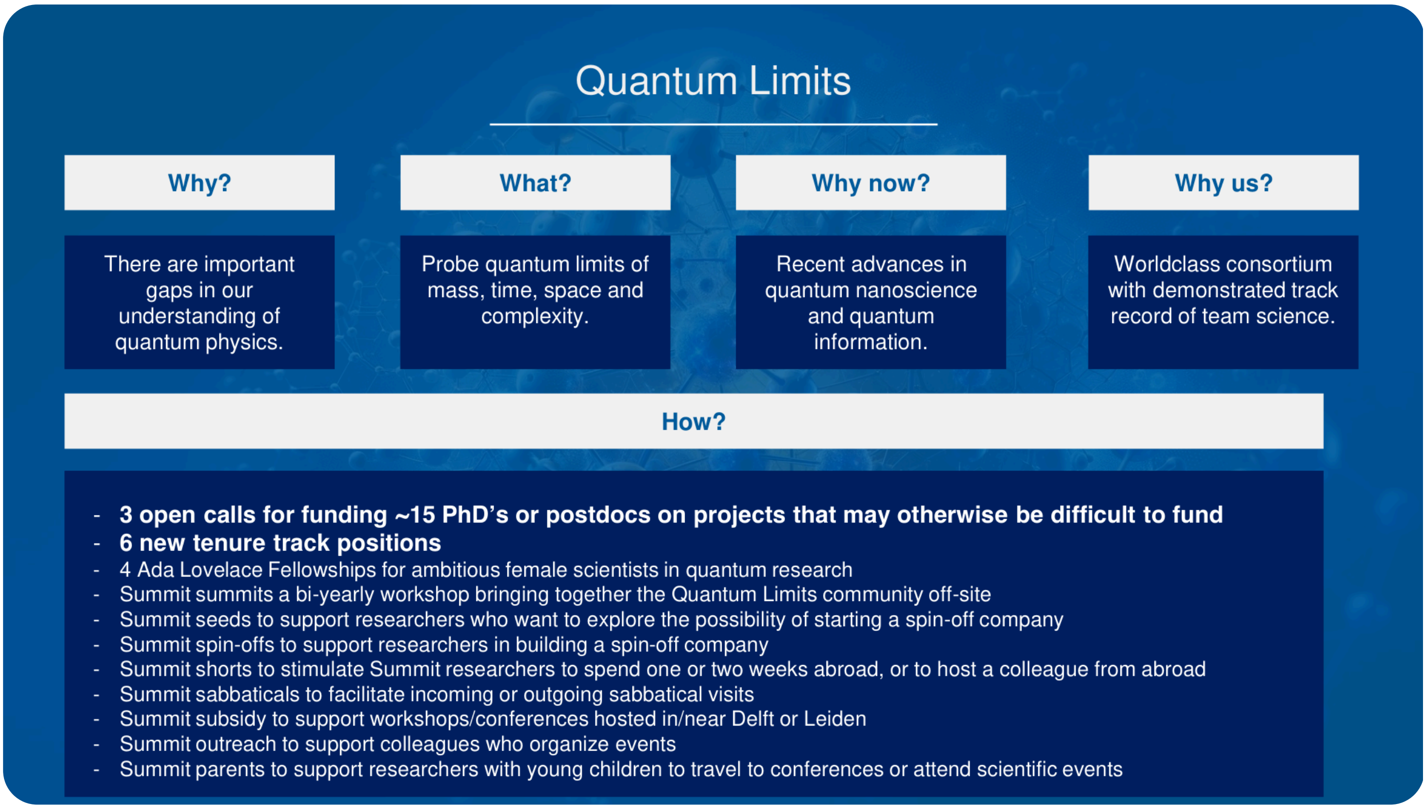
10 year SUMMIT program:
Quantum Limits

Mass-axis meeting

14:30	Opening
14:40	Massimiliano Rossi: Towards macroscopic quantum motion of levitated particles
15:30	Short Break
15:35	Discussion/brainstorm session
16:00	Jean-Paul van Soest: Towards Massive Superpositions: Cavity Optomechanics and Photon-Pressure Circuits
16:30	Lab tour Ultra Microscopy Hall: Low frequency cryogenic vibration isolation
17:00	Borrel (Fussie bar, Gorlaeus building)

Massimiliano Rossi
Rossi Lab,
Quantum Nanoscience,
Delft University of Technology

Jean-Paul van Soest
Steele Lab,
Quantum Nanoscience,
Delft University of Technology



Quantum Limits

Why?	What?	Why now?	Why us?
There are important gaps in our understanding of quantum physics.	Probe quantum limits of mass, time, space and complexity.	Recent advances in quantum nanoscience and quantum information.	Worldclass consortium with demonstrated track record of team science.

