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Quantifying Parallelism of Vectors Is the Quantification of Distributed N-Party Entanglement

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Abstract : The three-way distributive entanglement is shown to be related to the parallelism of vectors. Using a measurement-based approach a set of 2−dimensional vectors is formed, representing the post-measurement states of one of the parties. These vectors originate at the same point and have an angular distance between them. The area spanned by a pair of such vectors is a measure of the entanglement of formation. This leads to a geometrical manifestation of the 3−tangle in 2−dimensions, from inequality in the area which generalizes for n− qubits to reveal that the n− tangle also has a planar structure. Quantifying the genuine n−party entanglement in every $1|(n-1)$ bi-partition it is shown that the genuine n−way entanglement does not manifest in n− tangle. A new quantity geometrically similar to 3−tangle is then introduced that represents the genuine n− way entanglement. Extending the formalism to 3− qutrits, the nonlocality without entanglement can be seen to arise from a condition under which the post-measurement state vectors of a separable state show parallelism. A connection to nontrivial sum uncertainty relation analogous to Maccone and Pati uncertainty relation is then presented using decomposition of post-measurement state vectors along parallel and perpendicular direction of the pre-measurement state vectors. This study opens a novel way to understand multiparty entanglement in qubit and qudit systems.

Keywords : Geometry of quantum entanglement, Multipartite and distributive entanglement, Parallelism of vectors , Tangle
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