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Quantum linear systems algorithm with exponentially improved dependence on precision[1] ROLANDO SOMMA, Los Alamos National Laboratory, ANDREW CHILDS, University of Maryland, ROBIN KOTHARI, Massachusetts Institute of Technology — Harrow, Hassidim, and Lloyd showed that for a suitably specified $N \times N$ matrix A and N-dimensional vector $\vec{b}$, there is a quantum algorithm that outputs a quantum state proportional to the solution of the linear system of equations $A\vec{x} = \vec{b}$. If A is sparse and well-conditioned, their algorithm runs in time polynomial in $\log N$ and $1/\epsilon$, where ϵ is the desired precision in the output state. We improve this to an algorithm whose running time is polynomial in $\log(1/\epsilon)$, exponentially improving the dependence on precision while keeping essentially the same dependence on other parameters. Our algorithm is based on a general technique for implementing any operator with a suitable Fourier or Chebyshev series representation. This allows us to bypass the quantum phase estimation algorithm, whose dependence on ϵ is prohibitive.

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