Deterministic Entanglement Of Trapped Ion Spin Qubits

Quantum Computation
Long Distance Entanglement Between Quantum Memories
Laser Spectroscopy
Exploring the Quantum/classical Frontier
Principles Of Quantum Computation And Information: A Comprehensive Textbook
Computational Complexity
Charged Particle Traps II
Frank Wilczek: 50 Years Of Theoretical Physics
Physics Of Quantum Information, The - Proceedings Of The 28th Solvay Conference On Physics
Quantum Networking
A Guide to Experiments in Quantum Optics
Bio-Inspired and Nanoscale Integrated Computing
TCP 2006
Photonics
Scalable Microchip Ion Traps for Quantum Computation
Metrology and Fundamental Constants
Quantum Computation and Quantum Information
Theory
High-Fidelity Quantum Logic in Ca+
Fast Gates and Mixed-Species Entanglement with Trapped Ions
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CASSIDY HARLEY

Quantum Computation
IOS Press
Work has been completed on the three projects supported by this grant. This Final Project Report summarizes the achievements of the project and the project milestones, which highlight deterministic entanglement between two trapped ions and the demonstration of the highest efficiency conditional single photon source to date. *Long Distance Entanglement Between Quantum Memories* Bentham Science Publishers

The rapidly developing topic of ultracold atoms has many actual and potential applications for condensed-matter science, and the contributions to this book emphasize these connections. Ultracold Bose and Fermi quantum gases are introduced at a level appropriate for first-year graduate students and non-specialists such as more mature general physicists. The reader will find answers to questions like: how are experiments conducted and how are the results...
interpreted? What are the advantages and limitations of ultracold atoms in studying many-body physics? How do experiments on ultracold atoms facilitate novel scientific opportunities relevant to the condensed-matted community? This volume seeks to be comprehensible rather than comprehensive; it aims at the level of a colloquium, accessible to outside readers, containing only minimal equations and limited references. In large part, it relies on many beautiful experiments from the past fifteen years and their very fruitful interplay with basic theoretical ideas. In this particular context, phenomena most relevant to condensed-matter science have been emphasized. Introduces ultracold Bose and Fermi quantum gases at a level appropriate for non-specialists. Discusses landmark experiments and their fruitful interplay with basic theoretical ideas. Comprehensible rather than comprehensive, containing only minimal equations.

Laser Spectroscopy World Scientific Quantum computation and information is a rapidly developing interdisciplinary field. It is not easy to understand its fundamental
concepts and central results without facing numerous technical details. This book provides the reader with a useful guide. In particular, the initial chapters offer a simple and self-contained introduction; no previous knowledge of quantum mechanics or classical computation is required. Various important aspects of quantum computation and information are covered in depth, starting from the foundational concepts and computational complexity, energy, entropy, and information, quantum superposition and entanglement, elementary quantum gates, the main quantum algorithms, quantum teleportation, and quantum cryptography) up to advanced topics (like entanglement measures, quantum discord, quantum noise, quantum channels, quantum error correction, quantum simulators, and tensor networks). It can be used as a broad range textbook for a course in quantum information and computation, both for upper-level undergraduate students and for graduate students. It contains a large number of solved exercises, which are an essential complement to the text, as they will help the student to
become familiar with the subject. The book may also be useful as general education for readers who want to know the fundamental principles of quantum information and computation and who have the basic background acquired from their undergraduate course in physics, mathematics, or computer science, as well as for researchers interested in some of the latest spin-off of the field, including the use of quantum information in the theories of many-body systems. Exploring the Quantum/classical Frontier World Scientific A new discipline, Quantum Information Science, has emerged in the last two decades of the twentieth century at the intersection of Physics, Mathematics, and Computer Science. Quantum Information Processing is an application of Quantum Information Science which covers the transformation, storage, and transmission of quantum information; it represents a revolutionary approach to information processing. Classical and Quantum Information covers topics in quantum computing, quantum information theory, and quantum error correction, three important areas of quantum information.
Deterministic Entanglement Of Trapped Ion Spin Qubits

processing. Quantum information theory and quantum error correction build on the scope, concepts, methodology, and techniques developed in the context of their close relatives, classical information theory and classical error correcting codes. Presents recent results in quantum computing, quantum information theory, and quantum error correcting codes.

