SYQE 1: Quantum Correlations Beyond Entanglement I

Time: Tuesday 14:00–16:00 Location: Audimax

Invited Talk SYQE 1.1 Tue 14:00 Audimax
The role of quantum discord in quantum information theory — •Alexander Streltsov — ICFO - The Institute of Photonic Sciences, Castelldefels, Spain

Quantum correlations beyond entanglement - in particular represented by quantum discord - have become a major research field in the last few years. In this talk we report on the role of quantum discord in several fundamental tasks in quantum information theory. Starting with the role of quantum discord in the quantum measurement process, we will also discuss its role in the tasks of information sharing and entanglement distribution. Finally, we will also show the limits of these results and present possible ways to go beyond these limits.

Invited Talk SYQE 1.2 Tue 14:30 Audimax
Experimental entanglement distribution by separable states — •Roman Schnabel[1], C.E. Vollmer[1], D. Schulze[1], T. Eberle[1], V. Händchen[1], and J. Fiurasek[2] — [1]Institut für Gravitationsphysik (Albert-Einstein-Institut), Leibniz Universität Hannover — [2]Department of Optics, Palacky University, Olomouc, Czech Republic

Distribution of entanglement between macroscopically separated parties is crucial for future quantum information networks. Surprisingly, it has been theoretically shown [1,2] that two distant systems can be entangled by sending a third system that is not entangled with either of them. Here, we experimentally distribute entanglement and successfully prove that our transmitted light beam is indeed not entangled with the parties' local systems. Our work [3], as well as related work by other groups [4,5], demonstrates an unexpected variant of entanglement distribution [6] and improves the understanding necessary to engineer multipartite quantum networks in noisy environments.

[1] T. S. Cubitt, F. Verstraete, W. Dür, J. I. Cirac, Phys. Rev. Lett. 91, 037902 (2003).

[2] L. Mista, N. Korolkova, Phys. Rev. A 77, 050302 (2008).

[3] C. E. Vollmer, D. Schulze, T. Eberle, V. Händchen, J. Fiurasek, R. Schnabel, Phys. Rev. Lett. 111, 230505 (2013).

[4] A. Fedrizzi, M. Zuppardo, G. G. Gillett, M. A. Broome, M. de Almeida, M. Paternostro, A. G. White, T. Paterek, Phys. Rev. Lett. 111, 230504 (2013).

[5] C. Peuntinger, V. Chille, L. Mista, N. Korolkova, M. Förtsch, J. Korger, C. Marquardt, G. Leuchs, Phys. Rev. Lett. 111, 230506 (2013).

[6] C. Silberhorn, Viewpoint: Sharing Entanglement without Sending It, Physics 6, 132 (2013).

Invited Talk SYQE 1.3 Tue 15:00 Audimax
Quantum computing with black-box quantum subroutines — Jayne Thompson[1], Mile Gu[2,1], •Kavan Modi[3], and Vlatko Vedral[4,1,5] — [1]Centre for Quantum Technologies, National University of Singapore, 3 Science Drive 2, 117543 Singapore, Singapore — [2]Center for Quantum Information, Institute for Interdisciplinary Information Sciences, Tsinghua University, Beijing, China — [3]School of Physics, Monash University, Clayton, Victoria 3800, Australia — [4]Department of Physics, University of Oxford, Clarendon Laboratory, Oxford, OX1 3PU, United Kingdom — [5]Department of Physics, National University of Singapore, 2 Science Drive 3, 117551 Singapore, Singapore

In classical computation a subroutine is treated as a black box and we do not need to know its exact physical implementation to use it. A complex problem can be decomposed into smaller problems using such modularity. We show that quantum mechanically applying an unknown quantum process as a subroutine is impossible, and this restricts computation models such as DQC1 from operating on unknown inputs. We present a method to avoid this situation for certain computational problems and apply to a modular version of Shor's factoring algorithm. We examine how quantum entanglement and discord fare in this implementation. In this way we are able to study the role of discord in Shor's factoring algorithm.

Invited Talk SYQE 1.4 Tue 15:30 Audimax
Quantum metrology embraced for the worst — •Gerardo Adesso — School of Mathematical Sciences, University of Nottingham, Nottingham NG7 2RD (UK)

Quantum metrology exploits quantum mechanical laws to improve the precision in estimating technologically relevant parameters such as phase, frequency, or magnetic fields. Probe states are usually tailored on the particular dynamics whose parameters are being estimated. Here we consider a novel framework where quantum estimation is performed in an interferometric configuration, using bipartite probe states prepared without full knowledge of the generating Hamiltonian. We introduce a figure of merit for the scheme, given by the worst case precision over a suitable class of Hamiltonians, and prove that it amounts exactly to a measure of quantum discord for the input probe. We demonstrate the superiority of discordant probes over classically correlated ones in a highly controllable metrology experiment with room temperature nuclear magnetic resonance, one of the paradigmatic testbeds for quantum information processing. We thus provide a rigorous operational interpretation of discord, shedding light on its potential for quantum technology.