SYSA 2 Quantum state analysis and estimation II

Zeit: Dienstag 14:00–16:00 Raum: HVI

Hauptvortrag SYSA 2.1 Di 14:00 HVI

Optimal quantum measurements: From minimum error to maximum confidence — •Stephen Barnett — Department of Physics, University of Strathclyde, Glasgow G4 0NG, UK

The superposition principle carries with it the existence of quantum states that are similar in the sense that no measurement strategy can distinguish between them with certainty. Under such circumstances it is both interesting and of practical importance to ask what is the best that can be done.

In my talk I will concentrate of quantum communications problems in which prior information about the set of possible states and their associated probabilities is known. Within this I will discuss state detection with minimum error and unambiguous, or error-free state discrimination, which works by including the possibility of an inconclusive result. I will also describe a new strategy, the maximum confidence measurement, which is optimised so that we can be as confident of our state identification as is possible within the rules of quantum theory. I will show how such measurements can be performed by reference to experiments performed using optical polarisation.

If we have two quantum systems then the range of possible observations and conclusions is greatly enhanced by the possibility of using entangled states. As an example, we seek to determine whether or not the two systems have been prepared in the same state, without the need to identify the state itself. I will conclude with some examples of such "state comparison" measurements.

Hauptvortrag SYSA 2.2 Di 14:30 HVI

Discriminating mixed quantum states: General relations and applications — •Ulrike Herzog — Institut für Physik, Humboldt-Universität Berlin, Newtonstr. 15, 12489 Berlin

State discrimination with minimum error, on the one hand, and optimum unambiguous state discrimination, on the other hand, are two different optimized measurement strategies for distinguishing between given quantum states that occur with given prior probabilities. In the latter case the discrimination is error-free provided that the measurement succeeds, but inconclusive results, where the measurement fails, are admitted as well, and their probability is minimized.

We provide general inequalities for the minimum failure probability in a measurement for optimum unambiguous discrimination of two mixed states, as well as exact solutions in certain special cases. Moreover, we discuss two applications for optimized mixed-state discrimination. The first is quantum state comparison, where we want to decide whether two quantum systems are in the same or different pure states, both of which are unknown and have arbitrary prior probabilities to occur. The second application is quantum state identification, where we assume that two reference qubits are prepared in two different but unknown pure states and that the state of a third qubit is guaranteed to coincide, with given prior probability of occurrence, with either one of these two states. We determine the two different optimized measurement strategies for identifying the state of the third qubit, studying also the modified problem that the state of one of the reference qubits is known.

Hauptvortrag SYSA 2.3 Di 15:00 HVI

Superbroadcasting of mixed states — •Chiara Macchiavello — Dipartimento di Fisica "A. Volta", Via Bassi 6, 27100 Pavia (Italy)

"Broadcasting", namely distributing information over many users, suffers in-principle limitations when the information is quantum. For pure states ideal broadcasting coincides with the so-called "quantum cloning", which is forbidden by the no-cloning theorem for pure states drawn from a nonorthogonal set. For mixed states the no-broadcasting theorem says that perfect broadcasting from an input state drawn from a set of two noncommuting density operators to two output states cannot be achieved. We prove that this theorem cannot be generalized to more than a single input copy. Moreover, we present the phenomenon of superbroadcasting, where it is possible to purify the input states while broadcasting. We also discuss the relations between optimal superbroadcasting and other tasks of interest in quantum information.

Hauptvortrag SYSA 2.4 Di 15:30 HVI

A consumer guide to quantum state preparators — •Reinhard Werner — Inst. Math.Phys, TU Braunschweig

One of the basic requirements for a quantum computer is that we can initialize it in a specific, usually pure quantum state. However, any physical state source will produce deviations form the desired state, and we need to employ methods of error correction to improve the quality of the initialization, especially at the beginning of a very long computation.

In this talk we ask: What promise do we need about the quality of the source so that we can guarantee any desired quality of initial states after error correction? In order to isolate this problem from the problem of improving on noisy gates, we assume that unitary operations can be performed exactly, but that the ancillas used for irreversible operations, including measurements, are also obtained from the noisy source under investigation.

A typical sufficient promise about the source would be exact independence of the successive states. However, this is hardly realistic in experimental situations. It would seem that some approximate version of independence would suffice, but we show that *no promise made with finite accuracy will ever do.* Possible alternatives for the premise of a threshold theorem (such as stationarity and entropy criteria) are discussed.