Electricity at almost the Speed of Light

Physicists at the University of California, Irvine and elsewhere have fabricated new two-dimensional quantum materials with breakthrough electrical and magnetic attributes that could make them building blocks of future quantum computers and other advanced electronics. [16]

NIST has been granted a patent for technology that may hasten the advent of a long-awaited new generation of high-performance, low-energy computers. [15]

Researchers have shown how to create a rechargeable "spin battery" made out of materials called topological insulators, a step toward building new spintronic devices and quantum computers. [14]

Fermions are ubiquitous elementary particles. They span from electrons in metals, to protons and neutrons in nuclei and to quarks at the sub-nuclear level. Further, they possess an intrinsic degree of freedom called spin with only two possible configurations, either up or down. In a new study published in EPJ B, theoretical physicists explore the possibility of separately controlling the up and down spin populations of a group of interacting fermions. [13]

An international consortium led by researchers at the University of Basel has developed a method to precisely alter the quantum mechanical states of electrons within an array of quantum boxes. The method can be used to investigate the interactions between various types of atoms and electrons, which is essential for future quantum technologies, as the group reports in the journal Small. [12]

Quantum systems are extremely hard to analyze if they consist of more than just a few parts. It is not difficult to calculate a single hydrogen atom, but in order to describe an atom cloud of several thousand atoms, it is usually necessary to use rough approximations. The reason for this is that quantum particles are connected to each other and cannot be described separately. [11]

Quantum coherence and quantum entanglement are two landmark features of quantum physics, and now physicists have demonstrated that the two phenomena are "operationally equivalent"—that is, equivalent for all practical purposes, though still conceptually distinct. This finding allows physicists to apply decades of research on entanglement to the more fundamental but less-well-researched concept of coherence, offering the possibility of advancing a wide range of quantum technologies. [10]

The accelerating electrons explain not only the Maxwell Equations and the Special Relativity, but the Heisenberg Uncertainty Relation, the Wave-Particle

Duality and the electron's spin also, building the Bridge between the Classical and Quantum Theories.

The Planck Distribution Law of the electromagnetic oscillators explains the electron/proton mass rate and the Weak and Strong Interactions by the diffraction patterns. The Weak Interaction changes the diffraction patterns by moving the electric charge from one side to the other side of the diffraction pattern, which violates the CP and Time reversal symmetry.

The diffraction patterns and the locality of the self-maintaining electromagnetic potential explains also the Quantum Entanglement, giving it as a natural part of the relativistic quantum theory.

The asymmetric sides are creating different frequencies of electromagnetic radiations being in the same intensity level and compensating each other. One of these compensating ratios is the electron – proton mass ratio. The lower energy side has no compensating intensity level, it is the dark energy and the corresponding matter is the dark matter.

Contents

Preface 4

Physicists design 2-D materials that conduct electricity at almost the speed of light 4

NIST invents fundamental component for 'spintronic' computing 6

Rechargeable 'spin battery' promising for spintronics and quantum computing 8

Potential new applications stem from controlling particles' spin configurations 10

Controlling quantum states atom by atom 10

- Similar to a breadboard in electrical engineering 10
- Essential tool for quantum technology 11

Solving hard quantum problems: Everything is connected 11

- Quantum Correlations 11
- Only Correlations Can Explain the Experimental Data 12

Physicists find quantum coherence and quantum entanglement are two sides of the same coin 12

- Close relatives with the same roots 13
- Converting one to the other 13
- Future quantum connections 14

Quantum entanglement 14

- Quantum Biology 15

Quantum Consciousness 15
Quantum Cognition 15
Human Perception 15
Human memory 16
Knowledge representation 16
Quantum Information 16
Quantum Teleportation 17
Quantum Computing 17
The Bridge 18
Accelerating charges 18
Relativistic effect 18
Heisenberg Uncertainty Relation 18
Wave – Particle Duality 19
Atomic model 19
The Relativistic Bridge 19
The weak interaction 19
The General Weak Interaction 20
Fermions and Bosons 21
Van Der Waals force 21
Electromagnetic inertia and mass 21
Electromagnetic Induction 21
Relativistic change of mass 21
The frequency dependence of mass 21
Electron – Proton mass rate 22
Gravity from the point of view of quantum physics 22
The Gravitational force 22
The Higgs boson 23
Higgs mechanism and Quantum Gravity 23
What is the Spin? 24
The Graviton 24
Dark Matter and Energy 24
Cosmic microwave background 24
Thermal radiation 24
Conclusions 25

References 26

Author: George Rajna

Preface

Physicists are continually looking for ways to unify the theory of relativity, which describes large-scale phenomena, with quantum theory, which describes small-scale phenomena. In a new proposed experiment in this area, two toaster-sized "nanosatellites" carrying entangled condensates orbit around the Earth, until one of them moves to a different orbit with different gravitational field strength. As a result of the change in gravity, the entanglement between the condensates is predicted to degrade by up to 20%. Experimentally testing the proposal may be possible in the near future. [5]

Quantum entanglement is a physical phenomenon that occurs when pairs or groups of particles are generated or interact in ways such that the quantum state of each particle cannot be described independently – instead, a quantum state may be given for the system as a whole. [4]

I think that we have a simple bridge between the classical and quantum mechanics by understanding the Heisenberg Uncertainty Relations. It makes clear that the particles are not point like but have a dx and dp uncertainty.

Physicists design 2-D materials that conduct electricity at almost the speed of light

Physicists at the University of California, Irvine and elsewhere have fabricated new two-dimensional quantum materials with breakthrough electrical and magnetic attributes that could make them building blocks of future quantum computers and other advanced electronics.

In three separate studies appearing this month in Nature, Science Advances and Nature Materials, UCI researchers and colleagues from UC Berkeley, Lawrence Berkeley National Laboratory, Princeton University, Fudan University and the University of Maryland explored the physics behind the 2-D states of novel materials and determined they could push computers to new heights of speed and power.

The common threads running through the papers are that the research is conducted at extremely cold temperatures and that the signal carriers in all three studies are not electrons - as with traditional silicon-based technologies - but Dirac or Majorana fermions, particles without mass that move at nearly the speed of light.

"Finally, we can take exotic, high-end theories in physics and make something useful," said UCI associate professor of physics & astronomy Jing Xia, a corresponding author on two of the studies. "We're exploring the possibility of making topological quantum computers [currently theoretical] for the next 100 years."

One of the key challenges of such research is handling and analyzing miniscule material samples, just two atoms thick, several microns long and a few microns across. Xia's lab at UCI is equipped with a fiber-optic Sagnac interferometer microscope that he built. (The only other one in existence is at Stanford University, assembled by Xia when he was a graduate student there.) Calling it the most sensitive magnetic microscope in the world, Xia compares it to a telescope that an ornithologist in Irvine could use to inspect the eye of a bird in New York.

"This machine is the ideal measurement tool for these discoveries," said UCI graduate student Alex Stern, lead author on two of the papers. "It's the most accurate way to optically measure magnetism in a material."

In a study to be published April 24 in Nature, the researchers detail their observation - via the Sagnac interferometer - of magnetism in a microscopic flake of chromium germanium telluride. The compound, which they created, was viewed at minus 387 degrees Fahrenheit. CGT is a cousin of graphene, a superthin atomic carbon film. Since its discovery, graphene has been considered a potential replacement for silicon in next-generation computers and other devices because of the speed at which electronic signals skitter across its almost perfectly flat surface.

But there's a catch: Certain computer components, such as memory and storage systems, need to be made of materials that have both electronic and magnetic properties. Graphene has the former but not the latter. CGT has both.