both classical and quantum information theory and error correcting codes. The last chapter of the book covers physical implementation of quantum information processing devices. Covers the mathematical formalism and the concepts in Quantum Mechanics critical for understanding the properties and the transformation s of quantum information. Principles Of Quantum Computation And Information: A Comprehensiv e Textbook Cambridge University Press. Provides fully updated coverage of new experiments in quantum optics. This fully revised and expanded edition of a well-established textbook on experiments on quantum optics covers new concepts, results, procedures, and developments in state-of-the-art experiments. It starts with the basic
beginning blocks and ideas of quantum optics, then moves on to detailed procedures and new techniques for each experiment. Focusing on metrology, communications, and quantum logic, this new edition also places more emphasis on single photon technology and hybrid detection. In addition, it offers end-of-chapter summaries and full problem sets throughout.

Beginning with an introduction to the subject, A Guide to Experiments in Quantum Optics, 3rd Edition presents readers with chapters on classical models of light, photons, quantum models of light, as well as basic optical components. It goes on to give readers full coverage of lasers and amplifiers, and examines numerous photodetection techniques being used today. Other chapters examine quantum noise, squeezing experiments, the application of squeezed light, and fundamental tests of quantum mechanics. The book finishes with a section on quantum information before summarizing of the contents and offering an outlook on the future of the field. -Provides all new updates to the field of quantum optics,
Deterministic Entanglement Of Trapped Ion Spin Qubits

covering the building blocks, models and concepts, latest results, detailed procedures, and modern experiments - Places emphasis on three major goals: metrology, communications, and quantum logic - Presents fundamental tests of quantum mechanics (Schrodinger Kitten, multimode entanglement, photon systems as quantum emulators), and introduces the density function - Includes new trends and technologies in quantum optics and photodetection, new results in sensing and metrology, and more coverage of quantum gates and logic, cluster states, waveguides for multimodes, discord and other quantum measures, and quantum control - Offers end of chapter summaries and problem sets as new features A Guide to Experiments in Quantum Optics, 3rd Edition is an ideal book for professionals, and graduate and upper level students in physics and engineering science. Computational Complexity Fast Gates and Mixed-Species Entanglement with Trapped Ions Quantum information theory has revolutionised our view on the true nature of information and has led to such intriguing topics as
teleportation and quantum computation. The field - by its very nature strongly interdisciplinary, with deep roots in the foundations both of quantum mechanics and of information theory and computer science - has become a major subject for scientists working in fields as diverse as quantum optics, superconductivity or information theory, all the way to computer engineering. 

Charged Particle Traps II American Mathematical Soc. This book provides a comprehensive view of the contemporary methods for quantum-light engineering. In particular, it addresses different technological branches and therefore allows the reader to quickly identify the best technology - application match. Non-classical light is a versatile tool, proven to be an intrinsic part of various quantum technologies. Its historical significance has made it the subject of many text books written both from theoretical and experimental point of view. This book takes another perspective by giving an insight to modern technologies used to generate and manipulate quantum light. 

Frank Wilczek: 50 Years Of Theoretical Physics Springer Quantum mechanics
Deterministic Entanglement Of Trapped Ion Spin Qubits

impacts on many areas of physics from pure theory to applications. However it is difficult to interpret, and philosophical contradictions and counter-intuitive results are apparent at a fundamental level. This book presents current understanding of the theory, providing a historical introduction and discussing many of its interpretations. Fully revised from the first edition, this book contains state-of-the-art research including loophole-free experimental Bell test, and theorems on the reality of the wave function including the PBR theorem, and a new section on quantum simulation. More interpretations are now included, and these are described and compared, including discussion of their successes and difficulties. Other sections have been expanded, including quantum error correction codes and the reference section. It is ideal for researchers in physics and maths, and philosophers of science interested in quantum physics and its foundations. Physics Of Quantum Information, The - Proceedings Of The 28th Solvay Conference On Physics SPIE-International Society for Optical Engineering The XV International Conference on Laser Spectroscopy
brought together spectroscopists from all over the world working in the very diverse and still growing field of laser spectroscopy. It addressed a large number of modern scientific issues at the highest level.

