Williams

Quantum Computing and Quantum Communications

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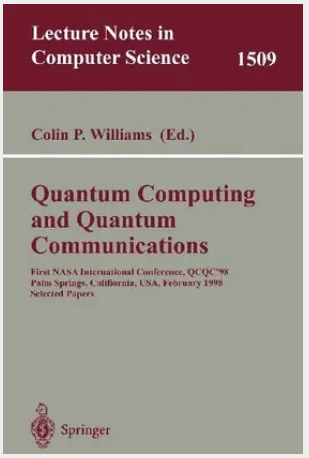

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? Colin P. Williams Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109-8099, email: Colin. P. Williams@jpl. nasa. gov Over the past half century computers have gone from being the room-sized servants of a privileged few to the totable companions of business travellers, schoolchildren,andjust aboutanyonewho canpoint andclick a mouse. Inpart, this transformation was made possible by the dramatic miniaturization in the basic components of a computer. This trend was quantied in 1964 by Gordon Moore, one of the founders of Intel, who noticed that the amount of information that could be stored on a given amount of silicon doubled roughly every 18 months. The doubling trend continues to this day and, by crude extrapolation, predicts that the computers of 2020 might be approaching the one-atom-per-bit level. Physical systems such as atoms, however, behave in ways that are very d-ferent from everyday objects. In fact they are governed by the laws of quantum mechanics rather than classical mechanics. In the early 1980's some foresighted physicists,suchesCharlesBennett(ourconferenceChairperson),RolfLandauer, Paul Benio, David Deutsch, and Richard Feynman, began to question what it would mean for a computer to operate at the one-atom-per-bit scale. The - ementary operations of such a computer would need to be described in terms of quantum mechanics. Recently, physicists and computer scientists have come to appreciate that certain quantum e ects, in particular superposition, int- ference, entanglement, non-locality, indeterminism, and non-clonability, allow entirely new kinds of tasks to be performed.

Entanglement and Quantum Algorithms.- Multi-particle Entanglement via Two-Particle Entanglement.- Quantum Wavelet Transforms: Fast Algorithms and Complete Circuits.- Quantum Computation of Fluid Dynamics.- Quantum Entanglement and the Communication Complexity of the Inner Product Function.- Quantum Recurrent Networks for Simulating Stochastic Processes.- Correlation between Correlations: Process and Time in Quantum Networks.- Quantum Effects in Algorithms.- Automated Design of Quantum Circuits.- Quantum Search on Structured Problems.- Generalized Grover Search Algorithm for Arbitrary Initial Amplitude Distribution.- Quantum Database Search by a Single Query.- Quantum Computer Can Not Speed Up Iterated Applications of a Black Box.- Quantum Resonance for Solving NP-complete Problems by Simulations.- Computational Complexity and Physical Law.- The Hidden Subgroup Problem and Eigenvalue Estimation on a Quantum Computer.- A Diakoptic Approach to Quantum Computation.- Quantum Cryptography.-Practical Free-Space Quantum Cryptography.- Quantum Cryptography, Eavesdropping, and Unsharp Spin Measurement.- Quantum Copying and Quantum Information Theory.- Information-Theoretic Aspects of Quantum Copying.- Universal Optimal Cloning of Qubits and Quantum Registers.- Entanglement of Assistance.- What Information Theory Can Tell Us About Quantum Reality.- Quantum Generalization of Conditional Entropy and Information.- Accessible Information in Multi-access Quantum Channels.- Capacities of Quantum Channels and Quantum Coherent Information.- Strengthened Lindblad Inequality: Applications in Non-equilibrium Thermodynamics and Quantum Information Theory.- Quantum Error Correction and Fault-Tolerant Quantum Computing.- Fault-Tolerant Quantum Computation with Higher-Dimensional Systems.- Quantum Convolutional Error Correction Codes.- On the Existence of Nonadditive Quantum Codes.- Quantum Error Correction Is Applicable for Reducing Spatially Correlated Decoherence.- Topological Quantum Computation.- Embodiments of Quantum Computers.- NMR GHZ.- Quantum Computing Using Electron-Nuclear Double Resonances.- Physical Implementations for Quantum Communication in Quantum Networks.- An Optical Approach to Quantum Computing.- Quantum Computation with Linear Optics.- Decoherence Control for Optical Qubits.- Adiabatic Controlled-NOT Gate for Quantum Computation.- Trapped Ion Quantum Computer Research at Los Alamos.- Arrays of Elliptical Ion Traps for Parallel Quantum Computing

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