



Quantum Information and Communications Lab

## ■ Contact information

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## ■ Current state of the Lab. (in 2025 Spring Semester)

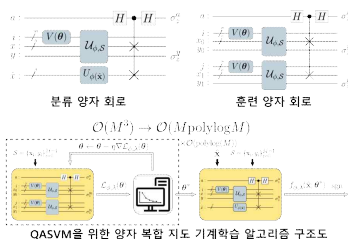
Postdoctoral Fellows : 1      PhD Students: 4      Master's Student: 3

## ■ Research Areas

### ✓ Quantum Approximate Support Vector Machine

A kernel-based quantum classifier is the most practical and influential quantum machine learning technique for the hyper-linear classification of complex data. Variational Quantum Approximate Support Vector Machine (VQASVM) algorithm demonstrates empirical sub-quadratic run-time complexity with quantum operations feasible even in NISQ computers.

We experimented our algorithm with toy example dataset on cloud-based NISQ machines as a proof of concept. We also numerically investigated its performance on the standard Iris flower and MNIST datasets to confirm the practicality and scalability.

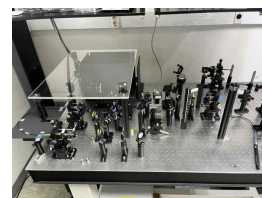


### ✓ Quantum Transformer

Quantum Transformer is an advanced fusion technology that integrates the core AI model, Transformer, with principles of quantum computing. By leveraging quantum circuits to perform attention calculations and feed-forward operations, it aims to enhance computational speed and representational power. Utilizing the superposition and entanglement of qubits, it offers potential gains in parallelism and efficiency.

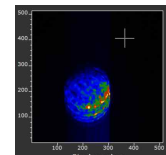
### ✓ Satellite based Quantum Key Distribution (SQKD)

Since the successful demonstration of a satellite-based quantum key distribution (QKD) system by a research team from the University of Science and Technology of China (USTC) in 2017, the world has been fervently engaged in a competition to secure future technologies. South Korea is also actively conducting research related to this field, and we are conducting research specifically on entangled photon pair (EPP) sources, which is one of the essential technologies for achieving this project. In this research, we utilize optical experimental setups to observe and confirm phenomena that demonstrate quantum properties.



### ✓ Quantum Ghost Imaging

The imaging technique allows the reconstruction of an image without directly detecting the photons that interact with the object. Despite a single photon from the signal not hitting the detector, the object can be obtained by utilizing the correlation between the detected signal and idler as the unique properties of the entanglement and non-locality of quantum mechanics.



## ■ Recommended courses & Career after graduation

Recommended courses are linear algebra, probability theory, quantum mechanics, information theory. Graduates have emancipated for various careers such as professors (Coventry U UK, IFSTAR France), and researchers at major companies (Samsung, LG Nex1, KT, ETRI, NSR).

## ■ Introduction to the Lab.

Our lab is currently engaged in research focused on quantum communication and quantum computing algorithms with near-term applications. In particular, we're focusing on the fields of quantum machine learning and quantum chemistry(i.e. VQE) as part of the broader scope of variational quantum algorithms. We are also carrying out exciting experimental research in areas like quantum ghost imaging and quantum key distribution. If you're interested, feel free to reach out to our lab.

## ■ Recent research achievements ('22~'25)

- Kim, J.W., Lim, S.S., et al., Efficient Satellite QKD Strategy Using High-Brightness Entangled Photon-Pair Source with Fixed-Intensity, Adv Quantum Technol. 2025, 8, 2400489 (2024)
- Kim, K.M., Lim, S.M., et al., Variational quantum eigensolver for closed-shell molecules with non-bosonic corrections, Physical Chemistry Chemical Physics, 26(10), 8390 (2024)
- Lim, H.C., Kang, D.H., et al., Fragment molecular orbital-based variational quantum eigensolver for quantum chemistry in the age of quantum computing, Scientific reports, 14(1), 2422 (2024)
- Junsang Oh, Jeongsik Cho, and June-Koo Kevin Rhee, Continuous-variable quantum key distribution with time-division dual-quadrature homodyne detection, Opt. Express 31, 30669-30681 (2023)
- Ryu, J.-Y.; Elala, E.; Rhee, J.-K.K. Quantum Graph Neural Network Models for Materials Search. Materials 2023 16, 4300.
- Park, S., Park, D.K. & Rhee, J.K.K. Variational quantum approximate support vector machine with inference transfer. Sci Rep 13, 3288 (2023).
- Kim, J.W., Cho, J.S., Sacarello, C. et al. Photon-counting statistics-based support vector machine with multi-mode photon illumination for quantum imaging. Sci Rep 12, 16594 (2022).