Contents:
- Bose-Einstein Condensation of Metastable Helium: Some Experimental Aspects (C I Westbrook et al.)
- Resonance Superfluidity in a Quantum Degenerate Fermi Gas (S Kokkelmans et al.)
- Measuring the Frequency of Light with Ultra Short Pulses (T W Hänsch et al.)
- Atomic Clocks and Cold Atom Scattering (K Gibble et al.)
- Cavity QED with Cold Atoms (H J Kimble and J McKeever)
- Advantages and Limits to Laser Cooling in Optical Lattices (D S Weiss)
- New Advances in Coherent Anti-Stokes Raman Scattering (CARS)
- Microscopy (J-X Cheng et al.)
- Speedy BEC in a Tiny Trap: Cohernet Matter Waves on a Microchip (J Reichel et al.)
- Merging Two Independent Femtosecond Lasers into One (L-S Ma et al.)
- Deterministic Delivery of a Single Atom (S Kuhr et al.) and other papers

Readership: Advanced undergraduates, graduate students, researchers and academics in atomic, laser, low-temperature, molecular and quantum physics, as well as biophysics.

Keywords:
Deterministic Entanglement Of Trapped Ion Spin Qubits

Quantum Networking
John Wiley & Sons
Advances in Atomic, Molecular, and Optical Physics publishes reviews of recent developments in a field that is in a state of rapid growth, as new experimental and theoretical techniques are used on many old and new problems. Topics covered include related applied areas, such as atmospheric science, astrophysics, surface physics and laser physics. Articles are written by distinguished experts and contain relevant review material and detailed descriptions of important recent developments. International experts Comprehensively articles New developments A Guide to Experiments in Quantum Optics Springer Nature This thesis describes significant advances in experimental capabilities using ultracold polar molecules. While ultracold polar molecules are an idyllic platform for quantum chemistry and quantum many-body physics, molecular samples prior to this work failed to be quantum degenerate, were plagued by chemical reactions, and lacked any evidence of many-body physics. These limitations were overcome by loading
molecules into an optical lattice to control and eliminate collisions and hence chemical reactions. This led to observations of many-body spin dynamics using rotational states as a pseudo-spin, and the realization of quantum magnetism with long-range interactions and strong many-body correlations. Further, a 'quantum synthesis' technique based on atomic insulators allowed the author to increase the filling fraction of the molecules in the lattice to 30%, a substantial advance which corresponds to an entropy-per-molecule entering the quantum degenerate regime and surpasses the so-called percolations threshold where long-range spin propagation is expected. Lastly, this work describes the design, construction, testing, and implementation of a novel apparatus for controlling polar molecules. It provides access to: high-resolution molecular detection and addressing; large, versatile static electric fields; and microwave-frequency electric fields for driving rotational transitions with arbitrary polarization. Further, the yield of molecules in this apparatus has been
demonstrated to exceed $10^5$, which is a substantial improvement beyond the prior apparatus, and an excellent starting condition for direct evaporative cooling to quantum degeneracy.

Bio-Inspired and Nanoscale Integrated Computing

Springer

Quantum networks build on entanglement and quantum measurement to achieve tasks that are beyond the reach of classical systems. Using quantum effects, we can detect the presence of eavesdroppers, raise the sensitivity of scientific instruments such as telescopes, or teleport quantum data from one location to another. Long-distance entanglement can be used to execute important tasks such as Byzantine agreement and leader election in fewer rounds of communication than classical systems, improving the efficiency of operations that are critical in distributed systems.