How?

- **3 open calls for funding ~15 PhD’s or postdocs on projects that may otherwise be difficult to fund**
- **6 new tenure track positions**
- 4 Ada Lovelace Fellowships for ambitious female scientists in quantum research
- Summit summits a bi-yearly workshop bringing together the Quantum Limits community off-site
- Summit seeds to support researchers who want to explore the possibility of starting a spin-off company
- Summit spin-offs to support researchers in building a spin-off company
- Summit shorts to stimulate Summit researchers to spend one or two weeks abroad, or to host a colleague from abroad
- Summit sabbaticals to facilitate incoming or outgoing sabbatical visits
- Summit subsidy to support workshops/conferences hosted in/near Delft or Leiden
- Summit outreach to support colleagues who organize events
- Summit parents to support researchers with young children to travel to conferences or attend scientific events

1. Which of the following, in your opinion, provides the best interpretation of quantum phenomena and interactions? (please pick only one) [Source: survey by Elizabeth Gibney, Senior Reporter, Nature, Nature Research]

20 respondenten

The “Copenhagen interpretation”* (classical and quantum domains are separate, nonlocality is real (changes to part of a system can influence the whole, no matter where they are). *the Copenhagen interpretation is not a self-consistent interpretation, but has become a popular description for physicists to say they adhere to.	10%	2 stemmen
Bohm-de Broglie pilot wave theory (particles are guided with respect to position by pilot waves; the apparent randomness of quantum physics is due to ignorance regarding the initial positions of all particles and action at a distance is real).	0%	0 stemmen
Everett/Many-Worlds/Consistent Histories (the quantum state only ever evolves smoothly and with no element of randomness; branching into different worlds explains the appearance of collapse and randomness in each branch).	25%	5 stemmen
Epistemic/information-based approaches (the wavefunction represents only information).	20%	4 stemmen
Spontaneous-collapse theories (suggests a physical collapse and that the Schrödinger equation must be modified so that it does not always evolve smoothly, such as GRW, CSL, Orch-OR).	25%	5 stemmen
Retrocausal theories (future measurements can influence past), including transactional interpretation.	0%	0 stemmen
Relational quantum mechanics (reality can only be described as the relation between various subsystems, for example system/observer).	10%	2 stemmen
Other (please elaborate)	10%	2 stemmen

The “Copenhagen interpretation”* (classical and quantum domains are separate, nonlocality is real (changes to part of a system can influence the whole, no matter where they are). *the Copenhagen interpretation is not a self-consistent interpretation, but has become a popular description for physicists to say they adhere to. - Commentaren **0**

Geen reacties voor dit antwoord

Bohm-de Broglie pilot wave theory (particles are guided with respect to position by pilot waves; the apparent randomness of quantum physics is due to ignorance regarding the initial positions of all particles and action at a distance is real). - Commentaren **0**

Geen reacties voor dit antwoord

Everett/Many-Worlds/Consistent Histories (the quantum state only ever evolves smoothly and with no element of randomness; branching into different worlds explains the appearance of collapse and randomness in each branch). - Commentaren **1**

everything else is speculation :-)

Epistemic/information-based approaches (the wavefunction represents only information). - Commentaren **1**

Reality is only created when the wave function interacts with the observer / environment. Until measurement is made, the wave functions only describe the possible realities.

Spontaneous-collapse theories (suggests a physical collapse and that the Schrödinger equation must be modified so that it does not always evolve smoothly, such as GRW, CSL, Orch-OR). - Commentaren **1**

Gravitational nonlinear effects need to alter QM. But, no master equations and density matrices please (so no GRW)

Retrocausal theories (future measurements can influence past), including transactional interpretation. - Commentaren **0**

Geen reacties voor dit antwoord

Relational quantum mechanics (reality can only be described as the relation between various subsystems, for example system/observer). - Commentaren **0**

Geen reacties voor dit antwoord

Other (please elaborate) - Commentaren 2

It s all a hoax

Modified Bohm-de Broglie, no action at a distance, hidden variable in initial state vombined with a background field. Background field is still a 'loophole' to the Bell proof.