His lab also used the Sagnac interferometer for a study published in Science Advances examining what happens at the precise moment bismuth and nickel are brought into contact with one another - again at a very low temperature (in this case, minus 452 degrees Fahrenheit). Xia said his team found at the interface between the two metals "an exotic superconductor that breaks time-reversal symmetry."

"Imagine you turn back the clock and a cup of red tea turns green. Wouldn't that make this tea very exotic? This is indeed exotic for superconductors," he said. "And it's the first time it's been observed in 2-D materials."

The signal carriers in this 2-D superconductor are Majorana fermions, which could be used for a braiding operation that theorists believe is vital to quantum computing.

"The issue now is to try to achieve this at normal temperatures," Xia said. The third study shows promise in overcoming that hurdle.

In 2012, Xia's lab delivered to the Defense Advanced Research Projects Agency a radio-frequency oscillator built around samarium hexaboride. The substance is an insulator on the inside but allows signal-carrying current made of Dirac fermions to flow freely on its 2-D surface.

Using a special apparatus built in the Xia lab - also one of only two in the world - UCI researchers applied tensile strain to the samarium hexaboride sample and demonstrated in the Nature Materials study that they could stabilize the 2-D surface state at minus 27 degrees Fahrenheit.

"Believe it or not, that's hotter than some parts of Canada," Xia quipped. "This work is a big step toward developing future quantum computers at nearly room temperature." [16]

NIST invents fundamental component for 'spintronic' computing

NIST has been granted a patent for technology that may hasten the advent of a long-awaited new generation of high-performance, low-energy computers.

Conventional microelectronic devices, for the most part, work by manipulating and storing electrical charges in semiconductor transistors and capacitors. Doing so requires a lot of energy and generates a lot of heat, especially as process engineers keep finding ways to pack more and smaller features into integrated circuits. Power consumption has become one of the principal obstacles to much higher performance.

One highly promising alternative approach, called "spintronics," utilizes the quantum spin of the electron to hold information in addition to the charge. The two different spin orientations (typically designated "up" and "down") are analogous to positive and negative electrical charges in conventional electronics. Because changing an electron's spin requires very little energy and can happen very fast, spintronics offers the possibility of significant energy reduction.

"Our invention," says co-inventor Curt Richter of NIST's Engineering Physics Division, "is designed to provide one key component in spintronic systems. It's a very simple, fundamental building block that can be used in a variety of different ways. It can serve as an on-off switch for spin currents, as an interconnect between different spintronic components, and as an interface between magnetic and electronic features to realize multifunctional devices."

Spin is what makes magnetic things magnetic: Every electron behaves somewhat like a bar magnet, with two opposite poles. Materials in which most of the electron spins are aligned in the same direction (polarized) produce a magnetic field with the same orientation. Electrons with the same spin alignment as the material pass easily through it; electrons with the opposite alignment are blocked.

This property has been exploited to make microscopic "spin valves"—typically a channel with a magnetic layer at each end. The relative polarity of the two magnets turns the valve on or off: If both magnets have the same alignment, the spin-polarized current passes through the channel. If the magnets have opposite alignments, current cannot flow.

The device is "switched" by reversing one magnet's polarity, which is done by applying a sufficient current of electrons with the opposite spin. However, flipping the magnet's polarity takes more energy than researchers would prefer.

"Typically with spin valves," Richter says. "You have to flow a significant amount of spin current to flip the component. Larger currents mean you're using more energy and generating more heat. Our invention dramatically reduces both."

At first, the researchers had no intention of making a device or obtaining a patent. They weren't even working directly on spin transport. They were studying the behavior of a different class of devices commonly referred to as "memristors" (memory resistors), a technology that is barely a decade old but is widely heralded as a potential high-speed, low-energy basic element for future computers.

Memristors are layered microstructure sandwiches with an electrode at the top and bottom, between which are a layer of metal (for example copper) which is a good electrical conductor and a layer of material (such as certain oxides) which is a poor conductor. This configuration is also the most common structure used in a new type of memory called resistive random-access memory (RRAM or ReRAM). When a voltage is applied to the electrodes in one direction, current can flow. Reversing the voltage shuts down the current.

Scientists believe that the reason for this phenomenon is that when a bias voltage is applied in one direction, it causes atoms of the metal conductor to diffuse into and interact with the oxide, forming tiny metal filaments that act as low-resistance channels penetrating through the insulating layer. If the voltage is applied in the opposite direction, the oxide layer is depleted of metal atoms, and resistance increases.

Either way, when the bias voltage is removed, the oxide's resistance state is frozen. Because that state was formed by a specific bias applied in a specific direction, the device "remembers" its last resistance. That characteristic makes memristors attractive for use in "non-volatile" computer memory in which the stored information does not disappear when the power is turned off.

"So when we got started, there were spin valves and there were memristors," Richter says. "But nobody had thought to put them together. Being measurement guys at NIST, we didn't originally think about putting them together to invent a new device. We put them together so that we could make measurements to better understand how memristors work.

"We wanted to investigate how this voltage switch turns on and off. We thought that if we added spin to the analysis, we could get more insights into how a normal memristor works. In the process of doing that, we made this device and said 'Hey, this thing by itself has very interesting technological ramifications.' It combines the non-volatile memory in memristors with the technology of a spin valve to create a device that allows you to turn on and off a spin channel."

"What makes it unique is that you can open or close a spin channel using an electric control," says co-inventor Hyuk-Jae Jang. "And so with a small amount of voltage, we can turn spin current on and off in sub-nanosecond time without having to flip the polarity of a spin valve's ferromagnetic electrode. This high speed and low power consumption operation is essential for building future spintronics-based logic technology to replace the current CMOS-based electronics technology used to fabricate nearly all integrated circuits today."

The NIST patent covers devices made with a variety of materials. The primary combination used in the inventors' experiments was, from the bottom up, a magnetic base layer made of cobalt that serves to spin-polarize the electrons, an insulating layer made of tantalum oxide, a layer of copper, and an alloy top electrode.

In the "on" configuration, the copper atoms are drawn into the oxide and their filaments extend all the way to the base cobalt layer. Reversing the voltage causes the copper to recede, and "there's an empty region in the oxide layer," Richter says. "As soon as that happens, the current stops. It could be only a few atoms' worth away, because of the exponential drop-off with distance. That makes it a very low-energy switch."

John Kramar, Acting Chief of NIST's Engineering Physics Division, calls the work "a very exciting invention that provides a great solution for the switching-energy problem for spin valves. It removes a significant technological barrier for spintronics to become a strong contender for beyond-CMOS microelectronics." [15]

Rechargeable 'spin battery' promising for spintronics and quantum computing

Researchers have shown how to create a rechargeable "spin battery" made out of materials called topological insulators, a step toward building new spintronic devices and quantum computers.

Unlike ordinary materials that are either insulators or conductors, topological insulators are both at the same time - they are insulators inside but conduct electricity on the surface. The materials might be used for spintronic devices and quantum computers more powerful than today's technologies.

Electrons can be thought of as having two spin states: up or down, and a phenomenon known as superposition allows electrons to be in both states at the same time. Such a property could be harnessed to perform calculations using the laws of quantum mechanics, making for computers much faster than conventional computers at certain tasks.

The conducting electrons on the surface of topological insulators have a key property known as "spin momentum locking," in which the direction of the motion of electrons determines the direction of its spin. This spin could be used to encode or carry information by using the down or up directions to represent 0 or 1 for spin-based information processing and computing, or spintronics.

