Contribution ID: **122** Type: **Poster**

Multipartite entanglement of trapped ions by graph-based optimized global Raman beams

Tuesday, 28 June 2022 17:55 (2 minutes)

Entangling gates are arguably the main ingredient of quantum information processing (QIP). Trapped ion systems have typically outshone other quantum hardware in preparing Bell states. Two ion entanglement has been extensively covered [1, 2, 3] and sequences of pairwise gates can be used to generate multipartite entanglement. Alternatively, global irradiation is faster, which is important as speed is essential for scaleable QIP and for quantum algorithms [4, 5]. As the ion number increases, more motional modes appear and the error increases. For example, crosstalk and fluctuations in the tightly focused individual addressing Raman beams can decrease the fidelity [6].

Modulation techniques are widely used to improve the gate fidelity by reducing residual spin-motion coupling, dealing with the complexity of clustered motional modes in large ion crystals. Also, optimizers are used to design pulses which solve theoretical gate constraints, but is limited when considering more ions as it is a NP-hard problem. To this end, we implement a modulated single global beam to illuminate all of the ions, creating a global entangling interaction and have single ion addressability provided by a 411nm shelving beam. Then by using graph-based optimization instead of solving constraints, we can quickly reach solutions for large ion crystal entanglement with faster gates. We show that our error scales better than pairwise entangling gates and that the gate duration is favourable.

References

[1] J. P. Gaebler et al. "High-Fidelity Universal Gate Set for 9Be+ Ion Qubits". In: Phys. Rev. Lett. 117 (6 Aug. 2016), p. 060505. DOI: 10.1103/PhysRevLett.117.060505. URL: https://link.aps.org/doi/10.1103/PhysRevLett.117.060505.

[2] C. J. Ballance et al. "High-Fidelity Quantum Logic Gates Using Trapped-Ion Hyperfine Qubits". In: Phys. Rev. Lett. 117 (6 Aug. 2016), p. 060504. DOI: 10.1103/PhysRevLett.117.060504. URL: https://link.aps.org/doi/10.1103/PhysRevLett.117.0605

[3] T. R. Tan et al. "Multi-element logic gates for trapped-ion qubits". In: Nature 528.7582(2015), pp. 380–383. ISSN: 0028-0836. DOI: 10.1038/nature16186.

[4] A Yu Kitaev. "Quantum measurements and the Abelian Stabilizer Problem". In: arXiv(1995).

[5] Jungsang Kim et al. "Modular Universal Scalable Ion-trap Quantum Computer (MUSIQC)".In: AIP Conference Proceedings 1363.1 (2011), pp. 190–193. ISSN: 0094-243X. DOI:10.1063/1.3630178.

[6] Yao Lu et al. "Global entangling gates on arbitrary ion qubits". In: Nature 572.7769 (2019), pp. 363–367. ISSN: 0028-0836. DOI: 10.1038/s41586-019-1428-4

Primary authors: Mr RAO, Arjun D. (The University of Sydney); Dr VALAHU , Christophe (The University of Sydney); Dr TAN, Tingrei (The University of Sydney)

Presenter: Mr RAO, Arjun D. (The University of Sydney)

Session Classification: Posters