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Towards Scalability and Fault Tolerance in Continuous-Variable Quantum Computation[1]

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Before they can be useful, quantum computers must be made large and robust to noise. I will discuss progress towards both requirements in the context of continuous-variable quantum information, where the data registers are Bosonic modes, such as spatial/temporal modes in quantum optics, or microwave resonator modes in superconducting qubit architectures. I will report on a recent experiment that deterministically generated large-scale quasi-two-dimensional resource states for measurement-based quantum computing [1]. I will also discuss the key challenges to using such states for quantum computation: the effects of limited squeezing and the requirement of a non-Gaussian operation. Fortunately, one can address both issues in one fell swoop: encoded qubits known as Gottesman-Kitaev-Preskill (GKP) states allow for universal quantum computing with a constant squeezing overhead in the entangled resource state, and simultaneously provide the necessary non-Gaussianity for universal quantum computation [2].

References:

[1] Time-Domain Multiplexed 2-Dimensional Cluster State: Universal Quantum Computing Platform, Warit Asavanant, Yu Shiozawa, Shota Yokoyama, Baramee Charoensombutamon, Hiroki Emura, Rafael N. Alexander, Shuntaro Takeda, Jun-ichi Yoshikawa, Nicolas C. Menicucci, Hidehiro Yonezawa, Akira Furusawa, arXiv:1903.03918 (2019)

[2] All-Gaussian universality and fault tolerance with the Gottesman-Kitaev-Preskill code, Ben Q. Baragiola, Giacomo Pantaleoni, Rafael N. Alexander, Angela Karanjai, Nicolas C. Menicucci, arXiv:1903.00012 (2019)

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