

## 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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