2. Which of the following do you believe best solves the quantum measurement problem (that is, the inconsistency between the well-described and smooth evolution of properties according to the Schrödinger wave equation and the probabilistic outcomes of measurements)? [Source: survey by Elizabeth Gibney, Senior Reporter, Nature, Nature Research]

19 respondenten

The wavefunction alone does not provide a complete description of the systems described, and additional variables play a role in the appearance of measurement outcomes.	5%	1 stem
The apparent discontinuity arises because the act of measurement involves a change from a fundamentally probabilistic quantum description to a classical one with definite outcomes and real observables.	26%	5 stemmen
The wavefunction continues to propagate through multiple universes/branches. The appearance of a single outcome is based on a given observer existing in only one of them.	26%	5 stemmen
Since the wavefunction gives only information, the 'collapse' of the wavefunction is not a physical process and so there is no measurement problem in the first place.	11%	2 stemmen
Schrödinger's equation should be modified such that, when it is used to describe a system consisting of not only a measured subsystem but also measuring equipment, the equation does predict (approximately) definite outcomes.	16%	3 stemmen
An alternative solution or combination of the above (please elaborate)	5%	1 stem
I don't have a view.	11%	2 stemmen

The wavefunction alone does not provide a complete description of the systems described, and additional variables play a role in the appearance of measurement outcomes. - Commentaren 0

Geen reacties voor dit antwoord

The apparent discontinuity arises because the act of measurement involves a change from a fundamentally probabilistic quantum description to a classical one with definite outcomes and real observables. - Commentaren 0

Geen reacties voor dit antwoord

The wavefunction continues to propagate through multiple universes/branches. The appearance of a single outcome is based on a given observer existing in only one of them. - Commentaren 1

This retains unitarity and locality

Since the wavefunction gives only information, the ‘collapse’ of the wavefunction is not a physical process and so there is no measurement problem in the first place. - Commentaren 0

Geen reacties voor dit antwoord

Schrödinger’s equation should be modified such that, when it is used to describe a system consisting of not only a measured subsystem but also measuring equipment, the equation does predict (approximately) definite outcomes. - Commentaren 1

Macroscopic superpositions should not exist because gravity/time, so when you measure (thus making macroscopic superposition) there should be collapse

An alternative solution or combination of the above (please elaborate) - Commentaren 1

I am not sure. It seems weird to me that there is heat somewhere out in the universe.

I don't have a view. - Commentaren 0

Geen reacties voor dit antwoord

3. A: What difficulties/challenges in preparing and measuring a delocalized state (superposition) of a large mass require more immediate attention? B: What are the differences/advantages/disadvantages between free/inverted potential expansion interferometric experiments vs interferometric experiments coupling mass to other quantum systems? C: How important is control over the object's (harmonic) potential to prepare large mass superpositions? (for example: do we need levitation? with tunable traps?) D: Ideas for cool new hybrid experiments?

5 respondenten

A: ground states have been reached, squeezed ones are on the go, so the need to replicate them with higher and higher fidelity but maybe the more important is exploring the many different ways of implementing the nonlinearity. B: the ancillary system can bring decoherence. This is a disadvantage. But it can also be a good way to readout with better precision than without since systems like NV centers are already established technologies. C: I believe it is crucial. I don't think one can get large mass superposition systems just out of random decoherence channels. D:Establishing coupling between cavity optomechanics and levitated optomechanics

A) keeping the process coherent for the whole duration. this somewhat depends on the characteristic eigenfrequency of the system. Usually large masses = lower eigenfreq, so longer characteristic times needed for protocols. (B) I actually do not know. It would be interesting to have a seminar about this next time. (C) I believe it is the main advantage (barred for lower decoherence) of using levitated platforms. I think that levitated systems with higher tunability offer more options over what kind of protocols you can do (= what kind of potentials you can create

D: Levitated particle bouncing off a drumhead optomechanical systen

B.: coupling to other systems not only bring "good" tools, but also "bad" ones! (decoherence, as usual!)

A: how do we even tell whether we see spontaneous collabs (if we want to investigate that) or 'classical' decoherence?