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Wavelets for quantum state generation

One exciting application of a scalable universal quantum computer would be for quantum-state generation, which is a key component of quantum algorithms for quantum simulation. We are exploring the advantages of wavelets as a representation for quantum simulation of quantum fields and many-body quantum systems. Our main focus is on quantum algorithms for quantum field theories, along the lines established by Jordan, Lee and Preskill [Science 336: 1130-1133 (2012)], for which initial-state preparation is a dominant computational cost of the algorithm. We express the quantum field in the wavelet representation according to the method of Brennen, Rohde, Sanders and Singh [Physical Review A 92: 032315 (2015)], and our wavelet-enhanced algorithm for initial-state preparation as part of the quantum-field-theory quantum algorithm has a significant computational time-cost reduction over the previous lattice-based method. We are also developing a coherent-state representation for Daubechies wavelets. Progress on these wavelet representations and their use for enhancing quantum-simulation algorithms will be reported.