Tata Institute of Fundamental Research
Survey No. 36/P, Gopanpally Village, Serilingampally, Ranga Reddy Dist., Hyderabad – 500 046

Internal Webinar

Generation and Characterisation of Multipartite Entangled States Through Inequalities and Entanglement Witness Operator

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Quantum technologies rely fundamentally on quantum entanglement, a uniquely non-classical resource essential for quantum communication, computation, and precision metrology. This work investigates the generation and characterisation of multipartite entangled states using both photonic platforms and superconducting-qubit processors. In the photonic system, entanglement is produced via SPDC and analysed through spectral properties, heralding efficiency, and entropy-based measures[1]. On IBM Quantum devices, multipartite states such as four-qubit Dicke states are prepared and tested using Bell-type inequalities and entanglement witnesses to verify nonclassical correlations. Experimental violations of Bell inequalities[2] and the implementation of witness operators demonstrate[3] robust entanglement even under realistic noise. Error-mitigation techniques are explored to improve the fidelity of operations on near-term quantum hardware. Overall, the results offer valuable insights into scalable quantum networks and quantum information processing.

References:

1. Tomis et al., "Theoretical investigation of JSI of type-II BBO Crystal", accepted in Photonics 2024, conference held at IIT Kharagpur.
2. Tomis et al., "Experimental demonstration of the Bell-type inequalities for four qubit Dicke state using IBM Quantum Processing Unit", arXiv:2410.20241, Adv Quantum Technol. 8, 11 (2025): e00366. https://doi.org/10.1002/qute.202500366
3. Tomis et al., "Experimental demonstration of entanglement witness for the Dicke state and noise analysis", arXiv:2507.07123, Int J Theor Phys 64, 237 (2025), https://doi.org/10.1007/s10773-025-06107-1

Thursday, Dec 18th 2025

11:30 Hrs