

Transistor Laser

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The propagating optical signals along the silver nanowire can be also transformed and detected as electrical signals by an optical signal detector. [14]

Now researchers at Tokyo Institute of Technology use dendrimers that mimic the electron valency of atoms and link them into arrays using molecules that coordinate with the dendrimer as they would form a covalent electron pair in their valence shell - "electron pair mimicry". [13]

In an electron microscope, electrons are emitted by pointy metal tips, so they can be steered and controlled with high precision. Recently, such metal tips have also been used as high precision electron sources for generating X-rays. [12]

In some chemical reactions both electrons and protons move together. When they transfer, they can move concertedly or in separate steps. Light-induced reactions of this sort are particularly relevant to biological systems, such as Photosystem II where plants use photons from the sun to convert water into oxygen. [11]

EPFL researchers have found that water molecules are 10,000 times more sensitive to ions than previously thought. [10]

Working with colleagues at the Harvard-MIT Center for Ultracold Atoms, a group led by Harvard Professor of Physics Mikhail Lukin and MIT Professor of Physics Vladan Vuletic have managed to coax photons into binding together to form molecules – a state of matter that, until recently, had been purely theoretical. The work is described in a September 25 paper in Nature.

New ideas for interactions and particles: This paper examines the possibility to origin the Spontaneously Broken Symmetries from the Planck Distribution Law. This way we get a Unification of the Strong, Electromagnetic, and Weak Interactions from the interference occurrences of oscillators. Understanding that the relativistic mass change is the result of the magnetic induction we arrive to the conclusion that the Gravitational Force is also based on the electromagnetic forces, getting a Unified Relativistic Quantum Theory of all 4 Interactions.

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Author: George Rajna

Tunneling holds key to high-speed modulation of transistor and laser development

In 2004, electrical engineering pioneers Nick Holonyak, Jr. and Milton Feng at the University of Illinois invented the transistor laser—a three-port device that incorporated quantum-wells in the base and an optical cavity—increasing its capacity to transmit data one hundred-fold. Two recent studies by the researchers are expected to significantly impact the fundamental modulation bandwidth of the transistor and the laser operation for energy-efficient high speed data transfer in optical and 5G wireless communications.

"The transistor (point-contact) invented by John Bardeen and Walter Brattain in 1947 revealed the operating principles of the emitter current injection, the base electron-hole recombination, and the collector current output." explained Milton Feng, the Holonyak Chair professor emeritus of electrical and computer engineering at Illinois. "The three-terminal transistor replaced the fragile vacuum tube for fast reliable electrical signal switching and amplification, and has made possible a revolution in modern electronics, communications, and computer technologies."

"We are especially grateful to John Bardeen for bringing transistor research to Urbana in 1951, and changing all of our lives world-wide with the new quantum-physics and solid state devices," stated Nick Holonyak Jr, Bardeen's first graduate student and current Bardeen Chair professor emeritus of electrical and computer engineering and Physics . In 2004, Feng and Holonyak realized the radiative recombination energy (light) at the base of an III-V heterojunction bipolar transistor could be modulated to be a signal and a three-port device that can harness the intricate physics between electrons and light.

"The fastest way for current to switch in a semiconductor material is for the electrons to jump between bands in the material in a process called tunneling," Feng stated. "Light photons help shuttle the electrons across, a process called intra-cavity photon-assisted tunneling, making the device much faster."

The laser transistor differs from the Bardeen and Brattain transistor in which the current gain is dependent on the ratio of the base electron-hole (e-h) spontaneous recombination lifetime to the emitter-collector transit time. The Feng and Holonyak transistor laser current gain depends upon the base (e-h) stimulated recombination, the base dielectric relaxation transport, and the collector stimulated tunneling.

In two recent papers, published in the Journal of Applied Physics, Feng—along with Holonyak and graduate researchers Junyi Qiu and Curtis Wang—have established the principles of operation for tunneling modulation of a quantum well transistor laser with current amplification and optical output via intra-cavity photon-assisted tunneling.

"We consider these two papers related to intra-cavity tunneling modulation of the transistor will change the fundamental speed operation of the transistor and the laser modulation," Feng said.

In their article, "Tunneling modulation of a quantum well-transistor laser," the authors explain that stimulated e-h recombination operating under the influence of quantum-well assistance in the base, and stimulated optical modulation under the influence of intra-cavity photon-assisted tunneling (ICPAT) at the collector. The authors named their new and novel idea as the "Feng-Holonyak Intra-Cavity Photon-Assisted Tunneling (FH-ICPAT)."

"The tunneling gain mechanism is the result of the unique transistor laser base transport properties under the influence of FH-ICPAT and base dielectric relaxation, which yields fast carrier base transport and fast recombination than the original Bardeen transistor," explained Wang. "The voltage and current dependence of the tunneling current gain and optical modulation have been revealed in detail. Although the analysis is carried out for the transistor laser intra-cavity photon-assisted tunneling, the operation mechanism should apply in general to tunneling collector transistors of various design configurations."

In a companion AIP article ("Intra-cavity photon-assisted tunneling collector-base voltage-mediated electron-hole spontaneous-stimulated recombination transistor laser," the authors explained how optical absorption and modulation in a p-n junction diode for a direct-gap semiconductor can be enhanced by photon-assisted tunneling in the presence of optical cavity and photon-field in a transistor laser.

"In the transistor laser, the coherent photons generated at the base quantum-well interact with the collector field and 'assist' optical cavity electron tunneling from the valence band of the base to the energy state of conduction band of the collector," Feng explained. "The stimulated light output can be modulated by either base current injection via stimulated optical generation or base-collector junction bias via optical absorption.

"In this work, we studied the intra-cavity coherent photon intensity on photon-assisted tunneling in the transistor laser and realize photon field-dependent optical absorption. This FH-ICPAT in a

transistor laser is the unique property of voltage (field) modulation and the basis for ultrahigh speed direct laser modulation and switching.

"We remain indebted to John Bardeen, our mentor, for his lifelong continuing interest in the transistor (parallel to the BCS theory), the effect of the electron and the hole (e-h) in helping to originate the diode laser and LED, and in addition now leading to the e-h recombination (electrical and optical) transistor laser," Feng added. [15]

Scientists develop new optical circuit components to manipulate light

Do you think your computer is fast enough? Think again. The computers of the future could work almost at the speed of light! Nanophotonics, the study of light at the nanometer scale, could indeed bring the speed of our technology to a completely different level. The Center for Integrated Nanostructure Physics (CINAP) within the Institute for Basic Science (IBS) have developed three key components of a circuit that works with light. Published in Nature Communications, these devices combine the advantages of photonics and electronics on the same platform.

While we are slowly approaching the end point of Moore's Law: a state where we physically cannot shrink the dimension of our transistors much further; the future of big data processing requires high performance computers with higher speed operations. Researchers reckon that if we build computers that process information through light, instead of electrons, computer will be able to work faster. However, at nanometer dimensions, the wavelength of light is larger than the diameter of the silicon fiber and for this reason some light can be lost. A solution to control the propagation of light in matter can come from surface plasmons. These are electromagnetic waves that propagate along the surface of some conductive materials like silver, gold, aluminum and copper. Using surface plasmons, optical information can be transmitted nearly at the speed of light and in extremely miniature volumes.

Using surface plasmons in silver nanowires and 2D semiconductors like molybdenum disulphide (MoS₂), IBS scientists built three key components for optical communication: optical transistors, optical multiplexers and optical signal detectors.

IBS scientists constructed the optical transistor by interconnecting the silver nanowire to a flake of MoS₂. Light shone on the device is converted to surface plasmon, then to exciton, back to surface plasmon and eventually emitted as light with a shorter wavelength compared to the initial input. For example, if the input light is green, the output light can be red.

Wavelength multiplexing devices were realized in a similar way, but instead of having only a flake of MoS₂, the researchers used an array of three different 2D semiconductor materials emitting light at different wavelengths. In this structure, for example, a single input light (violet color) generates three output lights (blue, green and red).

The propagating optical signals along the silver nanowire can be also transformed and detected as electrical signals by an optical signal detector.

"The originality of this paper arises from the exciton-plasmon interconversion. We published before the conversion of exciton to plasmon, and from plasmon to exciton using silver nanowire/2D semiconductor hybrids, but this is the first time that we can complete the circle going from plasmons

to excitons and back to plasmons. Using this concept, we created optical transistors and multiplexors," explains professor Hyun Seok Lee, first author of this study. [14]

New aspect of atom mimicry for nanotechnology applications

In nanotechnology control is key. Control over the arrangements and distances between nanoparticles can allow tailored interaction strengths so that properties can be harnessed in devices such as plasmonic sensors. Now researchers at Tokyo Institute of Technology use dendrimers that mimic the electron valency of atoms and link them into arrays using molecules that coordinate with the dendrimer as they would form a covalent electron pair in their valence shell - "electron pair mimicry".

Kimihisa Yamamoto, Ken Albrecht, and colleagues at Tokyo Tech considered the dendritic polyphenylazomethine (DPA), which has a structure that branches out from a central core. "Lewis acid" molecules coordinate to the "Lewis base" sites of DPA. Analysis of the ratio of SnCl₂ Lewis acid molecules coordinating with each dendrimer revealed step increases from 2 to 4 to 8 to 16, which mimics the valency of the Bohr atom that has 2, 8, 18, and 32 electrons in the 1st, 2nd, 3rd, and 4th orbitals. This reflects the increase in the number of molecules that can coordinate with the dendrimer with increasing distance from the core, as the number of dendrimer branches and electron density increases.

Yamamoto's team analysed the coordination of DPA with a stronger binding Lewis acid - triphenylmethyl cation (TPM⁺) - bound to the rod-like molecule phenylene ethynylene. The phenylene ethynylene backbone is rigid enough that the acid cations at either end cannot then bind to the same dendrimer. Instead a polymer chain of dendrimers forms. Using a different starting dendrimer (ZnPG4 instead of DPAG4) - which has a core valency of four instead of two - led to the formation of two dimensional polymerisation of the dendrimers, producing a 2D array of nanocontainers for that can accumulate other Lewis acids into the outer orbitals.

The work describes "a new aspect of atom mimicry" conclude the researchers. "The geometry and pitch can be controlled by the design of the dendrimer and the linker and are potentially applicable to plasmonics (after seed-mediated growth) and nanoelectrode grids (which are also useful as electrocatalysts)."

The study is published in Science Advances.

Bohr atom

The Bohr model of the atom set out by Niels Bohr and Ernest Rutherford in 1913 describes the atom as a positive nucleus surrounded by electrons in different shells or energy levels. Each shell has a prescribed number of electrons that can occupy it - that is, two electrons can occupy the first shell, eight the next, and eighteen the next, and so on.

While there are aspects of the atom behaviour that the model does not cover, it is particularly successful at explaining the spectral emission lines. When excited, an electron can jump to the next energy level. When it returns to the initial energy level, the difference in the energies is emitted as light at the specific wavelength equivalent to the energy difference.

Where a shell is not full, the atom can bond with another chemical species. In this way the valency of an atom describes how full the electron shell is and how readily bonds can form. The electron density gradient of dendrimers moving radially from the core to the more branched outer regions dictates how many Lewis acid coordinating molecules it can accommodate and in this way it mimics the energy levels of the Bohr atom.

What is a Lewis acid

A Lewis acid is a chemical species that can accept a lone pair of electrons from a chemical that can donate a lone pair, that is, from a Lewis base. This behaviour is defined by the electron structure of the chemical. Lewis acids include acidic compounds but also metal cations.

When the dendrimer coordinates with the Lewis acids it takes the place of the Lewis base that would donate an electron pair. The researchers describe the di-Lewis acid compound (linker molecule) as electron pair mimicry.

Isosbestic points

When two chemicals react the amount of light absorbed can change depending on how much light the products versus the reactants absorb. If the products and reactants absorb the same amount of light at a particular wavelength, it is described as the isosbestic point.

The researchers used isosbestic points to identify the step increases in Lewis acid reacting with the dendrimers. A wavelength shift in the isosbestic point indicates coordination of the Lewis acid to the subsequent layer of the dendrimer. [13]

Controlling electrons in time and space

In an electron microscope, electrons are emitted by pointy metal tips, so they can be steered and controlled with high precision. Recently, such metal tips have also been used as high precision electron sources for generating X-rays. A team of researchers at TU Wien (Vienna), together with colleagues from the FAU Erlangen-Nürnberg (Germany), have developed a method of controlling electron emissions with higher precision than ever before. With the help of two laser pulses, it is now possible to switch the flow of electrons on and off on extremely short time scales.

It's Just the Tip of the Needle

"The basic idea resembles a lightning rod," says Christoph Lemell (TU Wien). "The electrical field around a needle is always strongest right at the tip. That's why the lightning always strikes the tip of a rod, and for the same reason, electrons leave a needle right at the tip."

Extremely pointy needles can be fabricated with the methods of modern nanotechnology. Their tip is just a few nanometres wide, so the point at which the electrons are emitted is known with very high accuracy. In addition to that, it is also important to control at which point in time the electrons are emitted.

This kind of temporal control has now become possible using a new approach: "Two different laser pulses are fired at the metal tip," explains Florian Libisch (TU Wien). The colours of these two lasers

are chosen such that the photons of one laser have exactly twice the energy of the other laser's photons. Also, it is important to ensure that both light waves oscillate in perfect synchronicity.

With the help of computer simulations, the team from TU Wien was able to predict that a small time delay between the two laser pulses can serve as a "switch" for electron emission. This prediction has now been confirmed by experiments performed by Professor Peter Hommelhoff's research group at FAU Erlangen-Nürnberg. Based on these experiments, it is now possible to understand the process in detail.

Absorbing Photons

When a laser pulse is fired at the metal tip, its electrical field can rip electrons out of the metal – that is a well-known phenomenon. The new idea is that a combination of two different lasers can be used to control the emission of the electrons on a femtosecond time scale.

There are different ways an electron can gain enough energy to leave the metal tip: It can absorb two photons from the high-energy laser or four electrons from the low-energy laser. Both mechanisms lead to the same result. "Much like a particle in a double-slit experiment, which travels on two different paths at the same time, the electron can take part in two different processes at the same time," says Professor Joachim Burgdörfer (TU Wien). "Nature does not have to pick one of the two possibilities – both are equally real and interfere with each other."

By carefully tuning the two lasers, it is possible to control whether the two quantum physical processes amplify each other, which leads to an increased emission of electrons, or whether they cancel each other, which means that hardly any electrons are emitted at all. This is a simple and effective way of controlling electron emission.

It is not just a new method of performing experiments with high energy electrons, the new technology should open the door to controlled X-ray generation. "Innovative X-ray sources are already being built using arrays of narrow metal tips as electron sources," says Lemell. "With our new method, these nano tips could be triggered in exactly the right way so that coherent X-ray radiation is produced." [12]

Using light to move electrons and protons

In some chemical reactions both electrons and protons move together. When they transfer, they can move concertedly or in separate steps. Light-induced reactions of this sort are particularly relevant to biological systems, such as Photosystem II where plants use photons from the sun to convert water into oxygen.

To better understand how light can lead to the transfer of protons in a chemical reaction, a group of researchers from the University of North Carolina, Shanxi University in China, and Memorial University in Newfoundland have conducted adsorption studies on a new family of experiments to observe the transition that occurs when protons transfer between hydrogen-bonded complexes in solution. They provide evidence for new optical transitions characteristic of the direct transfer of a proton. This report recently appeared in the Proceedings of the National Academy of Sciences.

N-methyl-4,4'-bipyridinium cation (MQ⁺) serves as proton acceptor, where a proton will add to the non-methylated pyridinium amine. If proton transfer occurs, then MQ⁺ will form a radical cation (MQH^{+•}) whose absorbance spectra in the UV/visible range can be compared to N, N'-dimethyl-4, 4'-bipyridinium (MV²⁺).

By using ultrafast laser flash photolysis measurements, they found direct evidence for a low energy absorption band between p-methoxyphenyl and the methylviologen acceptor, MQ⁺. It appears at 360 nm and as early as 250 fs after the laser pulse. Based on these properties, it is clearly the product of proton transfer from the phenol to give MeOPhO[•]—H-MQ⁺.

The appearance of this reaction involving the transfer of both an electron and proton after absorbing a single photon is supported by the vibrational coherence of the radical cation and by its characteristic spectral properties. By inference, related transitions, which are often at low intensities, could play an important role in the degradation of certain biological molecules, such as DNA.

The appearance of these absorption bands could have theoretical significance. They demonstrate a way to use simple spectroscopic measurements to explore the intimate details of how these reactions occur in nature. This provides new physical insight into processes that could be of broad biological and chemical relevance. [11]

A single ion impacts a million water molecules

EPFL researchers have found that water molecules are 10,000 times more sensitive to ions than previously thought.

Water is simple and complex at the same time. A single water molecule (H₂O) is made up of only 3 atoms. Yet the collective behavior of water molecules is unique and continues to amaze us. Water molecules are linked together by hydrogen bonds that break and form several thousands of billions of times per second. These bonds provide water with unique and unusual properties. Living organisms contain around 60% water and salt. Deciphering the interactions among water, salt and ions is thus fundamentally important for understanding life.

Not 100 but 1,000,000 molecules react

Researchers at EPFL's Laboratory for fundamental BioPhotonics, led by Sylvie Roke, have probed the influence of ions on the structure of water with unprecedentedly sensitive measurements. According to their multi-scale analyses, a single ion has an influence on millions of water molecules, i.e. 10,000 times more than previously thought. In an article appearing in *Science Advances*, they explain how a single ion can "twist" the bonds of several million water molecules over a distance exceeding 20 nanometers causing the liquid to become "stiffer". "Until now it was not possible to see beyond a hundred molecules. Our measurements show that water is much more sensitive to ions than we thought," said Roke, who was also surprised by this result.

The molecules line up around the ions

Water molecules are made up of one negatively charged oxygen atom and two positively charged hydrogen atoms. The Mickey Mouse-shaped molecule therefore does not have the same charge at

its center as at its extremities. When an ion, which is an electrically charged atom, comes into contact with water, the network of hydrogen bonds is perturbed. The perturbation spreads over millions of surrounding molecules, causing water molecules to align preferentially in a specific direction. This can be thought of as water molecules "stiffening their network" between the various ions.

From atomistic to macroscopic length scales

Water's behavior was tested with three different approaches: ultrafast optical measurements, which revealed the arrangement of molecules on the nanometric scale; a computer simulation on the atomic scale; and measurement of the water's surface structure and tension, which was done at the macroscopic level. "For the last method, we simply dipped a thin metal plate into the water and pulled gently using a tensiometer to determine the water's resistance," said Roke. "We observed that the presence of a few ions makes it easier to pull the plate out, that is, ions reduce the surface resistance of water. This strange effect had already been observed in 1941, but it remained unexplained until now. Through our multiscale analysis we were able to link it to ion-induced stiffening of the bulk hydrogen bond network: a stiffer bulk results in a comparatively more flexible surface."

Testing different salts and different "waters"

The researchers carried out the same experiment with 21 different salts: they all affected water in the same way. Then they studied the effect of ions on heavy water, whose hydrogen atoms are heavy isotopes (with an additional neutron in the nucleus). This liquid is almost indistinguishable from normal water. But here the properties are very different. To perturb the heavy water in the same way, it required a concentration of ions six times higher. Further evidence of the uniqueness of water.

No link with water memory

Roke and her team are aware that it might be tempting to link these stunning results to all sorts of controversial beliefs about water. They are however careful to distance themselves from any far-fetched interpretation. "Our research has nothing to do with water memory or homeopathy," she said. "We collect scientific data, which are all verifiable. "To prove the role of water in homeopathy, another million-billion-billion water molecules would have to be affected to even come close, and even then we are not certain."

The new discovery about the behavior of water will be useful in fundamental research, and in other areas too. The interaction between water and ions is omnipresent in biological processes related to enzymes, ion channels and protein folding. Every new piece of knowledge gives greater insight into how life works. [10]

Photonic molecules

Working with colleagues at the Harvard-MIT Center for Ultracold Atoms, a group led by Harvard Professor of Physics Mikhail Lukin and MIT Professor of Physics Vladan Vuletic have managed to coax photons into binding together to form molecules – a state of matter that, until recently, had been purely theoretical. The work is described in a September 25 paper in Nature.

The discovery, Lukin said, runs contrary to decades of accepted wisdom about the nature of light. Photons have long been described as massless particles which don't interact with each other – shine two laser beams at each other, he said, and they simply pass through one another.

"Photonic molecules," however, behave less like traditional lasers and more like something you might find in science fiction – the light saber.

"Most of the properties of light we know about originate from the fact that photons are massless, and that they do not interact with each other," Lukin said. "What we have done is create a special type of medium in which photons interact with each other so strongly that they begin to act as though they have mass, and they bind together to form molecules. This type of photonic bound state has been discussed theoretically for quite a while, but until now it hadn't been observed. [9]

The Electromagnetic Interaction

This paper explains the magnetic effect of the electric current from the observed effects of the accelerating electrons, causing naturally the experienced changes of the electric field potential along the electric wire. 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. [2]

Asymmetry in the interference occurrences of oscillators

The asymmetrical configurations are stable objects of the real physical world, because they cannot annihilate. One of the most obvious asymmetry is the proton – electron mass rate $M_p = 1840 M_e$ while they have equal charge. We explain this fact by the strong interaction of the proton, but how remember it his strong interaction ability for example in the H – atom where are only electromagnetic interactions among proton and electron.

This gives us the idea to origin the mass of proton from the electromagnetic interactions by the way interference occurrences of oscillators. The uncertainty relation of Heisenberg makes sure that the particles are oscillating.

The resultant intensity due to n equally spaced oscillators, all of equal amplitude but different from one another in phase, either because they are driven differently in phase or because we are looking at them an angle such that there is a difference in time delay:

$$(1) I = I_0 \sin^2 n \phi/2 / \sin^2 \phi/2$$

If ϕ is infinitesimal so that $\sin\phi = \phi$, than

$$(2) I = n^2 I_0$$

This gives us the idea of

$$(3) M_p = n^2 M_e$$

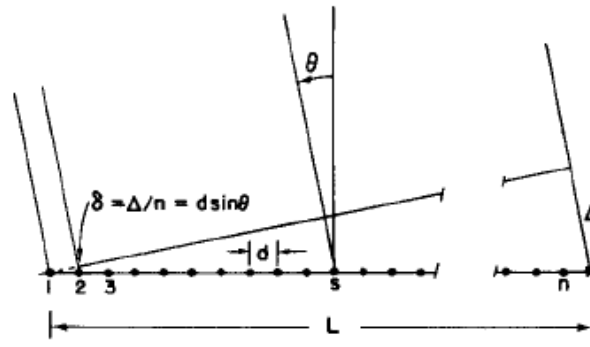


Fig. 30-3. A linear array of n equal oscillators, driven with phases $\alpha_s = s\alpha$.

Figure 1.) A linear array of n equal oscillators

There is an important feature about formula (1) which is that if the angle ϕ is increased by the multiple of 2π , it makes no difference to the formula.

So

$$(4) \quad d \sin \theta = m \lambda$$

and we get m -order beam if λ less than d . [6]

If d less than λ we get only zero-order one centered at $\theta = 0$. Of course, there is also a beam in the opposite direction. The right chooses of d and λ we can ensure the conservation of charge.

For example

$$(5) \quad 2(m+1) = n$$

Where $2(m+1) = N_p$ number of protons and $n = N_e$ number of electrons.

In this way we can see the H_2 molecules so that $2n$ electrons of n radiate to $4(m+1)$ protons, because $d_e > \lambda_e$ for electrons, while the two protons of one H_2 molecule radiate to two electrons of them, because of $d_e < \lambda_e$ for this two protons.

To support this idea we can turn to the Planck distribution law, that is equal with the Bose – Einstein statistics.

Spontaneously broken symmetry in the Planck distribution law

The Planck distribution law is temperature dependent and it should be true locally and globally. I think that Einstein's energy-matter equivalence means some kind of existence of electromagnetic oscillations enabled by the temperature, creating the different matter formulas, atoms molecules, crystals, dark matter and energy.

Max Planck found for the black body radiation

As a function of wavelength (λ), Planck's law is written as:

$$B_{\lambda}(T) = \frac{2hc^2}{\lambda^5} \frac{1}{e^{\frac{hc}{\lambda k_B T}} - 1}.$$

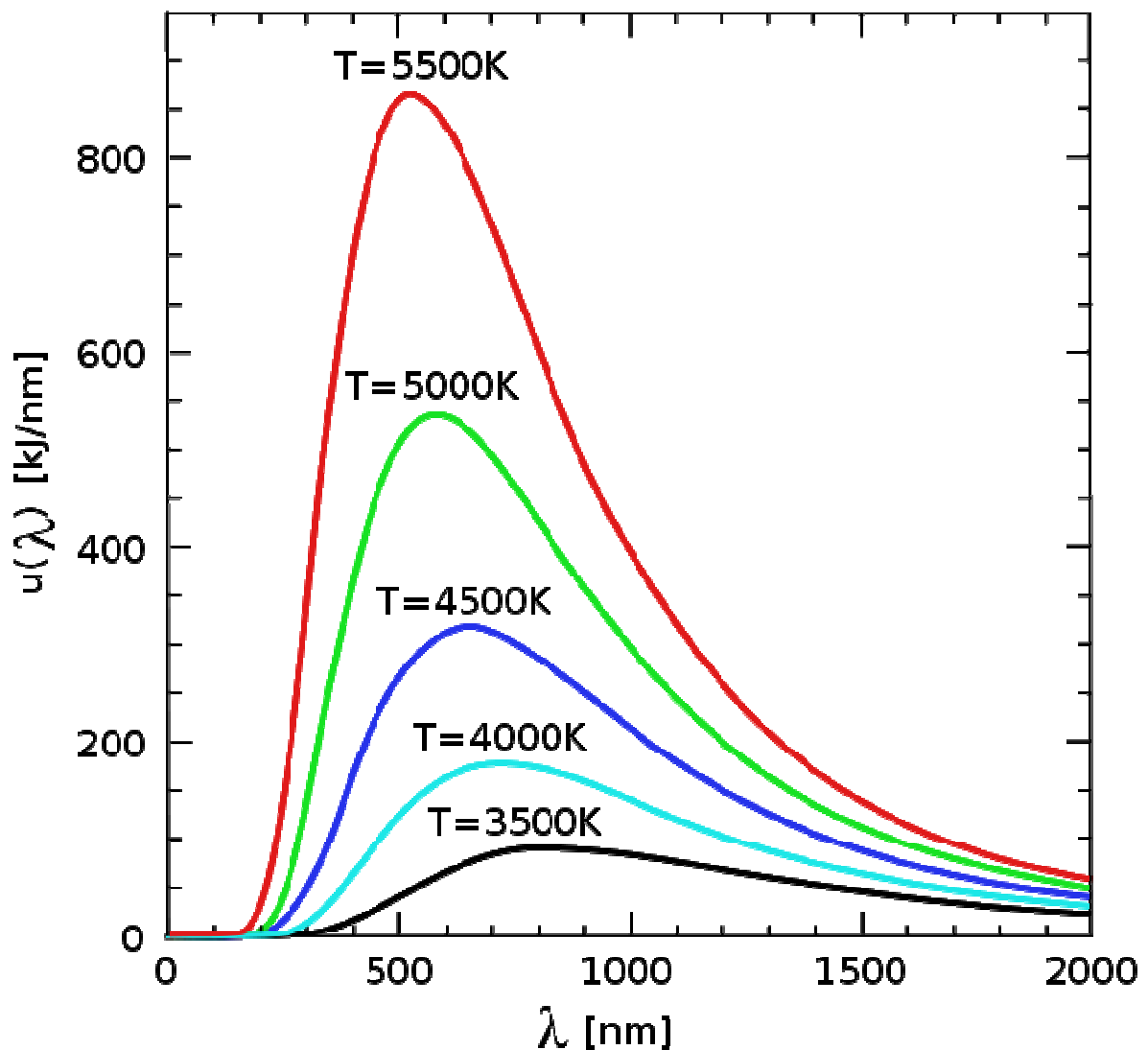


Figure 2. The distribution law for different T temperatures

We see there are two different λ_1 and λ_2 for each T and intensity, so we can find between them a d so that $\lambda_1 < d < \lambda_2$.

We have many possibilities for such asymmetrical reflections, so we have many stable oscillator configurations for any T temperature with equal exchange of intensity by radiation. All of these configurations can exist together. At the λ_{\max} is the annihilation point where the configurations are symmetrical. The λ_{\max} is changing by the Wien's displacement law in many textbooks.

$$(7) \quad \lambda_{\max} = \frac{b}{T}$$

where λ_{\max} is the peak wavelength, T is the absolute temperature of the black body, and b is a constant of proportionality called *Wien's displacement constant*, equal to $2.8977685(51) \times 10^{-3} \text{ m} \cdot \text{K}$ (2002 CODATA recommended value).

By the changing of T the asymmetrical configurations are changing too.

