External Awards

The Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology, Award for Science and Technology in Research Category
Winner: Hiroki Takesue, NTT Basic Research Laboratories
Date: April 8, 2022
Organization: Ministry of Education, Culture, Sports, Science and Technology

For his achievements in quantum communications such as quantum key distribution and quantum entanglement generation for the telecommunication band and coherent Ising machines based on optical parametric oscillators.

The Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology, the Young Scientists' Award
Winner: Koji Azuma, NTT Basic Research Laboratories
Date: April 8, 2022
Organization: Ministry of Education, Culture, Sports, Science and Technology

For his achievements in theory of quantum repeaters necessary for the development of a quantum internet.

IEICE Communications Society Excellent Paper Award, Best Paper Award
Winners: Yuya Omori, NTT Computer and Data Science Laboratories/NTT Device Innovation Center; Ken Nakamura, NTT Computer and Data Science Laboratories/NTT Device Innovation Center; Takayuki Onishi, NTT Computer and Data Science Laboratories; Daisuke Kobayshi, NTT Computer and Data Science Laboratories/NTT Device Innovation Center; Tatsuya Osawa, NTT Corporate Strategy Planning Department; Hiroe Iwasaki, Tokyo University of Agriculture and Technology
Date: May 11, 2022
Organization: The Institute of Electronics, Information and Communication Engineers (IEICE)

For "4K 120fps HEVC Encoder with Multi-chip Configuration."
Published as: Y. Omori, K. Nakamura, T. Onishi, D. Kobayshi, T. Osawa, and H. Iwasaki, "4K 120fps HEVC Encoder with Multi-chip Configuration," IEICE Transactions on Communications, Vol. E104-B, No. 7, pp. 749–759, 2021.

Papers Published in Technical Journals and Conference Proceedings

Dither-free Bias Condition Monitoring Technique Utilizing Reference Light for Inservice Optical IQ modulator

H. Kawakami, S. Kuwahara, and Y. Kisaka

27th OptoElectronics and Communications Conference (OECC 2022), TuP-B-7, Toyama, Japan, July 2022.

We developed a dither-free bias condition monitoring technique for IQ modulators utilizing reference light and a low-speed power monitor. Experimental results for confirming the principle are also shown.

Divide-and-conquer Verification Method for Noisy Intermediate-scale Quantum Computation

Y. Takeuchi, Y. Takahashi, T. Morimae, and S. Tani

Quantum, Vol. 6, p. 758, July 2022.

Several noisy intermediate-scale quantum computations can be regarded as logarithmic-depth quantum circuits on a sparse quantum computing chip, where two-qubit gates can be directly applied on only some pairs of qubits. In this paper, we propose a method to efficiently verify such noisy intermediate-scale quantum computation. To this end, we first characterize small-scale quantum operations with respect to the diamond norm. Then by using these characterized quantum operations, we estimate the fidelity $\langle \psi_t | \hat{\rho}_{\mathrm{out}} | \psi_t \rangle$ between an actual n-qubit output state $\hat{\rho}_{\mathrm{out}}$ obtained from the noisy intermediate-scale quantum computation and the ideal output state (i.e., the target state) $|\psi_t\rangle$. Although the direct fidelity estimation method requires $O(2^n)$ copies of $\hat{\rho}_{\mathrm{out}}$ on average, our method requires only $O(D^3 2^{12D})$ copies even in the worst case, where D is the denseness of $|\psi_t\rangle$. For logarithmic-depth quantum circuits on a sparse chip, D is at most $O(\log n)$, and thus $O(D^3 2^{12D})$ is a polynomial in n. By using the IBM Manila 5-qubit chip, we also perform a proof-of-principle experiment to observe the practical performance of our method.

Passive Verification Protocol for Thermal Graph States

K. Akimoto, S. Tsuchiya, R. Yoshii, and Y. Takeuchi

Physical Review A, Vol. 106, 012405, July 2022.

Graph states are entangled resource states for universal measurement-based quantum computation. Although matter qubits such as superconducting circuits and trapped ions are promising candidates to generate graph states, it is technologically hard to entangle a large number of them due to several types of noise. Since they must be sufficiently cooled to maintain their quantum properties, thermal noise is one of the major ones. In this paper, we show that, for any temperature T, the fidelity $\langle G|\rho_T|G\rangle$ between an ideal graph state $|G\rangle$ at zero temperature and a thermal graph state ρ_T, which is a graph state at temperature T, can be efficiently estimated by using only one measurement setting. A remarkable property of our protocol is that it is passive, while existing protocols are active, namely, they switch between at least two measurement settings. Since thermal noise is equivalent to an independent phase-flip error, our estimation protocol also works for that error. By generalizing our protocol to hypergraph states, we apply our protocol to the quantum-computational-supremacy demonstration with instantaneous quantum polynomial time circuits. Our results should make the characterization of entangled matter qubits extremely feasible under thermal noise.

Computational Self-testing for Entangled Magic States

A. Mizutani, Y. Takeuchi, R. Hiromasa, Y. Aikawa, and S. Tani

Physical Review A, Vol. 106, L010601, July 2022.

Can classical systems grasp quantum dynamics executed in an untrusted quantum device? Metger and Vidick answered this question affirmatively by proposing a computational self-testing protocol for Bell states that certifies generation of Bell states and measurements on them. Since their protocol relies on the fact that the target states are stabilizer states, it is highly nontrivial to reveal whether the other class of quantum states, *nonstabilizer states*, can be self-tested. Among nonstabilizer states, magic states are indispensable resources for universal quantum computation. Here, we show that a magic state for the *CCZ* gate can be self-tested while that for the *T* gate cannot. Our result is applicable to a proof of quantumness, where we can classically verify whether a quantum device generates a quantum state having nonzero magic.