"Because of the spin-momentum locking, you can make the spin of electrons line up or 'locked' in one direction if you pass a current through the topological insulator material, and this is a very interesting effect," said Yong P. Chen, a Purdue University professor of physics and astronomy and electrical and computer engineering and director of the Purdue Quantum Center.

Applying an electric current to the material induces an electron "spin polarization" that might be used for spintronics. Ordinarily, the current must remain turned on to maintain this polarization. However, in new findings, Purdue researchers are the first to induce a long-lived electron spin polarization lasting two days even when the current is turned off. The electron spin polarization is detected by a magnetic voltage probe, which acts as a spin-sensitive voltmeter in a technique known as "spin potentiometry".

The new findings are detailed in a research paper appearing on April 14 in the journal Science Advances. The experiment was led by postdoctoral research associate Jifa Tian.

"Such an electrically controlled persistent spin polarization with unprecedented long lifetime could enable a rechargeable spin battery and rewritable spin memory for potential applications in spintronics and quantum information systems," Tian said.

This "writing current" could be likened to recording the ones and zeroes in a computer's memory.

"However, a better analog is that of a battery," Chen said. "The writing current is like a charging current. It's slow, just like charging your iPhone for an hour or two, and then it can output power for several days. That's the similar idea. We charge up this spin battery using this writing current in half an hour or one hour and then the spins stay polarized for two days, like a rechargeable battery."

The finding was a surprise.

"This was not predicted nor something we were looking for when we started the experiment," he said. "It was an accidental discovery, thanks to Jifa's patience and persistence, running and repeating the measurements many times, and effectively charging up the spin battery to output a measurable persistent spin polarization signal."

The researchers are unsure what causes the effect. However, one theory is that the spin- polarized electrons might be transferring their polarization to the atomic nuclei in the material. This hypothesis as a possible explanation to the experiment was proposed by Supriyo Datta, Purdue's Thomas Duncan Distinguished Professor of Electrical and Computer Engineering and the leader of the recently launched Purdue "spintronics preeminent team initiative."

"In one meeting, Professor Datta made the critical suggestion that the persistent spin signal Jifa observed looked like a battery," Chen said. "There were some analogous experiments done earlier on a nuclear spin powered battery, although they typically required much more challenging conditions such as high magnetic fields. Our observation so far is consistent with the effect also arising from the nuclear spins, even though we don't have direct evidence."

Nuclear spin has implications for development of quantum memory and quantum computing.

"And now we have an electrical way to achieve this, meaning it is potentially useful for quantum circuits because you can just pass current and you polarize nuclear spin," Chen said. "Traditionally that has been very difficult to achieve. Our spin battery based on topological insulators works even at zero magnetic field, and moderately low temperatures such as tens of kelvins, which is very unusual."

Seokmin Hong, a former Purdue doctoral student working with Datta who is now a software engineer at Intel Corp., said, "While an ordinary charged battery outputs a voltage that can be used to drive a charge current, a 'spin battery' outputs a 'spin voltage,' or more precisely a chemical potential difference between the spin up and spin down electrons, that can be used to drive a non-equilibrium spin current."

The researchers used small flakes of a material called bismuth tellurium selenide. It is in the same class of materials as bismuth telluride, which is behind solid-state cooling technologies such as commercial thermoelectric refrigerators. However, unlike the commercial grade material that is a "doped" bulk semiconductor, the material used in the experiment was carefully produced to have ultra-high-purity and little doping in the bulk so the conduction is dominated by the spin-polarized electrons on the surface. It was synthesized by research scientist Ireneusz Miotkowski in the semiconductor bulk crystal lab managed by Chen in Purdue's Department of Physics and Astronomy. The devices were fabricated by Tian in the Birck Nanotechnology Center in Purdue's Discovery Park.

The paper was authored by Tian; Hong; and Miotkowski, Datta, and Chen.

Future research will include work to probe what causes the effect by directly probing the nuclear spin, and also to explore how this spin battery can be used in potential practical applications. [14]

Potential new applications stem from controlling particles' spin configurations

Fermions are ubiquitous elementary particles. They span from electrons in metals, to protons and neutrons in nuclei and to quarks at the sub-nuclear level. Further, they possess an intrinsic degree of freedom called spin with only two possible configurations, either up or down. In a new study published in EPJ B, theoretical physicists explore the possibility of separately controlling the up and down spin populations of a group of interacting fermions. Their detailed theory describing the spin population imbalance could be relevant, for instance, to the field of spintronics, which exploits polarised spin populations.

Imbalanced Fermi particle mixtures occur in matter like, for example, semiconductors placed in a magnetic field, in nuclear matter, and in the plasma of neutron stars, which combines the elementary sub-particles quarks and gluons. Pierbiagio Pieri and Giancarlo Calvanese Strinati from the University of Camerino, Italy, focused on an interacting fermion system where the up and down spin populations are imbalanced. They extended the proof of a theorem that was originally conceived for the exact theory of a Fermi liquid with equal populations of up and down spin, called the Luttinger theorem, to these imbalanced systems.

Previous experimental observations involved separately controlling the number of fermions with a given spin, leading to free movement with no viscosity in the gas particles, reaching a superfluid state. The work by Wolfgang Ketterle and his group at MIT, USA, in 2008, also demonstrated that the difference between two spin populations can be made so large that superfluidity is destroyed and the system remains normal even at zero temperature.

In turn, this latest theoretical work introduces a constraint that is key to numerical calculations for such large quantum many-body systems, namely that the radii of the two Fermi spheres, which characterise the non-interacting systems of spin-up and spin-down fermions, are separately preserved when the interaction between the spin-up and spin-down fermions is initiated. [13]

Controlling quantum states atom by atom

Applications of quantum mechanics are often compromised by the fundamental property of quanta: any measurement inevitably modifies the measured state. Technologies such as quantum computers can be designed only on the basis of known, clearly defined and simple interactions between individual components. The Department of Physics at the University of Basel together with the Swiss Nanoscience Institute has now developed a method that can be used to study these kinds of interactions in a well-defined system.

Similar to a breadboard in electrical engineering

Breadboards are used in electronic measurement technology to design and test prototypes of electronic circuits and for teaching purposes. The procedure developed by the international consortium led by Prof. Thomas Jung of the University of Basel works in a similar way: for the first time, the new method allows researchers to configure a network of quantum boxes in order to form various quantum electronic states. A quantum box is an artificially produced structure that restricts a particle's movements, so that it can move in only two dimensions. This reduces the complexity of a particle interaction and simplifies the process of measurement and analysis.

The research team refined an established method in which atoms are repositioned one after the other using scanning tunneling microscopy, allowing the creation of clearly defined quantum systems. Through the targeted relocating of xenon atoms in quantum boxes, the team succeeded in generating different patterns that correspond to a wide range of quantum states.

Essential tool for quantum technology

The development of quantum technology relies on a detailed understanding of the interdependence between different electronic states; for example, in various atoms. With the physicists' method, quantum states can be accurately reproduced and interactions between various chemical elements and well-defined electronic states examined - an "unlimited playing field for the study of quantum states", as the researchers write in Small.