TCP 2006 Nova Publishers Advances in Atomic, Molecular, and Optical Physics publishes reviews of recent developments in a field which is in a state of rapid growth, as new experimental and theoretical techniques are used on
many old and new problems. Topics covered include related applied areas, such as atmospheric science, astrophysics, surface physics and laser physics. Articles are written by distinguished experts, and contain both relevant review material and detailed descriptions of important recent developments. International experts Comprehensively articles New developments Photonics John Wiley & Sons This second volume of the Charged Particle Traps deals with the rapidly expanding body of research exploiting the electromagnetic confinement of ions, whose principles and techniques were the subject of volume I. These applications include revolutionary advances in diverse fields, ranging from such practical fields as mass spectrometry, to the establishment of an ult-stable standard of frequency and the emergent field of quantum computing made possible by the observation of the quantum behavior of laser-cooled confined ions. Both experimental and theoretical activity in these applications has proliferated widely, and the number of diverse articles in the literature on its many facets has reached the point where it is useful to distill and
organize the published work in a unified volume that describes the current status of the field. As explained in volume I, the technique of confining charged particles in suitable electromagnetic fields was initially conceived by W. Paul as a three-dimensional version of his rf quadrupole mass filter. Its first application to rf spectroscopy on atomic ions was completed in H. G. Dehmelt’s laboratory where notable work was later done on the free electron using the Penning trap. The further exploitation of these devices has followed more or less dependently along the two initial broad areas: mass spectrometry and high resolution spectroscopy. In volume I a detailed account is given of the theory of operation and experimental techniques of the various forms of Paul and Penning ion traps.

Scalable Microchip Ion Traps for Quantum Computation CRC Press

This book highlights novel research work done on cold atom-based quantum networks. Given that one of the main challenges in building the quantum network is the limited entanglement distribution distance, this book presents some state-of-the-art experiments in tackling this challenge and,
for the first time, establishes entanglement between quantum memories via metropolitan-scale fiber transmission. This achievement is accomplished by cooperating high-efficiency cold quantum memories, low-loss quantum frequency conversion modules, and long-fiber phase-locking techniques. In the book, the scheme design, experimental setup, data analyses, and numerous technical details are given. Therefore, it suits a broad readership that includes all students, researchers, and technicians who work in quantum information sciences. Academic Press Brings the latest advances in nanotechnology and biology to computing. This pioneering book demonstrates how nanotechnology can create even faster, denser computing architectures and algorithms. Furthermore, it draws from the latest advances in biology with a focus on bio-inspired computing at the nanoscale, bringing to light several new and innovative applications such as nanoscale implantable biomedical devices and neural networks. Bio-Inspired and Nanoscale Integrated Computing features an
expert team of interdisciplinary authors who offer readers the benefit of their own breakthroughs in integrated computing as well as a thorough investigation and analyses of the literature. Carefully edited, the book begins with an introductory chapter providing a general overview of the field. It ends with a chapter setting forth the common themes that tie the chapters together as well as a forecast of emerging avenues of research. Among the important topics addressed in the book are modeling of nano devices, quantum computing, quantum dot cellular automata, dielectrophoretic reconfigurable nano architectures, multilevel and three-dimensional nanomagnetic recording, spin-wave architectures and algorithms, fault-tolerant nanocomputing, molecular computing, self-assembly of supramolecular nanostructures, DNA nanotechnology and computing, nanoscale DNA sequence matching, medical nanorobotics, heterogeneous nanostructures for biomedical diagnostics, biomimetic cortical nanocircuits, bio-applications of carbon nanotubes,
and nanoscale image processing. Readers in electrical engineering, computer science, and computational biology will gain new insights into how bio-inspired and nanoscale devices can be used to design the next generation of enhanced integrated circuits. **Metrology and Fundamental Constants**

John Wiley & Sons

Of all measurement units, frequency is the one that may be determined with the highest degree of accuracy. It equally allows precise measurement of other physical and technical quantities, whenever they can be measured in terms of frequency. This volume covers the central methods and techniques relevant for frequency standards developed in physics, electronics, and quantum electronics, and statistics. After a review of the basic principles, the book looks at the realisation of commonly used components. It then continues with the description and characterisation of important frequency standards from atomic clocks, to frequency stabilised lasers. The whole is rounded of with a discussion of topical applications in engineering, telecommunic
Deterministic Entanglement Of Trapped Ion Spin Qubits

