



Contribution ID: 323

Type: **Poster Presentation**

Protecting quantum information using topological armour

An open challenge in quantum information processing and communication is enhancing the robustness of quantum information against environmental noise, a major obstacle in real-world applications. In this work, we study the decay of quantum states under generic noise, as measured by the decline of conventional entanglement witnesses, typically used as resources for quantum information encoding. Instead of the conventional approach of encoding information into these witnesses, we propose leveraging the topology of recently discovered quantum Skyrmions. Through a comprehensive theoretical framework and experimental evidence, we demonstrate that the topological observables of the state remain invariant under noise, revealing a robust mechanism for protecting quantum information through this encoding scheme. This method offers a promising pathway for intrinsic quantum information resilience through topology, with strong implications for real-world applications, including global quantum networks and noisy quantum computing.

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Session Classification: Poster Session

Track Classification: Track C - Photonics