การประกวดโครงงาน“ค้นคว้าอิสระระดับปริญญาตรี สาขาวิชาฟิสิกส์ ครั้งที่ 14" ชิงถ้วยพระราชทานสมเด็จพระเจ้าพี่นางเธอ เจ้าฟ้ากัลยาณิวัฒนา กรมหลวงนราธิวาสราชนครินทร์

ในงานประชุมวิชาการ Siam Physics Congress 2022

ชื่อโครงงาน (Title): Simulation of Two-Hops Quantum Network with Entangled Photon Pair Source (EPPS) Protocol based on International Space Station (ISS) Trajectory

ชื่อ-สกุลนักศึกษา (Student's name): Poramat Chianvichai

มหาวิทยาลัย (University): Department of Physics, Faculty of Science, Mahidol University

อาจารย์ที่ปรึกษา (Advisor's name): Asst. Prof. Dr. Sujin Suwanna

บทคัดย่อ (Abstract):

Quantum computers offer algorithms that can potentially solve impactful problems that classical algorithms are inefficient or incapable. As a classical network enhances classical computing performance, a quantum network can do so with quantum computers, and it has become one of the active research topics in quantum communication. It is how to connect two or more quantum objects (qubits) to improve computational power and implement the quantum algorithm. Currently, there are many models and protocols of a quantum network. Here we investigate a quantum network with the entangled photon pair source (EPPS) with a dynamic node, such as a low earth orbit (LEO) satellite, to distribute single photons. Entangled photons are sent from the middle node, swapped with matter qubits at the end nodes, and a Bell pair is created between the matter qubits at the end node. Modelling the International Space Station (ISS) as the middle node, we simulate a quantum network based on EPPS and study the parameters that affect the network performance. We use the quantum state fidelity as an indicator of this performance because it is widely used and desirable in quantum communication. Our proposed quantum network has three nodes of varying distance which act as the ground stations, which we suppose they are located in Chiang Mai, Bangkok and Songkhla provinces. The location of the ground stations and the ISS trajectory [1] will be located with respect to Earth's longitude-latitude coordinates and transformed into a relation of the distance between the ground stations and the ISS as a function of time. This quantum network is simulated with qwanta software [2] based on the Python programming language. We find that distance of the node and measurement errors affect the quantum state fidelity due to photon loss, where the measurement errors have stronger effects. With longer coherent time, the fidelity can meet the minimum requirement of 0.84 for quantum key distribution between Chiang Mai, Bangkok and Songkhla via the ISS node. Xxxxx. Our research shines light on a possible creation of a quantum network for Thailand by implementing EPPS on a LEO satellite.

[1] Open Notify -- API Doc | ISS Current Location (open-notify.org)

[2] Poramet Pathumsoot, Development of Second Generation Network with Quantum Repeaters, Master's thesis, Department of Physics, Faculty of Science, Mahidol University, 2022.