Metrological Measurements

and, third, the flurry of new and unexpected discoveries in this field, with a correlated series of Nobel Prizes bestowed to individuals working in Fundamental Constants research and novel experimental methods. One of the most fascinating and exciting characteristics of metrology is its intimate relationship between fundamental physics and the leading edge of technology which is needed to perform advanced and challenging experiments and measurement s, as well as the determination of the values and interrelations between the Fundamental Constants. In some cases, such as the caesium fountains clocks or the optical frequency standards, the definition of the value of a quantity is, in the laboratory, in the region of 10-16 and
deterministic entanglement of trapped ion spin qubits

experiments are under way to reach 10^{-18}. Many of these results and the avenues leading to further advances are discussed in this volume, along a major step in metrology, expected in the near future, which could change the “old” definition of the kilogram, still based on a mechanical artefact, toward a new definition resting on a fixed value of a fundamental constant.

Quantum Logic in Ca+ World Scientific Frank Wilczek is one of the foremost theoretical physicists of the past half-century. He has made several fundamental contributions that shape our understanding of high energy physics, cosmology, condensed matter physics, and statistical physics. In all these fields his many discoveries continue to play a key role in shaping the direction of modern theoretical physics. Among Wilczek’s major achievements is the discovery of asymptotic freedom, which predicts and explains the ultraviolet behavior of non-abelian gauge theories. The axion, which he co-discovered and named, has emerged as the prevalent candidate for explaining the origin of dark matter in the Universe. His invention of color-flavor locking

High-Fidelity
Deterministic Entanglement Of Trapped Ion Spin Qubits

explains chiral symmetry breaking in high density quantum chromodynamics. His introduction of fractional statistics and anyons are pivotal to our understanding of the fractional quantum Hall effect and form the building blocks of topological quantum computing. His invention of the time crystal concept has catalyzed extensive investigations of dynamical phases of physical systems. Frank Wilczek received the 2004 Nobel Prize in Physics for the discovery of asymptotic freedom. He is also the recipient of several Prizes and honorary awards including the MacArthur Fellowship, the Lorentz Medal of the Royal Netherlands Academy of Arts and Sciences, the Lilienfeld Prize of the American Physical Society, the High Energy and Particle Physics Prize of the European Physical Society, and the King Faisal International Prize for Science of the King Faisal Foundation. He is a member of the National Academy of Sciences, American Academy of Arts and Sciences, and the American Philosophical Society. He is also a foreign member of the Royal Netherlands Academy of Arts and Sciences and of the Royal Academy of...
Deterministic Entanglement Of Trapped Ion Spin Qubits

Sciences in Sweden. He is currently the Herman Feshbach Professor of Physics at MIT Center for Theoretical Physics. He also holds a professorship at Stockholm University, is a Distinguished Professor at Arizona State University, and is the founding director of the Tsung-Dao Lee Institute and Chief Scientist of the Wilczek Quantum Center at Shanghai Jiao Tong University. This volume serves as a tribute to Frank Wilczek's legendary scientific contributions, commemorating his 70th birthday and the first 50 years of his career as a theoretical physicist. The contributors include several of his PhD students, close collaborators, and both past and present colleagues. This thesis shows that it is possible to accelerate the

information-processing operation of quantum computers. Two crucial performance metrics for logic gates are their precision and speed. Quantum processors based on trapped ions have always been the touchstone for gate precision, but have suffered from slow speed relative to other quantum logic platforms such as solid state systems. This thesis shows that it is possible to accelerate the

Quantum logic gates are the crucial

Fast Gates and Mixed-Species Entanglement with Trapped Ions IOS Press

Quantum logic gates are the crucial

Quantum logic gates are the crucial
logic "clock speed" from kHz to MHz speeds, whilst maintaining a precision of 99.8%. This is almost as high as the world record for conventional trapped-ion gates, but more than 20 times faster. It also demonstrates entanglement generation in a time (480ns) shorter than the natural timescale of the ions' motion in the trap, which starts to probe an interesting new regime of ion trap physics. In separate experiments, some of the first "mixed-species" quantum logic gates are performed, both between two different elements, and between different isotopes. The mixed-isotope gate is used to make the first test of the quantum-mechanical Bell inequality between two different species of isolated atoms.

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