Symposium Quantum Coherence in Quantum Technology (SYQC)

jointly organized by
the Quantum Optics and Photonics Division (Q) and
the Atomic Physics Division (A)

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Quantum coherence is a fundamental feature of nature, arising from the superposition principle of quantum mechanics. Very recently, coherence has been recognized as a useful resource for the emerging quantum technologies, which has led to the development of a resource theory of quantum coherence. This theory allows for a systematic study of coherence and its role in fundamental technological applications such as quantum computation and quantum metrology. In this symposium, the speakers report on the most recent theoretical and experimental advances on coherence theory, including its role for control of quantum systems, interferometry, and quantum sensing.

Overview of Invited Talks and Sessions

(Lecture room RW HS)

Invited Talks

SYQC 1.1	Thu	14:00–14:30	RW HS	**The resource theory of quantum coherence** — •Martin B Plenio
SYQC 1.2	Thu	14:30–15:00	RW HS	**Interferometric visibility and coherence** — •Andreas Winter
SYQC 1.3	Thu	15:00–15:30	RW HS	**Quantum coherence and interference patterns** — •Florian Mintert
SYQC 1.4	Thu	15:30–16:00	RW HS	**Experiments on directly measuring quantum coherence and using it for quantum sensing** — •Chuan-Feng Li

Sessions

SYQC 1.1–1.4	Thu	14:00–16:00	RW HS	**Quantum Coherence in Quantum Technology**

SYQC 1: Quantum Coherence in Quantum Technology

Time: Thursday 14:00–16:00 Location: RW HS

Invited Talk SYQC 1.1 Thu 14:00 RW HS
The resource theory of quantum coherence — •Martin B Plenio — Institut für Theoretische Physik, Universität Ulm

Resource Theories provide a unifying structure in which the quantification of the usefulness of a broad range of physical properties finds its most natural setting. Whenever practical or fundamental constraints limit the operations that are accessible to us, physical states that cannot be generated under this constrained set of operations achieve the character of a useful resource that may be consumed to achieve tasks that cannot be achieved under the constrained operations alone. Local operations and classical communication is perhaps the most well known example which gave birth to the resource theory of entanglement. Recently, a similar treatment was adopted for the arguably more fundamental concept of quantum coherence and the resulting resource theory of coherence is now a highly active field of research. In this talk I will discuss recent developments in the field, especially those that are aimed to connect the concepts of coherence with control of quantum systems by classical control as well as the relationship between coherence and classicality in dynamical evolutions.

Invited Talk SYQC 1.2 Thu 14:30 RW HS
Interferometric visibility and coherence — •Andreas Winter — Universitat Autonoma de Barcelona, Spain

Recently, the basic concept of quantum coherence (or superposition) has gained a lot of renewed attention, after Baumgratz et al. [PRL 113:140401 (2014)], following Aberg [arXiv:quant-ph/0612146], have proposed a resource theoretic approach to quantify it. This has resulted in a large number of papers and preprints exploring various coherence monotones, and debating possible forms for the resource theory. Here we take the view that the operational foundation of coherence in a state, be it quantum or otherwise wave mechanical, lies in the observation of interference effects. Our approach here is to consider an idealised multi-path interferometer, with a suitable detector, in such a way that the visibility of the interference pattern provides a quantitative expression of the amount of coherence in a given probe state. We present a general framework of deriving coherence measures from visibility, and demonstrate it by analysing several concrete visibility parameters, recovering some known coherence measures and obtaining some new ones. [arXiv:1701.05051]

Invited Talk SYQC 1.3 Thu 15:00 RW HS
Quantum coherence and interference patterns — •Florian Mintert — Imperial College London

Quantum coherence is the basis for many quantum technological applications. Quantum sensors often rely on the coherent superposition of only two system eigenstates, whereas a quantum computer would exploit the superposition of many such basis states. Our ability to build quantum devices can thus be characterised in terms of the number of of eigenstates that we manage to coherently superpose. I will discuss how this number can be read off an interference pattern and report on our progress towards tests that can assess this number in the presence of experimental imperfections.

Invited Talk SYQC 1.4 Thu 15:30 RW HS
Experiments on directly measuring quantum coherence and using it for quantum sensing — •Chuan-Feng Li — CAS Key Lab of Quantum Information, University of Science and Technology of China, Hefei 230026, P. R. China

In this talk, I will first introduce the experiment on direct measurement of quantum coherence. We develop a method to measure coherence directly using its most essential behavior, i.e., the interference fringes. We also use the witness observable to witness coherence, and the optimal witness constitutes another direct method to measure coherence.Then I will introduce our recent work on demonstrating a novel quantum sensor based on rare-earth ions, which provides unprecedented long coherence time up to 4.3 hours for sensitive detection of low-frequency magnetic fields.