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Entangled states of neutrinos as qutrits

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Flavor superposed neutrino states exhibit bipartite and tripartite mode entanglement [1]. In [2], the quantum simulation of bipartite entanglement in the two-neutrino system has been done on an IBM quantum computer. The present work describes the mapping of two and three mode neutrino states to the Poincare sphere using the SU(2) Pauli matrices and SU(3) Gell-Mann matrices, respectively. This enables us to map the neutrino states to the qutrit states of quantum information theory. By considering neutrinos as qutrits we generalize the concept of tripartite mode flavor entanglement in the three-neutrino system. The entanglement measures such as concurrence and negativity for two qutrit neutrino states are studied which reveal the existence of bipartite qutrit entanglement. Thus, neutrinos can be considered as potential quantum information resources.

References:
[1] Abhishek Kumar Jha, Supratik Mukherjee and Bindu A. Bambah, ''Tripartite entanglement in neutrino oscillations," Modern Physics Letters A, Vol. 36, No. 09, 2150056 (2021), DOI: 10.1142/S0217732321500565, (arXiv:2004.14853 [hep-ph]).
[2] Abhishek Kumar Jha, Akshay Chatla and Bindu A. Bambah, ''Quantum studies of neutrinos," Presented at the XIX international workshop on Neutrino Telescopes (Neutel 21), Padova (Italy)- online: Zenodo. http://doi.org/10.5281/zenodo.468052

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