Symposium Entanglement (SYEN)

jointly organised by
the Theoretical and Mathematical Physics Division (MP),
the Gravitation and Relativity Division (GR), and
the Working Group on Philosophy of Physics (AGPhil)

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"Entanglement" has gone a long way from a puzzle about some peculiar quantum mechanical states, triggering illustrous disputes about the interpretation of QM, to a dominant effect in finite-temperature solid-state physics, a resource in quantum computation, a driving agent in black hole thermodynamics, and a tool in quantum measurement. The symposium aims to present some of these amazing facets with interest to many communities.

Overview of Invited Talks

(Lecture hall J-HS D, Adenauerallee 24-42)

Invited Talks

SYEN 1.1	Thu	11:00–11:40	J-HS D	**Entanglement and Complexity in Quantum Many-Body Systems** — •Tomaz Prosen
SYEN 1.2	Thu	11:40–12:20	J-HS D	**Entanglement and Explanation** — •Chris Timpson
SYEN 1.3	Thu	12:20–13:00	J-HS D	**Production and observation of entanglement in quantum optics** — •Roman Schnabel

SYEN 1: Entanglement

Time: Thursday 11:00–13:00 Location: J-HS D

Invited Talk SYEN 1.1 Thu 11:00 J-HS D
Entanglement and Complexity in Quantum Many-Body Systems — •Tomaz Prosen — University of Ljubljana, Faculty of mathematics and physics, Jadranska 19, SI1000 Ljubljana, Slovenia

The question of characterising the complexity of dynamics of quantum systems with many interacting particles is, at the same time, very attractive and extremely illusive. Although a generalisation of the notion of Kolmogorov complexity to (non-commutative) quantum dynamical systems has existed for a long time, it does not provide a very useful measure of complexity. For example, it assigns positive complexity even to quasi-free or non-interacting evolutions in the so-called thermodynamic limit.

Within a recent intense burst of studies on dynamical chaos in many-body systems, which were largely motivated by the proposals of Kitaev, Maldacena, Stanford and others on holographic models of black holes, new, more intuitive and more useful, measures of dynamical complexity have been proposed. Amongst the most promising one is the concept of the so-called operator spreading with a complexity indicator given by operator entanglement. Most recently, even non-trivial, exactly solvable models of many-body dynamical chaos appeared, where measures of state and operator entanglement can be computed and the transitions from regularity to chaos analytically shown. These models are particularly topical, as they provide physical examples that may be used to demonstrate quantum supremacy of the currently emerging quantum computers.

Invited Talk SYEN 1.2 Thu 11:40 J-HS D
Entanglement and Explanation — •Chris Timpson — Faculty of Philosophy, University of Oxford

The last thirty years have seen significant increases in our understanding (and exploitation) of the phenomenon of quantum entanglement. Much of this (quantitative and qualitative) understanding has been driven by developments in quantum information theory. However many traditional conceptual puzzles about how we should understand entanglement remain, particularly when we seek to explain the violation of Bell Inequalities in correlations between spacelike separated measurement events. Perhaps surprisingly, there remain good reasons why even so straightforward a question as whether such an explanation must involve nonlocality continues to be disputed. I will sketch this landscape of debate out, with a particular focus on the questions 1) of what kind of explanation one might seek, and 2) on whether John Bell's formal statement of his informal Local Causality principle in fact fully captures the informal idea when considering families of theories which may involve fundamental non-separability like entanglement.

Invited Talk SYEN 1.3 Thu 12:20 J-HS D
Production and observation of entanglement in quantum optics — •Roman Schnabel — Universität Hamburg, Institut für Laserphysik, Hamburg

Production and manifestation of entanglement is a natural feature of (quantum) physics. The experimental proof that a certain system is composed of entangled subsystems or, more generally, comprises quantum correlations, however, is not trivial. This talk will give an overview of experimental approaches to produce and observe entanglement between optical light fields. Generic inseparability, Einstein-Podolsky-Rosen entanglement as well as Bell entanglement will be considered. This talk will also provide a physical description of the nature of entanglement and quantum correlations in general.