A range of institutions contributed to the project's success: the theory was outlined by researchers from Linköping (Sweden), the molecules used were synthesized in Heidelberg (Germany), and scientists from San Sebastián (Spain) were responsible for some of the complex measurements of the specific quantum states. [12]

Solving hard quantum problems: Everything is connected

Quantum systems are extremely hard to analyse if they consist of more than just a few parts. It is not difficult to calculate a single hydrogen atom, but in order to describe an atom cloud of several thousand atoms, it is usually necessary to use rough approximations. The reason for this is that quantum particles are connected to each other and cannot be described separately. Kaspar Sakmann (TU Wien, Vienna) and Mark Kasevich (Stanford, USA) have now shown in an article published in Nature Physics ("Single-shot simulations of dynamic quantum many-body systems") that this problem can be overcome. They succeeded in calculating effects in ultra-cold atom clouds which can only be explained in terms of the quantum correlations between many atoms. Such atom clouds are known as Bose-Einstein condensates and are an active field of research.

Quantum Correlations

Quantum physics is a game of luck and randomness. Initially, the atoms in a cold atom cloud do not have a predetermined position. Much like a die whirling through the air, where the number is yet to be determined, the atoms are located at all possible positions at the same time. Only when they are measured, their positions are fixed. "We shine light on the atom cloud, which is then absorbed by the atoms", says Kaspar Sakmann. "The atoms are photographed, and this is what determines their position. The result is completely random."

There is, however, an important difference between quantum randomness and a game of dice: if different dice are thrown at the same time, they can be seen as independent from each other. Whether or not we roll a six with die number one does not influence the result of die number seven. The atoms in the atom cloud on the other hand are quantum physically connected. It does not make sense to analyse them individually, they are one big quantum object. Therefore, the result of every position measurement of any atom depends on the positions of all the other atoms in a mathematically complicated way.

"It is not hard to determine the probability that a particle will be found at a specific position", says Kaspar Sakmann. "The probability is highest in the centre of the cloud and gradually diminishes towards the outer fringes." In a classically random system, this would be all the information that is needed. If we know that in a dice roll, any number has the probability of one sixth, then we can also determine the probability of rolling three ones with three dice. Even if we roll five ones consecutively, the probability remains the same the next time. With quantum particles, it is more complicated than that.

"We solve this problem step by step", says Sakmann. "First we calculate the probability of the first particle being measured on a certain position. The probability distribution of the second particle depends on where the first particle has been found. The position of the third particle depends on the first two, and so on." In order to be able to describe the position of the very last particle, all the other positions have to be known. This kind of quantum entanglement makes the problem mathematically extremely challenging.

Only Correlations Can Explain the Experimental Data

But these correlations between many particles are extremely important - for example for calculating the behaviour of colliding Bose-Einstein-condensates. "The experiment shows that such collisions can lead to a special kind of quantum waves. On certain positions we find many particles, on an adjacent position we do not find any", says Kaspar Sakmann. "If we consider the atoms separately, this cannot be explained. Only if we take the full quantum distribution into account, with all its higher correlations, these waves can be reproduced by our calculations."

Also other phenomena have been calculated with the same method, for instance Bose-Einstein-condensates which are stirred with a laser beam, so that little vortices emerge - another typical quantum many-particle-effect. "Our results show how important theses correlations are and that it is possible to include them in quantum calculations, in spite of all mathematical difficulties", says Sakmann. With certain modifications, the approach can be expected to be useful for many other quantum systems as well. [11]

Physicists find quantum coherence and quantum entanglement are two sides of the same coin

Quantum coherence and quantum entanglement are two landmark features of quantum physics, and now physicists have demonstrated that the two phenomena are "operationally equivalent"—that is, equivalent for all practical purposes, though still conceptually distinct. This finding allows physicists to apply decades of research on entanglement to the more fundamental but less-well-researched concept of coherence, offering the possibility of advancing a wide range of quantum technologies.

Close relatives with the same roots

Although physicists have known that coherence and entanglement are close relatives, the exact relationship between the two resources has not been clear.

It's well-known that quantum coherence and quantum entanglement are both rooted in the superposition principle—the phenomenon in which a single quantum state simultaneously consists of multiple states—but in different ways. Quantum coherence deals with the idea that all objects have wave-like properties. If an object's wave-like nature is split in two, then the two waves may coherently interfere with each other in such a way as to form a single state that is a superposition of the two states. This concept of superposition is famously represented by Schrödinger's cat, which is both dead and alive at the same time when in its coherent state inside a closed box. Coherence also lies at the heart of quantum computing, in which a qubit is in a superposition of the "0" and "1" states, resulting in a speed-up over various classical algorithms. When such a state experiences decoherence, however, all of its quantumness is typically lost and the advantage vanishes.

The second phenomenon, quantum entanglement, also involves superposition. But in this case, the states in a superposition are the shared states of two entangled particles rather than those of the two split waves of a single particle. The intrigue of entanglement lies in the fact that the two entangled particles are so intimately correlated that a measurement on one particle instantly affects the other particle, even when separated by a large distance. Like coherence, quantum entanglement also plays an essential role in quantum technologies, such as quantum teleportation, quantum cryptography, and super dense coding.

Converting one to the other

In a paper to be published in Physical Review Letters, physicists led by Gerardo Adesso, Associate Professor at the University of Nottingham in the UK, with coauthors from Spain and India, have provided a simple yet powerful answer to the question of how these two resources are related: the scientists show that coherence and entanglement are quantitatively, or operationally, equivalent, based on their behavior arising from their respective resource theories.

The physicists arrived at this result by showing that, in general, any nonzero amount of coherence in a system can be converted into an equal amount of entanglement between that system and another initially incoherent one. This discovery of the conversion between coherence and entanglement has several important implications. For one, it means that quantum coherence can be measured through entanglement. Consequently, all of the comprehensive knowledge that researchers have obtained about entanglement can now be directly applied to coherence, which in general is not nearly as well-researched (outside of the area of quantum optics). For example, the new knowledge has already allowed the physicists to settle an important open question concerning the geometric measure of coherence: since the geometric measure of entanglement is a "full convex monotone," the same can be said of the associated coherence measure. As the scientists explained, this is possible because the new results allowed them to define and quantify one resource in terms of the other.

"The significance of our work lies in the fact that we prove the close relation between entanglement and coherence not only qualitatively, but on a quantitative level," coauthor Alex Streltsov, of ICFO-The Institute of Photonic Sciences in Barcelona, told Phys.org. "More precisely, we show that any quantifier of entanglement gives rise to a quantifier of coherence. This concept allowed us to prove that the geometric measure of coherence is a valid coherence quantifier, thus answering a question left open in several previous works."

While the results show that coherence and entanglement are operationally equivalent, the physicists explain that this doesn't mean that are the exact same thing, as they are still conceptually different ideas.

"Despite having the same roots of origin, namely quantum superposition, coherence and entanglement are conceptually different," said coauthors Uttam Singh, Himadri Dhar, and Manabendra Bera at the Harish-Chandra Research Institute in Allahabad, India. "For example, coherence can be present in single quantum systems, where entanglement is not well-defined. Also, coherence is defined with respect to a given basis, while entanglement is invariant under local basis changes. In all, we believe coherence and entanglement are operationally equivalent but conceptually different."

Future quantum connections

The operational equivalence of coherence and entanglement will likely have a far-reaching impact on areas ranging from quantum information theory to more nascent fields such as quantum biology and nanoscale thermodynamics. In the future, the physicists plan to investigate whether coherence and entanglement might also be interconverted into a third resource—that of quantum discord, which, like entanglement, is another type of quantum correlation between two systems.

"Our future plans are diverse," Adesso said. "On the theoretical side, we are working to construct a unified framework to interpret, classify and quantify all different forms of quantum resources, including and beyond entanglement and coherence, and highlight the interlinks among them from an operational perspective. This will allow us to navigate the hierarchy of quantumness indicators in composite systems with a common pilot, and to appreciate which particular ingredients are needed in various informational tasks.

