TEQ Junior Workshop II
5th July, 15:00-18:00 CEST

BOOKLET OF ABSTRACTS

An Optomechanical Platform for Quantum Hypothesis Testing for Collapse Models – Alessio Belenchia (QUB)

Quantum Hypothesis Testing has shown the advantages that quantum resources can offer inthe discrimination of competing hypothesis. In this work, we apply this framework to optomechanical systems and fundamental physics questions. In particular, we focus on an optomechanical system composed of two cavities employed to perform quantum channel discrimination. We show that input squeezed optical noise, and feasible measurement schemes on the output cavity modes, allow to obtain an advantage with respect to any comparable classical schemes. We apply these results to thediscrimination of models of spontaneous collapse of the wavefunction, highlighting the possibilities offered by this scheme for fundamental physics searches.

Advances in Quantum Reference Frames - Luis Cortes Barbado (OEAW)

I will introduce several works developed in our group, that push forward the research on Quantum Reference Frames (QRF) along different directions. First, we developed a formalism for QRF transformation for spin quantum systems, which allows to generalize the rotation group (a non-abelian group), considered as a group of transformations between reference frames with different orientations, to coherent quantum superpositions of rotations. Second, we extended the Bell tests with relativistic Dirac particles to the realm of QRFs: The formalism on QRF transformations allows to identify the correct spin operator for which the CHSH inequality is maximally violated. Third, we generalized Einstein's Equivalence principle for superpositions of gravitational fields and QRFs, by introducing a relational formalism to describe a quantum particle in a superposition of spacetimes. And fourth, we generalized Page-Wooters formalism to include several observers with different quantum clocks (which can be considered as a sort QRF for time), and combined such formalism with process matrix formalism to describe indefinite causal structures (coherent quantum superpositions of different causal structures).

Increasing the photoluminescence quantum yield of Yb:YLF4 nanocrystals. Towards optical refrigeration of nanocrystals - Jence Mulder (TU Delft)

Since the start of my PhD project, I've attempted to grow the highest quality nanocrystals (NCs) for the TEQ-project. Based on the requirements of the TEQ project, YLF4 NCs were chosen for the studies. By doping YLF4 with ytterbium ions (Yb3+), we could in theory also optically cool the NCs through photoexcitation and subsequent higher energy emission (where the extra energy is extracted from phonons in the NC). This should ensure that the NCs can be captured without heating in an optical trap at UCL. Unfortunately, the photoluminescence quantum yield (PLQY) of these NCs is currently too low, hence the NCs effectively heat up and rapidly degrade. In this talk, I will discuss the pathways that we think are responsible for the decrease in PLQY, and how we are trying to solve these issues.

Complex Molecular Ions for Testing the Large Scale Limit of Quantum Mechanics? - Steffen Meyer (AU)

I will present the recent progress on the AU partner's activity towards experiments with trapped and motional ground state cooled single highly charged complex molecular ions, and its potential relevance for TEQ. Cooling of the molecular ion's motional degrees of freedom are carried out through the interaction with a directly resolved sideband laser cooled single Ba+ ion, while the internal degrees of freedom are controlled by having the molecular ions trapped in a cryogenic cooled enclosure ensuring a low intensity blackbody radiation field (T~5K) and enabling helium buffer-gas cooling.

Low-noise electronics for TEQ experiments - Fabrizio Napolitano (INFN)

I shall present the latest developments for the TEQ low-noise electronics, including the low-noise signal generator, and present future plans for integration of the electronics in a unique device.

Latest developments in the TEQ programme at UCL - Antonio Pontin (UCL)

In this talk I will provide a progress update on the experimental activity at UCL in the TEQ framework. I will focus on two topics, the development and characterization of extremely low noise electronics to operate a linear Paul trap, and the study of the dynamics of YLF nanocrystals levitated in an optical tweezer.

Magnetic trapping for testing CSL at Southampton - Chris Timberlake (UoS)

Here, I present the latest updates in experiments at Southampton, which include magnetic levitation of ferromagnets in superconducting traps and characterisation of seismic noise sources that may be significant for development of the TEQ experiment. Magnetic traps are passive and the motion of the magnet can be measured using SQUIDs. This offers a distinct advantage to Paul traps, where active fields are required to achieve levitation and stability and laser fields are needed for detection, adding further thermal noise to the system. This, combined with the relative ease to load the trap, makes levitating magnets good alternative candidates for CSL detection experiments.