The structure of the proton

We must move to the higher T temperature if we want look into the nucleus or nucleon arrive to $d < 10^{-13} \text{ cm}$. If an electron with $\lambda_e < d$ move across the proton then by (5) $2(m+1) = n$ with $m = 0$ we get $n = 2$ so we need two particles with negative and two particles with positive charges. If the proton can fraction to three parts, two with positive and one with negative charges, then the reflection of oscillators are right. Because this very strange reflection where one part of the proton with the electron together on the same side of the reflection, the all parts of the proton must be quasi lepton so $d > \lambda_q$. One way dividing the proton to three parts is, dividing his oscillation by the three direction of the space. We can order $1/3 e$ charge to each coordinates and $2/3 e$ charge to one plane oscillation, because the charge is scalar. In this way the proton has two $+2/3 e$ plane oscillation and one linear oscillation with $-1/3 e$ charge. The colors of quarks are coming from the three directions of coordinates and the proton is colorless. The flavors of quarks are the possible oscillations differently by energy and if they are plane or linear oscillations. We know there is no possible reflecting two oscillations to each other which are completely orthogonal, so the quarks never can be free, however there is an asymptotic freedom while their energy are increasing to turn them to the orthogonally. If they will be completely orthogonal then they lose this reflection and take new partners from the vacuum. Keeping the symmetry of the vacuum the new oscillations are keeping all the conservation laws, like charge, number of baryons and leptons. The all features of gluons are coming from this model. The mathematics of reflecting oscillators show Fermi statistics.

Important to mention that in the Deuteron there are 3 quarks of $+2/3$ and $-1/3$ charge, that is three u and d quarks making the complete symmetry and because this its high stability.

The Pauli Exclusion Principle says that the diffraction points are exclusive!

The Strong Interaction

Confinement and Asymptotic Freedom

For any theory to provide a successful description of strong interactions it should simultaneously exhibit the phenomena of confinement at large distances and asymptotic freedom at short distances. Lattice calculations support the hypothesis that for non-abelian gauge theories the two domains are analytically connected, and confinement and asymptotic freedom coexist. Similarly, one way to show that QCD is the correct theory of strong interactions is that the coupling extracted at various scales (using experimental data or lattice simulations) is unique in the sense that its variation with scale is given by the renormalization group. [4]
Lattice QCD gives the same results as the diffraction theory of the electromagnetic oscillators, which is the explanation of the strong force and the quark confinement. [1]

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.

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 1/2 spin creator particle to make equal the spins of the weak interaction, for example neutron decay to 2 fermions, every particle is fermions with 1/2 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 $\frac{1}{2}$ 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. [5]

Fermions and Bosons

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

The Higgs boson or Higgs particle is a proposed elementary particle in the Standard Model of particle physics. The Higgs boson's existence would have profound importance in particle physics because it would prove the existence of the hypothetical Higgs field - the simplest of several proposed explanations for the origin of the symmetry-breaking mechanism by which elementary particles gain mass. [3]

The fermions' spin

The moving charges are accelerating, since only this way can self maintain the electric field causing their acceleration. The electric charge is not point like! This constant acceleration possible if there is a rotating movement changing the direction of the velocity. This way it can accelerate forever without increasing the absolute value of the velocity in the dimension of the time and not reaching the velocity of the light.

The Heisenberg uncertainty relation says that the minimum uncertainty is the value of the spin: $1/2 \hbar = \Delta x \Delta p$ or $1/2 \hbar = \Delta t \Delta E$, that is the value of the basic energy status.

What are the consequences of this in the weak interaction and how possible that the neutrinos' velocity greater than the speed of light?

The neutrino is the one and only particle doesn't participate in the electromagnetic interactions so we cannot expect that the velocity of the electromagnetic wave will give it any kind of limit.

The neutrino is a $1/2$ spin creator particle to make equal the spins of the weak interaction, for example neutron decay to 2 fermions, every particle is fermions with $1/2$ 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 source of the Maxwell equations

The electrons are accelerating also in a static electric current because of the electric force, caused by the potential difference. The magnetic field is the result of this acceleration, as you can see in [2].

The mysterious property of the matter that the electric potential difference is self maintained by the accelerating electrons in the electric current gives a clear explanation to the basic sentence of the relativity that is the velocity of the light is the maximum velocity of the matter. If the charge could move faster than the electromagnetic field than this self maintaining electromagnetic property of the electric current would be failed.

Also an interesting question, how the changing magnetic field creates a negative electric field? The answer also the accelerating electrons will give. When the magnetic field is increasing in time by

increasing the electric current, then the acceleration of the electrons will increase, decreasing the charge density and creating a negative electric force. Decreasing the magnetic field by decreasing the electric current will decrease the acceleration of the electrons in the electric current and increases the charge density, creating an electric force also working against the change.

In this way we have explanation to all interactions between the electric and magnetic forces described in the Maxwell equations.

The second mystery of the matter is the mass. We have seen that the acceleration change of the electrons in the flowing current causing a negative electrostatic force. This is the cause of the relativistic effect - built-in in the Maxwell equations - that is the mass of the electron growing with its acceleration and its velocity never can reach the velocity of light, because of this growing negative electrostatic force. The velocity of light is depending only on 2 parameters: the magnetic permeability and the electric permittivity.

There is a possibility of the polarization effect created by electromagnetic forces creates the negative and positive charges. In case of equal mass as in the electron-positron pair it is simply, but on higher energies can be asymmetric as the electron-proton pair of neutron decay by weak interaction and can be understood by the Feynman graphs.

Anyway the mass can be electromagnetic energy exceptionally and since the inertial and gravitational mass are equals, the gravitational force is electromagnetic force and since only the magnetic force is attractive between the same charges, is very important for understanding the gravitational force.