"On the practical side, we are investigating experimentally friendly schemes to detect, quantify, and preserve coherence, entanglement and other quantum correlations in noisy environments. More fundamentally, we hope these results will inspire us to devise scalable and efficient methods to convert between different quantum resources for technological applications, and bring us closer to understanding where the boundaries of the quantum world ultimately lie in realistic scenarios." [10]

Quantum entanglement

Measurements of physical properties such as position, momentum, spin, polarization, etc. performed on entangled particles are found to be appropriately correlated. For example, if a pair of particles is generated in such a way that their total spin is known to be zero, and one particle is found to have clockwise spin on a certain axis, then the spin of the other particle, measured on the same axis, will be found to be counterclockwise. Because of the nature of quantum measurement, however, this behavior gives rise to effects that can appear paradoxical: any measurement of a property of a particle can be seen as acting on that particle (e.g. by collapsing a number of superimposed states); and in the case of entangled particles, such action must be on the entangled system as a whole. It thus appears that one particle of an entangled pair "knows" what measurement has been performed on the other, and with what outcome, even though there is no known means for such information to be communicated between the particles, which at the time of measurement may be separated by arbitrarily large distances. [4]

Quantum Biology

The human body is a constant flux of thousands of chemical/biological interactions and processes connecting molecules, cells, organs, and fluids, throughout the brain, body, and nervous system. Up until recently it was thought that all these interactions operated in a linear sequence, passing on information much like a runner passing the baton to the next runner. However, the latest findings in quantum biology and biophysics have discovered that there is in fact a tremendous degree of coherence within all living systems.

Quantum Consciousness

Extensive scientific investigation has found that a form of quantum coherence operates within living biological systems through what is known as biological excitations and biophoton emission. What this means is that metabolic energy is stored as a form of electromechanical and electromagnetic excitations. These coherent excitations are considered responsible for generating and maintaining long-range order via the transformation of energy and very weak electromagnetic signals. After nearly twenty years of experimental research, Fritz-Albert Popp put forward the hypothesis that biophotons are emitted from a coherent electrodynamics field within the living system.

What this means is that each living cell is giving off, or resonating, a biophoton field of coherent energy. If each cell is emitting this field, then the whole living system is, in effect, a resonating field-a ubiquitous nonlocal field. And since biophotons are the entities through which the living system communicates, there is near-instantaneous intercommunication throughout. And this, claims Popp, is the basis for coherent biological organization -- referred to as quantum coherence. This discovery led Popp to state that the capacity for evolution rests not on aggressive struggle and rivalry but on the capacity for communication and cooperation. In this sense the built-in capacity for species evolution is not based on the individual but rather living systems that are interlinked within a coherent whole: Living systems are thus neither the subjects alone, nor objects isolated, but both subjects and objects in a mutually communicating universe of meaning. . . . Just as the cells in an organism take on different tasks for the whole, different populations enfold information not only for themselves, but for all other organisms, expanding the consciousness of the whole, while at the same time becoming more and more aware of this collective consciousness.

Quantum Cognition

Human Perception

A Bi-stable perceptual phenomenon is a fascinating topic in the area of perception. If a stimulus has an ambiguous interpretation, such as a Necker cube, the interpretation tends to oscillate across time. Quantum models have been developed to predict the time period between oscillations and how these periods change with frequency of measurement. Quantum theory has also been used for modeling Gestalt perception, to account for interference effects obtained with measurements of ambiguous figures. [6]

Human memory

The hypothesis that there may be something quantum-like about the human mental function was put forward with “Spooky Activation at Distance” formula which attempted to model the effect that when a word’s associative network is activated during study in memory experiment, it behaves like a quantum-entangled system. Models of cognitive agents and memory based on quantum collectives have been proposed by Subhash Kak. But he also points to specific problems of limits on observation and control of these memories due to fundamental logical reasons. [6]

Knowledge representation

Concepts are basic cognitive phenomena, which provide the content for inference, explanation, and language understanding. Cognitive psychology has researched different approaches for understanding concepts including exemplars, prototypes, and neural networks, and different fundamental problems have been identified, such as the experimentally tested non classical behavior for the conjunction and disjunction of concepts, more specifically the Pet-Fish problem or guppy effect, and the overextension and under extension of typicality and membership weight for conjunction and disjunction. By and large, quantum cognition has drawn on quantum theory in three ways to model concepts.

Exploit the contextuality of quantum theory to account for the contextuality of concepts in cognition and language and the phenomenon of emergent properties when concepts combine.

Use quantum entanglement to model the semantics of concept combinations in a non-decompositional way, and to account for the emergent properties/associates/inferences in relation to concept combinations.

Use quantum superposition to account for the emergence of a new concept when concepts are combined, and as a consequence put forward an explanatory model for the Pet-Fish problem situation, and the overextension and under extension of membership weights for the conjunction and disjunction of concepts. The large amount of data collected by Hampton on the combination of two concepts can be modeled in a specific quantum-theoretic framework in Fock space where the observed deviations from classical set (fuzzy set) theory, the above mentioned over- and under-extension of membership weights, are explained in terms of contextual interactions, superposition, interference, entanglement and emergence. And, more, a cognitive test on a specific concept combination has been performed which directly reveals, through the violation of Bell’s inequalities, quantum entanglement between the component concepts. [6]

Quantum Information

In quantum mechanics, quantum information is physical information that is held in the "state" of a quantum system. The most popular unit of quantum information is the qubit, a two-level quantum system. However, unlike classical digital states (which are discrete), a two-state quantum system can actually be in a superposition of the two states at any given time.

Quantum information differs from classical information in several respects, among which we note the following:

However, despite this, the amount of information that can be retrieved in a single qubit is equal to one bit. It is in the processing of information (quantum computation) that a difference occurs.

The ability to manipulate quantum information enables us to perform tasks that would be unachievable in a classical context, such as unconditionally secure transmission of information. Quantum information processing is the most general field that is concerned with quantum information. There are certain tasks which classical computers cannot perform "efficiently" (that is, in polynomial time) according to any known algorithm. However, a quantum computer can compute the answer to some of these problems in polynomial time; one well-known example of this is Shor's factoring algorithm. Other algorithms can speed up a task less dramatically - for example, Grover's search algorithm which gives a quadratic speed-up over the best possible classical algorithm.

Quantum information, and changes in quantum information, can be quantitatively measured by using an analogue of Shannon entropy. Given a statistical ensemble of quantum mechanical systems with the density matrix S, it is given by.

Many of the same entropy measures in classical information theory can also be generalized to the quantum case, such as the conditional quantum entropy. [7]

Quantum Teleportation

Quantum teleportation is a process by which quantum information (e.g. the exact state of an atom or photon) can be transmitted (exactly, in principle) from one location to another, with the help of classical communication and previously shared quantum entanglement between the sending and receiving location. Because it depends on classical communication, which can proceed no faster than the speed of light, it cannot be used for superluminal transport or communication of classical bits. It also cannot be used to make copies of a system, as this violates the no-cloning theorem. Although the name is inspired by the teleportation commonly used in fiction, current technology provides no possibility of anything resembling the fictional form of teleportation. While it is possible to teleport one or more qubits of information between two (entangled) atoms, this has not yet been achieved between molecules or anything larger. One may think of teleportation either as a kind of transportation, or as a kind of communication; it provides a way of transporting a qubit from one location to another, without having to move a physical particle along with it.

