

# Bound Entanglement and Bound Information

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## BSc Project Plan

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## Motivation

One can show that there exists a correspondence between entanglement distillation in quantum mechanics and classical key agreement in information theory. In the same quantum-mechanical framework there are, furthermore, non-distillable, but entangled quantum states. So, considering the above analogy, does there exist some notion of bound information?

Following the intuition from the analogies of classical key agreement with entanglement distillation together with the features of bound entanglement one might hope to find characteristics/limitations of information-theoretic concepts.

## Project Description

Entanglement—a consequence of the linear structure of the mathematical formalism of quantum mechanics—is one of the astounding aspects of quantum mechanics and a valuable resource for a number of computational tasks. To measure entanglement one might consider the least number of maximally entangled bipartite quantum states—so-called singlets—required to prepare a density matrix  $\rho$  by local operations and classical communication. Similarly one might measure entanglement by the maximal number of singlets that can be obtained from  $\rho$  by local operations and classical communication. These measures are not the same. Particularly, there exist weakly entangled states—called bound-entangled—that require singlets for their preparation while they, in turn, do not allow to distill any singlets.

There are analogies to classical key agreement, for instance, entanglement distillation schemes based on protocols for classical key agreement. Together with an information-theoretic analogue for the entanglement cost, the so-called *information of formation* or *key cost*, one can ask whether there exists an information-theoretic analogue to bound entanglement. Is there a tripartite probability distribution, corresponding to Alice and Bob wanting to establish a key unknown to Eve, that has a non-zero key cost, while not allowing to distill any secret key?

## Goals

The aim of this project is to build an understanding of bound entanglement, the related measures of entanglement and their connections to concepts of classical key agreement, as well as related information-theoretic concepts, in order to approach this open question.

## Schedule

Although the project is mainly a research investigation the future work can be divided in the following tasks and milestones

- A) Project assessment
- B) Concepts of QM
- C) Concepts of information theory
- D) Investigation into bound information / Final submission

Tasks	w1	w2	w3	w4	w5	w6	w7	w8	w9	w10	w11	w12	w13	w14
project assessment														
basics of quantum mechanics														
quantum entanglement														
bound entanglement														
basics of information theory														
classical key agreement														
bound information														
writing thesis														
writing poster														
Milestones:		A			B			C						D