

令和 7 年度第 2 回超越量子未来アリーナ ネオ・エクセレントコアセミナー

Quantum Repeaters and Aggregated Channels: Building Blocks for Scalable Quantum Networks

講 演 者 : Dr. Nicolo Lo Piparo

Visiting Researcher, OIST

日 時 : 令和7年9月2日 (火) 15:00~16:00

開催場所 : 知識科学系講義棟 2 階 中講義室

※参加申込・予約は不要です。直接会場にお越しください。

【講演概要】

Future quantum networks will enable distant users to share quantum information, supporting secure communication, distributed quantum computation, and advanced quantum sensing. A central obstacle is bridging long distances between remote nodes: transmission rates in optical fibers decay exponentially with distance, making wide-area connections especially demanding. Quantum repeaters offer a solution to this challenge by dividing the channel into shorter segments, creating entanglement locally, and then extending it step by step through entanglement swapping and purification. In this presentation, I will discuss a quantum repeater architecture based on rotation-symmetric bosonic codes. By simulating realistic noise and loss conditions, I will show how different bosonic encodings (cat, binomial, and squeezed cat) influence achievable communication rates and error thresholds, and when they can outperform conventional qubit-based repeaters.

Beyond distance, another pressing limitation is the restricted capacity of individual links, which can cause congestion and under-utilization. I will also discuss the concept of aggregated quantum networks, where multiple physical channels are combined into a single effective one. This approach enhances fidelity, reduces latency, and improves fairness across users, offering a scalable way to manage network traffic and support multi-user communication.

Together, these developments illustrate how quantum repeaters and aggregation strategies can form key building blocks for tomorrow's large-scale quantum networks.

【講演者略歴】

I graduated in Theoretical Physics at the University of Catania (Italy), completing a thesis on the renormalization group applied to non-Abelian gauge theories. I then moved to the UK, where I obtained a PhD in Electronic and Electrical Engineering, focusing on long-distance quantum communication (QKD) and studying the impact of multi-photon emission from ensemble-based quantum memories on QKD protocols. After a short postdoctoral position, I was awarded a JSPS fellowship and moved to Tokyo to work at the National Institute of Informatics on developing more practical approaches to quantum error correction codes. Three years ago, I joined OIST as a staff scientist, where I have continued to pursue research on the theoretical aspects of long-distance quantum communication, quantum error correction, and quantum networks.

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