The seminal paper first expounding the idea was published by C. H. Bennett, G. Brassard, C. Crépeau, R. Jozsa, A. Peres and W. K. Wootters in 1993. Since then, quantum teleportation has been realized in various physical systems. Presently, the record distance for quantum teleportation is 143 km (89 mi) with photons, and 21 m with material systems. In August 2013, the achievement of "fully deterministic" quantum teleportation, using a hybrid technique, was reported. On 29 May 2014, scientists announced a reliable way of transferring data by quantum teleportation. Quantum teleportation of data had been done before but with highly unreliable methods. [8]

Quantum Computing

A team of electrical engineers at UNSW Australia has observed the unique quantum behavior of a pair of spins in silicon and designed a new method to use them for "2-bit" quantum logic operations.

These milestones bring researchers a step closer to building a quantum computer, which promises dramatic data processing improvements.

Quantum bits, or qubits, are the building blocks of quantum computers. While many ways to create a qubits exist, the Australian team has focused on the use of single atoms of phosphorus, embedded inside a silicon chip similar to those used in normal computers.

The first author on the experimental work, PhD student Juan Pablo Dehollain, recalls the first time he realized what he was looking at.

"We clearly saw these two distinct quantum states, but they behaved very differently from what we were used to with a single atom. We had a real 'Eureka!' moment when we realized what was happening – we were seeing in real time the `entangled' quantum states of a pair of atoms." [9]

The Bridge

The accelerating electrons explain not only the Maxwell Equations and the Special Relativity, but the Heisenberg Uncertainty Relation, the wave particle duality and the electron's spin also, building the bridge between the Classical and Quantum Theories. [1]

Accelerating charges

The moving charges are self maintain the electromagnetic field locally, causing their movement and this is the result of their acceleration under the force of this field. In the classical physics the charges will distributed along the electric current so that the electric potential lowering along the current, by linearly increasing the way they take every next time period because this accelerated motion.
The same thing happens on the atomic scale giving a dp impulse difference and a dx way difference between the different part of the not point like particles.

Relativistic effect

Another bridge between the classical and quantum mechanics in the realm of relativity is that the charge distribution is lowering in the reference frame of the accelerating charges linearly: ds/dt = at (time coordinate), but in the reference frame of the current it is parabolic: $s = a/2\ t^2$ (geometric coordinate).

Heisenberg Uncertainty Relation

In the atomic scale the Heisenberg uncertainty relation gives the same result, since the moving electron in the atom accelerating in the electric field of the proton, causing a charge distribution on delta x position difference and with a delta p momentum difference such a way that they product is about the half Planck reduced constant. For the proton this delta x much less in the nucleon, than in the orbit of the electron in the atom, the delta p is much higher because of the greater proton mass.

This means that the electron and proton are not point like particles, but has a real charge distribution.

Wave – Particle Duality

The accelerating electrons explains the wave – particle duality of the electrons and photons, since the elementary charges are distributed on delta x position with delta p impulse and creating a wave packet of the electron. The photon gives the electromagnetic particle of the mediating force of the electrons electromagnetic field with the same distribution of wavelengths.

Atomic model

The constantly accelerating electron in the Hydrogen atom is moving on the equipotential line of the proton and it's kinetic and potential energy will be constant. Its energy will change only when it is changing its way to another equipotential line with another value of potential energy or getting free with enough kinetic energy. This means that the Rutherford-Bohr atomic model is right and only that changing acceleration of the electric charge causes radiation, not the steady acceleration. The steady acceleration of the charges only creates a centric parabolic steady electric field around the charge, the magnetic field. This gives the magnetic moment of the atoms, summing up the proton and electron magnetic moments caused by their circular motions and spins.

The Relativistic Bridge

Commonly accepted idea that the relativistic effect on the particle physics it is the fermions' spin - another unresolved problem in the classical concepts. If the electric charges can move only with accelerated motions in the self maintaining electromagnetic field, once upon a time they would reach the velocity of the electromagnetic field. The resolution of this problem is the spinning particle, constantly accelerating and not reaching the velocity of light because the acceleration is radial. One origin of the Quantum Physics is the Planck Distribution Law of the electromagnetic oscillators, giving equal intensity for 2 different wavelengths on any temperature. Any of these two wavelengths will give equal intensity diffraction patterns, building different asymmetric constructions, for example proton - electron structures (atoms), molecules, etc. Since the particles are centers of diffraction patterns they also have particle – wave duality as the electromagnetic waves have. [2]

The weak interaction

The weak interaction transforms an electric charge in the diffraction pattern from one side to the other side, causing an electric dipole momentum change, which violates the CP and time reversal symmetry. The Electroweak Interaction shows that the Weak Interaction is basically electromagnetic in nature. The arrow of time shows the entropy grows by changing the temperature dependent diffraction patterns of the electromagnetic oscillators.

Another important issue of the quark model is when one quark changes its flavor such that a linear oscillation transforms into plane oscillation or vice versa, changing the charge value with 1 or -1. This kind of change in the oscillation mode requires not only parity change, but also charge and time changes (CPT symmetry) resulting a right handed anti-neutrino or a left handed neutrino.

The right handed anti-neutrino and the left handed neutrino exist only because changing back the quark flavor could happen only in reverse, because they are different geometrical constructions, the u is 2 dimensional and positively charged and the d is 1 dimensional and negatively charged. It needs also a time reversal, because anti particle (anti neutrino) is involved.

The neutrino is a 1/2spin creator particle to make equal the spins of the weak interaction, for example neutron decay to 2 fermions, every particle is fermions with ½ spin. The weak interaction changes the entropy since more or less particles will give more or less freedom of movement. The entropy change is a result of temperature change and breaks the equality of oscillator diffraction intensity of the Maxwell–Boltzmann statistics. This way it changes the time coordinate measure and makes possible a different time dilation as of the special relativity.

The limit of the velocity of particles as the speed of light appropriate only for electrical charged particles, since the accelerated charges are self maintaining locally the accelerating electric force. The neutrinos are CP symmetry breaking particles compensated by time in the CPT symmetry, that is the time coordinate not works as in the electromagnetic interactions, consequently the speed of neutrinos is not limited by the speed of light.

The weak interaction T-asymmetry is in conjunction with the T-asymmetry of the second law of thermodynamics, meaning that locally lowering entropy (on extremely high temperature) causes the weak interaction, for example the Hydrogen fusion.

Probably because it is a spin creating movement changing linear oscillation to 2 dimensional oscillation by changing d to u quark and creating anti neutrino going back in time relative to the proton and electron created from the neutron, it seems that the anti neutrino fastest then the velocity of the photons created also in this weak interaction?

A quark flavor changing shows that it is a reflection changes movement and the CP- and T- symmetry breaking!!! This flavor changing oscillation could prove that it could be also on higher level such as atoms, molecules, probably big biological significant molecules and responsible on the aging of the life.

Important to mention that the weak interaction is always contains particles and antiparticles, where the neutrinos (antineutrinos) present the opposite side. It means by Feynman's interpretation that these particles present the backward time and probably because this they seem to move faster than the speed of light in the reference frame of the other side.

Finally since the weak interaction is an electric dipole change with ½ spin creating; it is limited by the velocity of the electromagnetic wave, so the neutrino's velocity cannot exceed the velocity of light.