The Uncertainty Relations of Heisenberg gives the answer, since only this way can be sure that the particles are oscillating in some way by the electromagnetic field with constant energies in the atom indefinitely. Also not by chance that the uncertainty measure is equal to the fermions spin, which is one of the most important feature of the particles. There are no singularities, because the moving electron in the atom accelerating in the electric field of the proton, causing a charge distribution on Δx position difference and with a Δp momentum difference such a way that they product is about the half Planck reduced constant. For the proton this Δx much less in the nucleon, than in the orbit of the electron in the atom, the Δp is much higher because of the greatest proton mass.

The Special Relativity

The mysterious property of the matter that the electric potential difference is self maintained by the accelerating electrons in the electric current gives a clear explanation to the basic sentence of the relativity that is the velocity of the light is the maximum velocity of the matter. If the charge could move faster than the electromagnetic field than this self maintaining electromagnetic property of the electric current would be failed. [8]

The Heisenberg Uncertainty Principle

Moving faster needs stronger acceleration reducing the Δx and raising the Δp . It means also mass increasing since the negative effect of the magnetic induction, also a relativistic effect!

The Uncertainty Principle also explains the proton – electron mass ratio since the Δx is much less requiring bigger Δp in the case of the proton, which is partly the result of a bigger mass m_p because of the higher electromagnetic induction of the bigger frequency (impulse).

The Gravitational force

The changing magnetic field of the changing current causes electromagnetic mass change by the negative electric field caused by the changing acceleration of the electric charge.

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 Big 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 ratio $M_p = 1840 M_e$. 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. [1]

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 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]

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 Casimir effect

The Casimir effect is related to the Zero-point energy, which is fundamentally related to the Heisenberg uncertainty relation. The Heisenberg uncertainty relation says that the minimum uncertainty is the value of the spin: $1/2 \hbar = \Delta x \Delta p$ or $1/2 \hbar = \Delta t \Delta E$, that is the value of the basic energy status.

The moving charges are accelerating, since only this way can self maintain the electric field causing their acceleration. The electric charge is not point like! This constant acceleration possible if there is a rotating movement changing the direction of the velocity. This way it can accelerate forever without increasing the absolute value of the velocity in the dimension of the time and not reaching the velocity of the light. 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 Δx position difference and with a Δp momentum difference such a way that they product is about the half Planck reduced constant. For the proton this Δx much less in the nucleon, than in the orbit of the electron in the atom, the Δp is much higher because of the greater proton mass. This means that the electron is not a point like particle, but has a real charge distribution.

Electric charge and electromagnetic waves are two sides of the same thing; the electric charge is the diffraction center of the electromagnetic waves, quantified by the Planck constant h .

The Fine structure constant

The Planck constant was first described as the proportionality constant between the energy (E) of a photon and the frequency (ν) of its associated electromagnetic wave. This relation between the energy and frequency is called the **Planck relation** or the **Planck–Einstein equation**:

$$E = h\nu .$$

Since the frequency ν , wavelength λ , and speed of light c are related by $\lambda\nu = c$, the Planck relation can also be expressed as

$$E = \frac{hc}{\lambda} .$$

Since this is the source of Planck constant, the e electric charge countable from the Fine structure constant. This also related to the Heisenberg uncertainty relation, saying that the mass of the proton should be bigger than the electron mass because of the difference between their wavelengths.

The expression of the fine-structure constant becomes the abbreviated

$$\alpha = \frac{e^2}{\hbar c}$$

This is a dimensionless constant expression, $1/137$ commonly appearing in physics literature.

This means that the electric charge is a result of the electromagnetic waves diffractions, consequently the proton – electron mass rate is the result of the equal intensity of the corresponding electromagnetic frequencies in the Planck distribution law, described in my diffraction theory.

Path integral formulation of Quantum Mechanics

The path integral formulation of quantum mechanics is a description of quantum theory which generalizes the action principle of classical mechanics. It replaces the classical notion of a single, unique trajectory for a system with a sum, or functional integral, over an infinity of possible trajectories to compute a quantum amplitude. [7]

It shows that the particles are diffraction patterns of the electromagnetic waves.

Conclusions

"It's a photonic interaction that's mediated by the atomic interaction," Lukin said. "That makes these two photons behave like a molecule, and when they exit the medium they're much more likely to do so together than as single photons." To build a quantum computer, he explained, researchers need to build a system that can preserve quantum information, and process it using quantum logic operations. The challenge, however, is that quantum logic requires interactions between individual quanta so that quantum systems can be switched to perform information processing. [9]

The magnetic induction creates a negative electric field, causing an electromagnetic inertia responsible for the relativistic mass change; it is the mysterious Higgs Field giving mass to the particles. The Planck Distribution Law of the electromagnetic oscillators explains the electron/proton mass ratio by the diffraction patterns. The accelerating charges 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 Relativistic Quantum Theories. The self-maintained electric potential of the accelerating charges equivalent with the General Relativity space-time curvature, and since it is true on the quantum level also, gives the base of the Quantum Gravity. The electric currents causing self-maintaining electric potential is the source of the special and general relativistic effects. The Higgs Field is the result of the electromagnetic induction. The Graviton is two photons together.

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