**Verification of pairwise non-locality trade-off in pure symmetric 3-qubit states using the IBM open access quantum computer ibmq\_lima**

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Violation of Bell inequality reveals inherent non-locality in quantum entangled systems [1]. In particular, the Clauser-Horne-Shimony-Holt (CHSH) inequality [2] may be used to verify pairwise non-locality of constituent two-qubits of multiqubit systems. Yet another essential feature of entangled multiparty systems is monogamy i.e., restriction placed on the shareability of entanglement [3]. Non-local correlations recorded by the violation of CHSH inequalities obey monogamy trade-off relations. Monogamy trade-off relation in the case of 3-qubit states is given by [4]:

where ; and are Pauli observables with orientation directions of qubits respectively. While violation of the CHSH inequality reveals non-locality, monogamy constraint imposes the trade-off relation on 3-qubit states. In the special case of 3-qubit permutation symmetric states for which , one obtains , in turn indicating that . Hence one ends up with the monogamy restriction on non-locality: Any arbitrary 2-qubit state extracted from 3-qubit permutation symmetric system cannot violate CHSH inequality, even though the constituent qubits are entangled.

In this work, we verify monogamy relations obeyed by one parameter family of symmetric 3-qubit states[5]: (known as W-class states) using open access IBM quantum computer ibmq\_belem. A scheme of of the paper is outlined here:

* Building quantum circuit using the IBM open-source software kit Qiskit to prepare the 3-qubit state for .
* Preparation the quantum state using ibmq\_belem
* Collecting measurement data (based on 8192 statistical trials) and constructing 2-qubit correlation matrices.
* Verification of monogamy relation

Our results agree with theoretical predictions and establish how shareability places restrictions on CHSH non-locality.

**References:**

1. J. S. Bell, On the Einstein–Podolsky–Rosen paradox, Physics **1**, 195 (1964)
2. J. F. Clauser, M. A. Horne, A. Shimony, R. A. Holt, Proposed experiment to test local hidden-variable theories. Phys. Rev. Lett. **23**, 880 (1969)

3. H. -H. Qin, S. -M. Fei, X. Li-Jost, Trade-off relations of Bell violations among pairwise qubit systems.

Phys. Rev. A **92**, 062339 (2015)

4. K. Anjali, S. H. Akshata, H. S. Karthik, S. Sahu, Sudha, A. R. Usha Devi, Characterizing nonlocality

of pure symmetric three-qubit states. Quantum Inform. Process. **20**, 18 (2021)

5. IBM quantum computing platform (2019). <https://quantum-computing.ibm.com/>