The General Weak Interaction

The Weak Interactions T-asymmetry is in conjunction with the T-asymmetry of the Second Law of Thermodynamics, meaning that locally lowering entropy (on extremely high temperature) causes for example the Hydrogen fusion. The arrow of time by the Second Law of Thermodynamics shows the increasing entropy and decreasing information by the Weak Interaction, changing the temperature

dependent diffraction patterns. A good example of this is the neutron decay, creating more particles with less known information about them.
The neutrino oscillation of the Weak Interaction shows that it is a general electric dipole change and it is possible to any other temperature dependent entropy and information changing diffraction pattern of atoms, molecules and even complicated biological living structures.
We can generalize the weak interaction on all of the decaying matter constructions, even on the biological too. This gives the limited lifetime for the biological constructions also by the arrow of time. There should be a new research space of the Quantum Information Science the 'general neutrino oscillation' for the greater then subatomic matter structures as an electric dipole change.
There is also connection between statistical physics and evolutionary biology, since the arrow of time is working in the biological evolution also.
The Fluctuation Theorem says that there is a probability that entropy will flow in a direction opposite to that dictated by the Second Law of Thermodynamics. In this case the Information is growing that is the matter formulas are emerging from the chaos. So the Weak Interaction has two directions, samples for one direction is the Neutron decay, and Hydrogen fusion is the opposite direction.

Fermions and Bosons

The fermions are the diffraction patterns of the bosons such a way that they are both sides of the same thing.

Van Der Waals force

Named after the Dutch scientist Johannes Diderik van der Waals – who first proposed it in 1873 to explain the behaviour of gases – it is a very weak force that only becomes relevant when atoms and molecules are very close together. Fluctuations in the electronic cloud of an atom mean that it will have an instantaneous dipole moment. This can induce a dipole moment in a nearby atom, the result being an attractive dipole–dipole interaction.

Electromagnetic inertia and mass

Electromagnetic Induction

Since the magnetic induction creates a negative electric field as a result of the changing acceleration, it works as an electromagnetic inertia, causing an electromagnetic mass. [1]

Relativistic change of mass

The increasing mass of the electric charges the result of the increasing inductive electric force acting against the accelerating force. The decreasing mass of the decreasing acceleration is the result of the inductive electric force acting against the decreasing force. This is the relativistic mass change explanation, especially importantly explaining the mass reduction in case of velocity decrease.

The frequency dependence of mass

Since $E = h\nu$ and $E = mc^2$, $m = h\nu / c^2$ that is the m depends only on the ν frequency. It means that the mass of the proton and electron are electromagnetic and the result of the electromagnetic induction, caused by the changing acceleration of the spinning and moving charge! It could be that the m_o inertial mass is the result of the spin, since this is the only accelerating motion of the electric charge. Since the accelerating motion has different frequency for the electron in the atom and the proton, they masses are different, also as the wavelengths on both sides of the diffraction pattern, giving equal intensity of radiation.

Electron – Proton mass rate

The Planck distribution law explains the different frequencies of the proton and electron, giving equal intensity to different lambda wavelengths! Also since the particles are diffraction patterns they have some closeness to each other – can be seen as a gravitational force. [2]

There is an asymmetry between the mass of the electric charges, for example proton and electron, can understood by the asymmetrical Planck Distribution Law. This temperature dependent energy distribution is asymmetric around the maximum intensity, where the annihilation of matter and antimatter is a high probability event. The asymmetric sides are creating different frequencies of electromagnetic radiations being in the same intensity level and compensating each other. One of these compensating ratios is the electron – proton mass ratio. The lower energy side has no compensating intensity level, it is the dark energy and the corresponding matter is the dark matter.

Gravity from the point of view of quantum physics

The Gravitational force

The gravitational attractive force is basically a magnetic force.

The same electric charges can attract one another by the magnetic force if they are moving parallel in the same direction. Since the electrically neutral matter is composed of negative and positive charges they need 2 photons to mediate this attractive force, one per charges. The Bing Bang caused parallel moving of the matter gives this magnetic force, experienced as gravitational force.

Since graviton is a tensor field, it has spin = 2, could be 2 photons with spin = 1 together.

You can think about photons as virtual electron – positron pairs, obtaining the necessary virtual mass for gravity.

The mass as seen before a result of the diffraction, for example the proton – electron mass rate Mp=1840 Me. In order to move one of these diffraction maximum (electron or proton) we need to intervene into the diffraction pattern with a force appropriate to the intensity of this diffraction maximum, means its intensity or mass.

The Big Bang caused acceleration created radial currents of the matter, and since the matter is composed of negative and positive charges, these currents are creating magnetic field and attracting forces between the parallel moving electric currents. This is the gravitational force experienced by the matter, and also the mass is result of the electromagnetic forces between the charged particles. The positive and negative charged currents attracts each other or by the magnetic forces or by the much stronger electrostatic forces!?

The gravitational force attracting the matter, causing concentration of the matter in a small space and leaving much space with low matter concentration: dark matter and energy.
There is an asymmetry between the mass of the electric charges, for example proton and electron, can understood by the asymmetrical Planck Distribution Law. This temperature dependent energy

distribution is asymmetric around the maximum intensity, where the annihilation of matter and antimatter is a high probability event. The asymmetric sides are creating different frequencies of electromagnetic radiations being in the same intensity level and compensating each other. One of these compensating ratios is the electron – proton mass ratio. The lower energy side has no compensating intensity level, it is the dark energy and the corresponding matter is the dark matter.

The Higgs boson

By March 2013, the particle had been proven to behave, interact and decay in many of the expected ways predicted by the Standard Model, and was also tentatively confirmed to have + parity and zero spin, two fundamental criteria of a Higgs boson, making it also the first known scalar particle to be discovered in nature, although a number of other properties were not fully proven and some partial results do not yet precisely match those expected; in some cases data is also still awaited or being analyzed.

Since the Higgs boson is necessary to the W and Z bosons, the dipole change of the Weak interaction and the change in the magnetic effect caused gravitation must be conducted. The Wien law is also important to explain the Weak interaction, since it describes the T_{max} change and the diffraction patterns change. [2]

Higgs mechanism and Quantum Gravity

The magnetic induction creates a negative electric field, causing an electromagnetic inertia. Probably it is the mysterious Higgs field giving mass to the charged particles? We can think about the photon as an electron-positron pair, they have mass. The neutral particles are built from negative and positive charges, for example the neutron, decaying to proton and electron. The wave – particle duality makes sure that the particles are oscillating and creating magnetic induction as an inertial mass, explaining also the relativistic mass change. Higher frequency creates stronger magnetic induction, smaller frequency results lesser magnetic induction. It seems to me that the magnetic induction is the secret of the Higgs field.

In particle physics, the Higgs mechanism is a kind of mass generation mechanism, a process that gives mass to elementary particles. According to this theory, particles gain mass by interacting with the Higgs field that permeates all space. More precisely, the Higgs mechanism endows gauge bosons in a gauge theory with mass through absorption of Nambu–Goldstone bosons arising in spontaneous symmetry breaking.

The simplest implementation of the mechanism adds an extra Higgs field to the gauge theory. The spontaneous symmetry breaking of the underlying local symmetry triggers conversion of components of this Higgs field to Goldstone bosons which interact with (at least some of) the other fields in the theory, so as to produce mass terms for (at least some of) the gauge bosons. This mechanism may also leave behind elementary scalar (spin-0) particles, known as Higgs bosons.

In the Standard Model, the phrase "Higgs mechanism" refers specifically to the generation of masses for the $W^{\pm}$, and Z weak gauge bosons through electroweak symmetry breaking. The Large Hadron

Collider at CERN announced results consistent with the Higgs particle on July 4, 2012 but stressed that further testing is needed to confirm the Standard Model.

