ENTANGLEMENT CATALYSIS FOR QUANTUM STATES AND NOISY CHANNELS

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18th January, 2023
PAMU Seminar Hall
03:00 PM

Everyone is invited to attend

ABSTRACT

Many applications of emerging quantum technologies, such as quantum teleportation and quantum key distribution, require singlets, maximally entangled states of two quantum bits. It is thus of utmost importance to develop optimal procedures for establishing singlets between remote parties. In general, this is not always possible with certainty. However, in some cases, conversion can still be achieved by using a catalyst that remains unchanged in the process. Therefore, it is very important to study the role of catalysis in entangled state transformations. We investigate different aspects of entanglement catalysis, both for quantum states and quantum channels. We prove that entanglement entropy completely characterizes state transformations in the presence of entangled catalysts. Furthermore, for transformations between bipartite pure states, we prove the existence of a universal catalyst, which can enable all possible transformations in this setup. We demonstrate the advantage of catalysis in asymptotic settings, going beyond the typical assumption of independent and identically distributed systems. We further develop methods to estimate the number of singlets that can be established via a noisy quantum channel when assisted by entangled catalysts. For various types of quantum channels, our results lead to optimal protocols, allowing us to establish the maximal number of singlets with a single use of the channel. We also demonstrate the usefulness of catalysis for entanglement distribution via a specific noisy channel.

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