An introduction to quantum computing, general theoretical ideas and examples of implementation

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Abstract

Since the 1994 discovery by Peter Shor, that a quantum computer may factor large numbers more efficiently than any known classical computing strategy, research in quantum computing has been studied by a large number of research communities and its potential has been recognized by a variety of national, international, strategic, and commercial funding initiatives.

Quantum computers may be built from physical quantum systems that are already studied extensively in the laboratory: trapped ions, cold atoms, superconducting circuits, liquid and solid state spin ensembles, etc., and numerous experiments have now demonstrated precise elementary gate operations. Significant progress has happened, partly due to rather simple theory ideas which have led to significant improvements of the original theoretical proposals, and partly due to technological progress that has been so fast that we can now do things that were unthinkable just few years ago.