What is the Spin?

So we know already that the new particle has spin zero or spin two and we could tell which one if we could detect the polarizations of the photons produced. Unfortunately this is difficult and neither ATLAS nor CMS are able to measure polarizations. The only direct and sure way to confirm that the particle is indeed a scalar is to plot the angular distribution of the photons in the rest frame of the centre of mass. A spin zero particles like the Higgs carries no directional information away from the original collision so the distribution will be even in all directions. This test will be possible when a much larger number of events have been observed. In the mean time we can settle for less certain indirect indicators.

The Graviton

In physics, the graviton is a hypothetical elementary particle that mediates the force of gravitation in the framework of quantum field theory. If it exists, the graviton is expected to be massless (because the gravitational force appears to have unlimited range) and must be a spin-2 boson. The spin follows from the fact that the source of gravitation is the stress-energy tensor, a second-rank tensor (compared to electromagnetism's spin-1 photon, the source of which is the four-current, a first-rank tensor). Additionally, it can be shown that any massless spin-2 field would give rise to a force indistinguishable from gravitation, because a massless spin-2 field must couple to (interact with) the stress-energy tensor in the same way that the gravitational field does. This result suggests that, if a massless spin-2 particle is discovered, it must be the graviton, so that the only experimental verification needed for the graviton may simply be the discovery of a massless spin-2 particle. [3]

Dark Matter and Energy

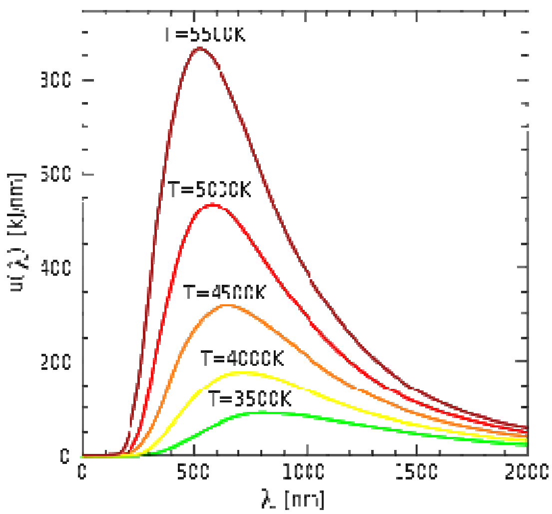
Dark matter is a type of matter hypothesized in astronomy and cosmology to account for a large part of the mass that appears to be missing from the universe. Dark matter cannot be seen directly with telescopes; evidently it neither emits nor absorbs light or other electromagnetic radiation at any significant level. It is otherwise hypothesized to simply be matter that is not reactant to light. Instead, the existence and properties of dark matter are inferred from its gravitational effects on visible matter, radiation, and the large-scale structure of the universe. According to the Planck mission team, and based on the standard model of cosmology, the total mass–energy of the known universe contains 4.9% ordinary matter, 26.8% dark matter and 68.3% dark energy. Thus, dark matter is estimated to constitute 84.5% of the total matter in the universe, while dark energy plus dark matter constitute 95.1% of the total content of the universe. [6]

Cosmic microwave background

The cosmic microwave background (CMB) is the thermal radiation assumed to be left over from the "Big Bang" of cosmology. When the universe cooled enough, protons and electrons combined to form neutral atoms. These atoms could no longer absorb the thermal radiation, and so the universe became transparent instead of being an opaque fog. [7]

Thermal radiation

Thermal radiation is electromagnetic radiation generated by the thermal motion of charged particles in matter. All matter with a temperature greater than absolute zero emits thermal radiation. When the temperature of the body is greater than absolute zero, interatomic collisions cause the kinetic energy of the atoms or molecules to change. This results in charge-acceleration and/or dipole oscillation which produces electromagnetic radiation, and the wide spectrum of radiation reflects the wide spectrum of energies and accelerations that occur even at a single temperature. [8]



Conclusions

The operational equivalence of coherence and entanglement will likely have a far-reaching impact on areas ranging from quantum information theory to more nascent fields such as quantum biology and nanoscale thermodynamics. In the future, the physicists plan to investigate whether coherence and entanglement might also be interconverted into a third resource—that of quantum discord, which, like entanglement, is another type of quantum correlation between two systems. [10]

The accelerated charges self-maintaining potential shows the locality of the relativity, working on the quantum level also. [1]

The Secret of Quantum Entanglement that the particles are diffraction patterns of the electromagnetic waves and this way their quantum states every time is the result of the quantum state of the intermediate electromagnetic waves. [2]

One of the most important conclusions is that the electric charges are moving in an accelerated way and even if their velocity is constant, they have an intrinsic acceleration anyway, the so called spin, since they need at least an intrinsic acceleration to make possible they movement .

The bridge between the classical and quantum theory is based on this intrinsic acceleration of the spin, explaining also the Heisenberg Uncertainty Principle. The particle – wave duality of the electric charges and the photon makes certain that they are both sides of the same thing. Basing the gravitational force on the accelerating Universe caused magnetic force and the Planck Distribution Law of the electromagnetic waves caused diffraction gives us the basis to build a Unified Theory of the physical interactions. The lower energy side has no compensating intensity level, it is the dark energy and the corresponding matter is the dark matter. Since the dark matter not participating in the diffraction patterns, also cannot be part of quantum entanglement, because of this we haven't information about it, we conclude its existence from its gravitational effect only.

References

[1] The Magnetic field of the Electric current and the Magnetic induction

http://academia.edu/3833335/The_Magnetic_field_of_the_Electric_current

[2] 3 Dimensional String Theory

http://academia.edu/3834454/3_Dimensional_String_Theory

[3] Graviton Production By Two Photon and Electron-Photon Processes In Kaluza-Klein Theories With Large Extra Dimensions

http://arxiv.org/abs/hep-ph/9909392

[4] Quantum Entanglement

http://en.wikipedia.org/wiki/Quantum_entanglement

[5] Space-based experiment could test gravity's effects on quantum entanglement

http://phys.org/news/2014-05-space-based-gravity-effects-quantum-entanglement.html

[6] Quantum Cognition

http://en.wikipedia.org/wiki/Quantum_cognition

[7] Information Entropy-Theory of Physics

https://www.academia.edu/3836084/Information_-_Entropy_Theory_of_Physics

[8] Quantum Teleportation

http://en.wikipedia.org/wiki/Quantum_teleportation

[9] Pairing up single atoms in silicon for quantum computing

http://phys.org/news/2014-06-pairing-atoms-silicon-quantum.html#nwlt

[10] Physicists find quantum coherence and quantum entanglement are two sides of the same coin

http://phys.org/news/2015-06-physicists-quantum-coherence-entanglement-sides.html

[11] Solving hard quantum problems: Everything is connected

http://www.nanowerk.com/nanotechnology-news/newsid=42443.php

[12] Controlling quantum states atom by atom

http://phys.org/news/2016-06-quantum-states-atom.html

[13] Potential new applications stem from controlling particles' spin configurations

https://phys.org/news/2017-04-potential-applications-stem-particles-configurations.html

[14] Rechargeable 'spin battery' promising for spintronics and quantum computing

https://phys.org/news/2017-04-rechargeable-battery-spintronics-quantum.html

[15] NIST invents fundamental component for 'spintronic' computing

https://phys.org/news/2017-04-nist-fundamental-component-spintronic.html

[16] Physicists design 2-D materials that conduct electricity at almost the speed of light

https://phys.org/news/2017-04-physicists-d-materials-electricity.html