Advanced Quantum Information Theory (WS 14/15)

Start:
Monday, 23.02.2015 at 8.30 in room 25.32.03.51
(Lecture time and day can be discussed/shifted if necessary)

Summary:
This lecture is a continuation of the quantum information concepts treated in “Theoretical Quantum Optics and Quantum Information”. Previous attendance of this lecture is helpful but not mandatory. After a short repetition of some basic concepts of Quantum Mechanics and Quantum Information Theory we will discuss the notion of “non-locality” and how this can in principle be confirmed in experiments. The principle of information causality is introduced and the consequences with respect to the strength of correlations are discussed. In connection with the concept of non-local boxes we try to give an information theoretic reasoning for “why quantum mechanics is as it is”.
It follows a characterization of multi-partite entangled states. We introduce the concept of SLOCC classes of entanglement and especially treat bound entangled states.
The last chapter will focus on the general problem of obtaining information about quantum states. Parameter estimation is introduced and extended by quantum metrology. Standard state tomography methods (state tomography via linear inversion, maximum likelihood estimation), as well as reconstruction methods using prior information (e.g. compressed sensing, restricted maximum likelihood estimation), are presented to complete this chapter.

Lecture: 23.02.-06.03, Mo-Fr,
8.30-12.30 or 8.30-10:30 (exercise days),
room: 25.32.03.51

Exercises: 10.30-12.30, room: 25.32.03.51
(24.02.15, 26.02.15, 02.03.15, 04.03.15, 06.03.15)
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(Material/Info’s: www.thphy.uni-duesseldorf.de/~ls3/teaching.html)

Content:

1. Basic concepts in quantum mechanics
   a. Postulates
   b. Measurement

2. Non local correlations
   a. Bell inequalities
   b. Non-local boxes
   c. Information causality

3. Multipartite entanglement
   a. SLOCC classes
   b. Bound entanglement

4. Quantum state tomography
   a. Parameter estimation
   b. Linear inversion
   c. Maximum Likelihood
   d. Reconstruction with prior knowledge

Literature:


