

Quantum Circuit Desing of Protected Edge States in One – Dimensional Quantum Walks

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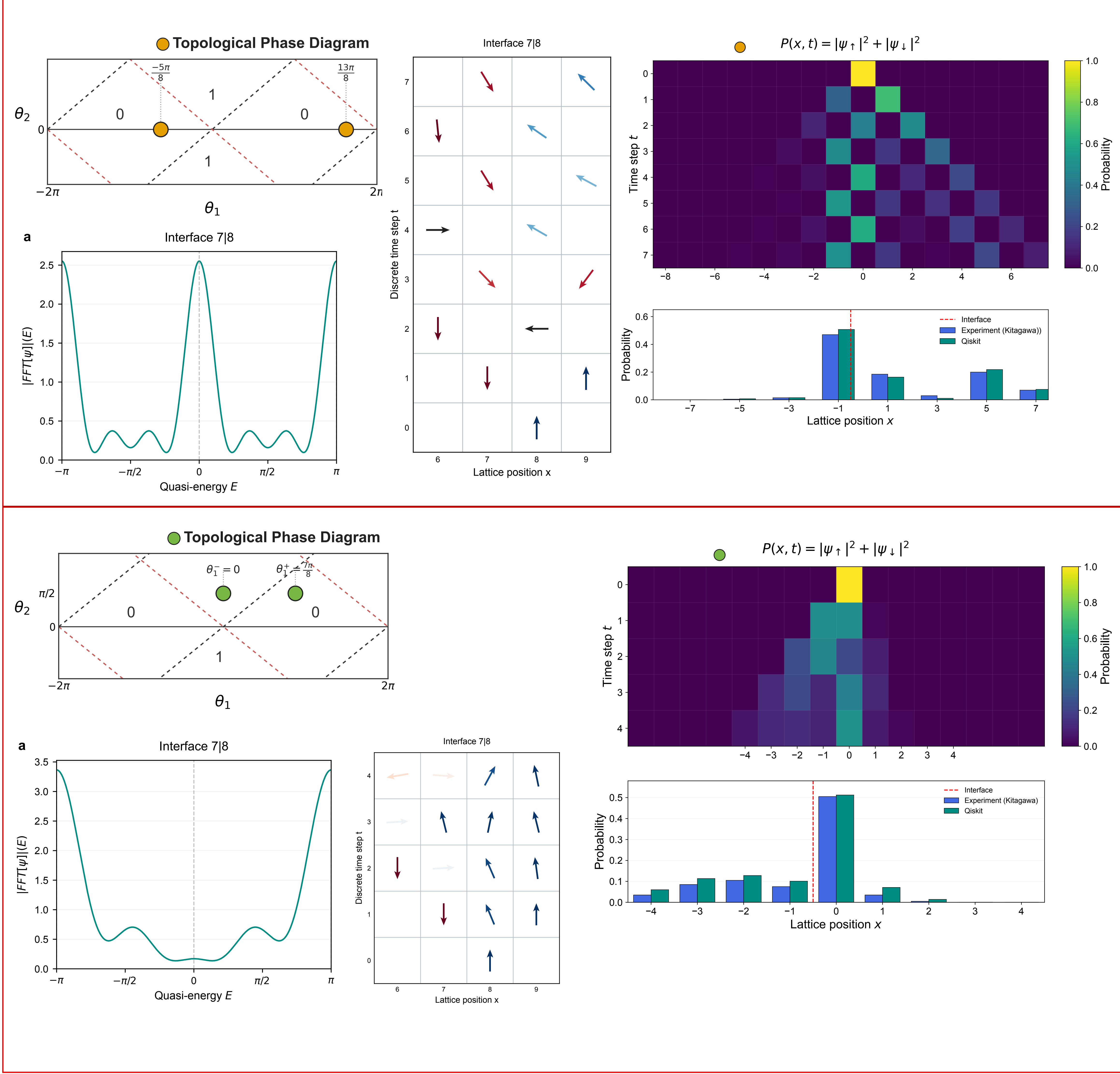
Introduction

1. The Quantum Walk has been well studied for its topological aspects. This dynamic processes allow the spontaneous generation of protected edge states in a non – equilibrium process. Finding quantum states robust to disorder is crucial for a number of different proposed technologies;
2. While quantum walks have been simulated in small scale systems, new quantum computing technology is now available that allows us to run simulations on large scales. This is important, both as a test of this technology, but also to explore fundamental questions about quantum walks. In particular the interplay between the spin and the dynamical nature of these walks. Moreover, controlling quantum degrees of freedom, like edge modes and their spin is a crucial first step for any application of quantum walks.

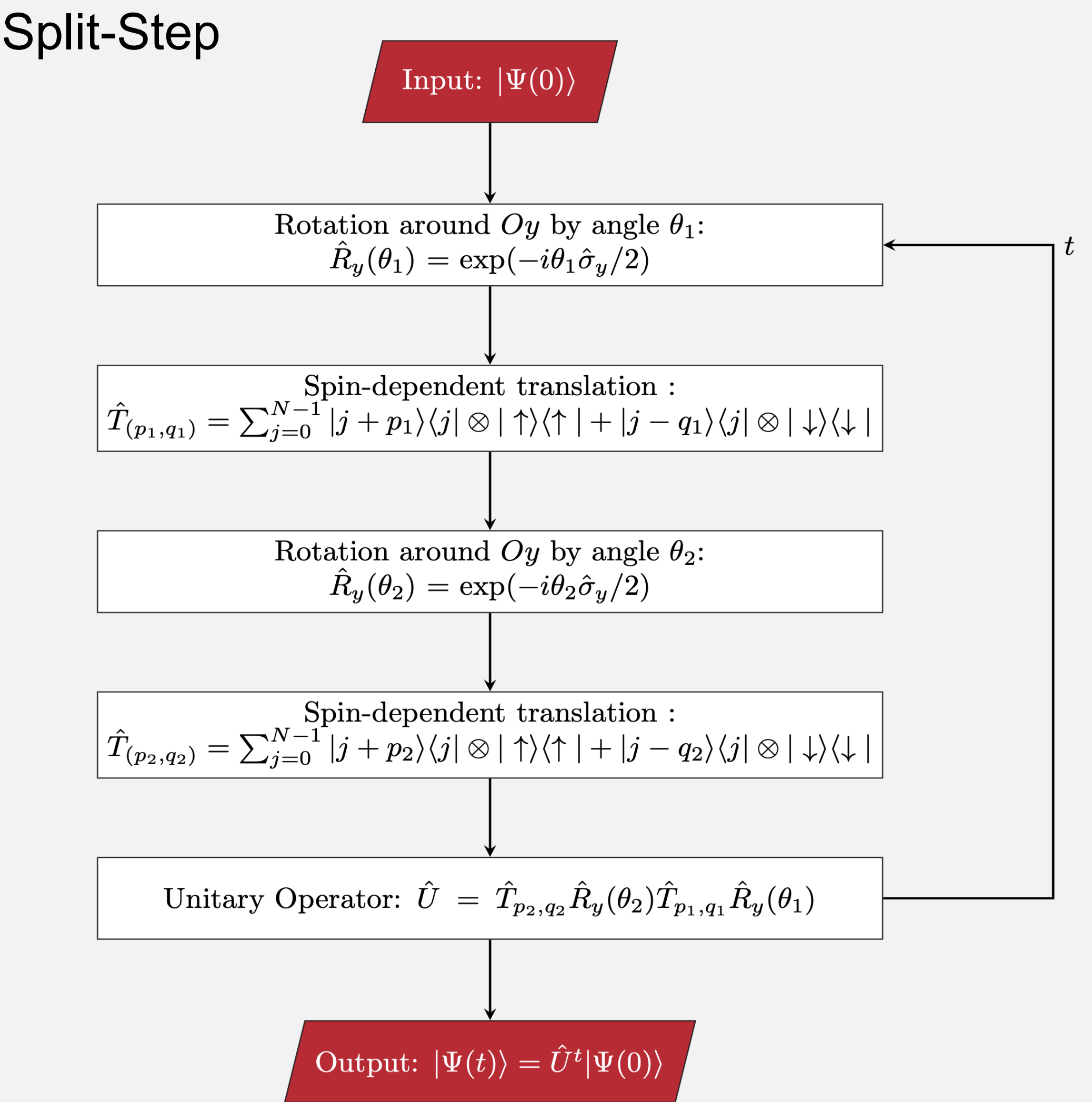
Goals

- Extend protocols for simple quantum walks to split – step quantum walks;
- Quantum circuit for fully implementing a split – step quantum walk that display topological modes;
- Identification and analysis of the spin structure of protected edge states;
- Comparing quantum circuit simulation with the protected edge states in photonic quantum walks

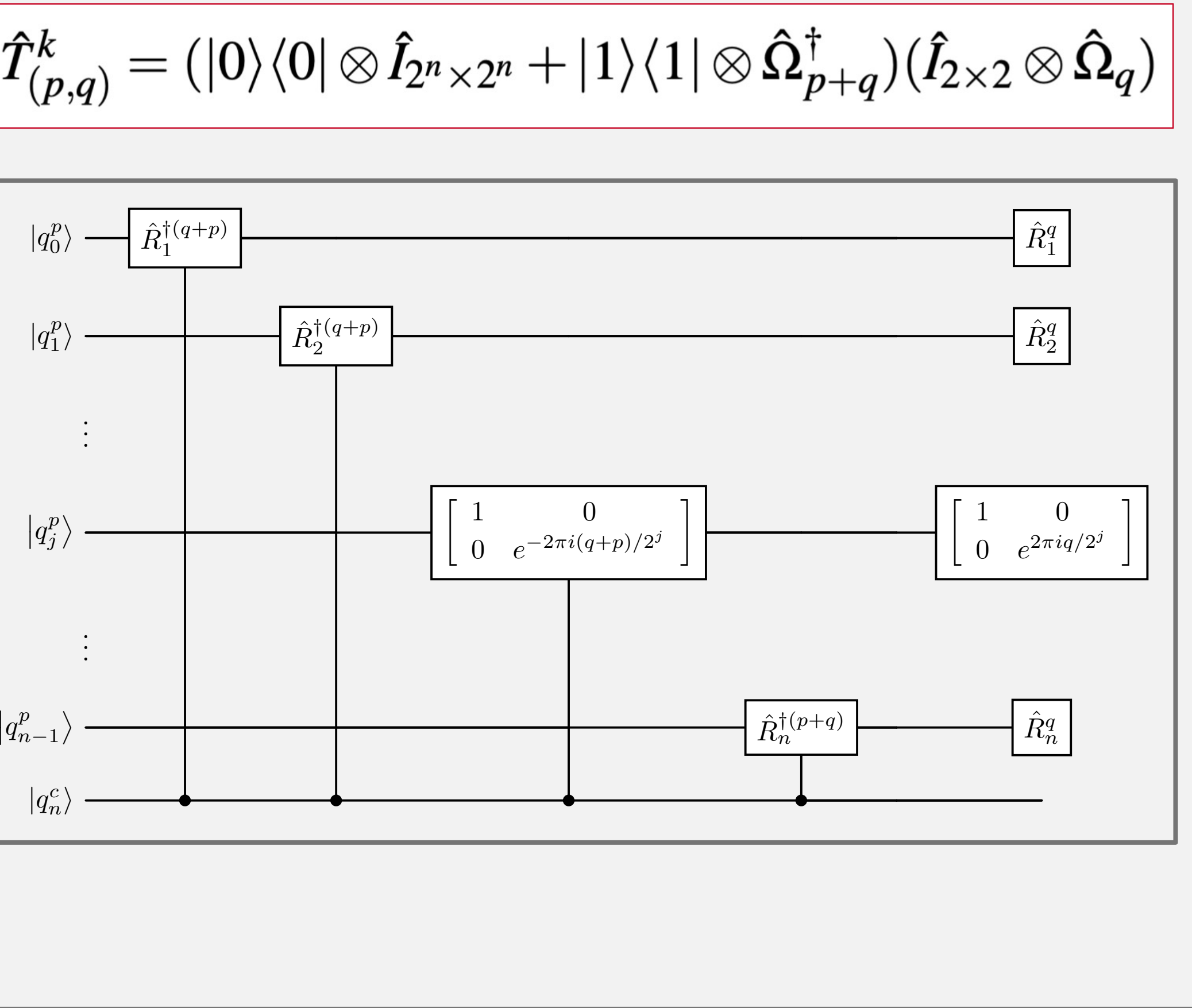
Results



Protocol



Quantum Circuit implementation



Acknowledgments

- Texas Tech University

References

○ Kitagawa, T. et al. Observation of topologically protected bound states in photonic quantum walks. *Nature Communications* **3**, 882 (2012).
○ Shakeel, A. Efficient and scalable quantum walk algorithms via the quantum Fourier transform. *Quantum Information Processing* **19**, 323 (2020).