6th International Conference on New Frontiers in Physics (ICNFP2017)

Contribution ID: **1272** Type: **Talk**

Gaussian intrinsic entanglement

Monday 21 August 2017 16:30 (30 minutes)

Entanglement measures proved to be a vital tool for development of quantum information science. For example, an important property of entanglement called monogamy is quantitative, and therefore cannot be captured without introducing entanglement measures. Additionally, entanglement measures provide useful bounds on several important hardly computable quantities, and they are indispensable in proofs of some quantum-information no-go theorems. In experiment, entanglement measures are needed to assess the quality of prepared entangled states and entangling gates, and they set bounds one has to surpass to demonstrate some crucial quantum protocols such as entanglement distillation.

A common feature of a vast majority of currently used entanglement measures is that either they possess a good physical meaning or are computable but not both. We probe the gap between computable and physically meaningful entanglement measures by introducing a new quantifier of entanglement which we call intrinsic entanglement (IE) [1,2]. The proposed quantity is a modification of the so called classical measure of entanglement [3], which is obtained by maximin optimization of intrinsic information [4] giving an upper bound on the secret-key rate in the classical secret key agreement protocol [5]. We investigate the IE within the framework of an important class of Gaussian states, operations, and measurements. We show, that in the Gaussian scenario IE simplifies to the mutual information of a Gaussian distribution of outcomes of measurements on parts of the system, conditioned on the outcomes of a measurement on a purifying subsystem, which is first minimized with respect to measurements on the purifying part and subsequently maximized over the remaining measurements. It is further demonstrated that the Gaussian intrinsic entanglement (GIE) vanishes only on separable states and it exhibits monotonicity under Gaussian local trace-preserving operations and classical communication. Finally, in the case of two-mode states we compute GIE for all pure states, all symmetric states with a three-mode purification, asymmetric squeezed thermal states with a three-mode purification and restricted local noises, as well as for symmetric squeezed thermal states with a four-mode purification and restricted local noises. Surprisingly, in all of these cases, GIE is equal to Gaussian Rényi-2 entanglement [6], which leads us to a conjecture that the two quantities are equal on all Gaussian states. As GIE is operationally associated to the secret-key agreement protocol and can be computed for several important classes of states, it offers a compromise between computable and physically meaningful entanglement quantifiers.

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Topic:

Mini-workshop: Continuous Variables and Relativistic Quantum Information

Summary

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Session Classification: Workshop on continuous variables and quantum information

Track Classification: Workshop on Cont. Variables and Rel. Quantum Information