Anti-Lasers

Scientists at the Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) have for the first time created a single device that acts as both a laser and an anti-laser, and they demonstrated these two opposite functions at a frequency within the telecommunications band. [16]

Laser researchers boldly go into uncharted THz territory. [15]

A new imaging technique developed by scientists at MIT, Harvard University, and Massachusetts General Hospital (MGH) aims to illuminate cellular structures in deep tissue and other dense and opaque materials. Their method uses tiny particles embedded in the material, that give off laser light. [14]

UCLA physicists have shown that shining multicolored laser light on rubidium atoms causes them to lose energy and cool to nearly absolute zero. This result suggests that atoms fundamental to chemistry, such as hydrogen and carbon, could also be cooled using similar lasers, an outcome that would allow researchers to study the details of chemical reactions involved in medicine. [13]

Powerful laser beams, given the right conditions, will act as their own lenses and "self-focus" into a tighter, even more intense beam. University of Maryland physicists have discovered that these self-focused laser pulses also generate violent swirls of optical energy that strongly resemble smoke rings. [12]

Electrons fingerprint the fastest laser pulses. [11]

A team of researchers with members from Germany, the U.S. and Russia has found a way to measure the time it takes for an electron in an atom to respond to a pulse of light. [10]

As an elementary particle, the electron cannot be broken down into smaller particles, at least as far as is currently known. However, in a phenomenon called electron fractionalization, in certain materials an electron can be broken down into smaller "charge pulses," each of which carries a fraction of the electron's charge. Although electron fractionalization has many interesting implications, its origins are not well understood. [9]

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.*

Lasers + anti-lasers: Marriage opens door to development of single device with exceptional range of optical capabilities 3

Reversing the laser 3

Balance and symmetry 4

Laser researchers boldly go into uncharted THz territory 5

Focusing on a solution 6

New imaging technique stimulates particles to emit laser light, could create higher-resolution images 7

A light in the dark 7

Chopstick lasers 7

Physicists use multicolored laser light to study atoms critical to medicine 8

Physicists discover 'smoke rings' made of laser light 10

Electrons fingerprint the fastest laser pulses 11

Superfast light pulses able to measure response time of electrons to light 12

When an electron splits in two 13

The Electromagnetic Interaction 15

Asymmetry in the interference occurrences of oscillators 15

Spontaneously broken symmetry in the Planck distribution law 17

The structure of the proton 18

The Strong Interaction 19

Confinement and Asymptotic Freedom 19

The weak interaction 19

The General Weak Interaction 20

Fermions and Bosons 21

The fermions' spin 21

The source of the Maxwell equations 21

The Special Relativity 22

The Heisenberg Uncertainty Principle 23

The Gravitational force 23

The Graviton 24

What is the Spin? 24

The Casimir effect 24

The Fine structure constant 25

Path integral formulation of Quantum Mechanics 25

Conclusions 26

References 26

Author: George Rajna

Lasers + anti-lasers: Marriage opens door to development of single device with exceptional range of optical capabilities

Bringing opposing forces together in one place is as challenging as you would imagine it to be, but researchers in the field of optical science have done just that.

Scientists at the Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) have for the first time created a single device that acts as both a laser and an anti-laser, and they demonstrated these two opposite functions at a frequency within the telecommunications band.

Their findings, reported in a paper to be published Monday, Nov. 7, in the journal Nature Photonics, lay the groundwork for developing a new type of integrated device with the flexibility to operate as a laser, an amplifier, a modulator, and an absorber or detector.

"In a single optical cavity we achieved both coherent light amplification and absorption at the same frequency, a counterintuitive phenomenon because these two states fundamentally contradict each other," said study principal investigator Xiang Zhang, senior faculty scientist at Berkeley Lab's Materials Sciences Division. "This is important for high-speed modulation of light pulses in optical communication."

Reversing the laser

The concept of anti-lasers, or coherent perfect absorber (CPA), emerged in recent years as something that reverses what a laser does. Instead of strongly amplifying a beam of light, an anti-laser can completely absorb incoming coherent light beams.

While lasers are already ubiquitous in modern life, applications for anti-lasers—first demonstrated five years ago by Yale University researchers—are still being explored. Because anti-lasers can pick up weak coherent signals in the midst of a "noisy" incoherent background, it could be used as an extremely sensitive chemical or biological detector.

A device that can incorporate both capabilities could become a valuable building block for the construction of photonic integrated circuits, the researchers said.

"On-demand control of light from coherent absorption to coherent amplification was never imagined before, and it remains highly sought after in the scientific community," said study lead author Zi Jing Wong, a postdoctoral researcher in Zhang's lab. "This device can potentially enable a very large contrast in modulation with no theoretical limits."

The researchers utilized sophisticated nanofabrication technology to build 824 repeating pairs of gain and loss materials to form the device, which measured 200 micrometers long and 1.5 micrometers wide. A single strand of human hair, by comparison, is about 100 micrometers in diameter.

The gain medium was made out of indium gallium arsenide phosphide, a well-known material used as an amplifier in optical communications. Chromium paired with germanium formed the loss medium. Repeating the pattern created a resonant system in which light bounces back and forth throughout the device to build up the amplification or absorption magnitude.

If one is to send light through such a gain-loss repeating system, an educated guess is that light will experience equal amounts of amplification and absorption, and the light will not change in intensity. However, this is not the case if the system satisfies conditions of parity-time symmetry, which is the key requirement in the device design.

Balance and symmetry

Parity-time symmetry is a concept that evolves from quantum mechanics. In a parity operation, positions are flipped, such as the left hand becoming the right hand, or vice versa.

Now add in the time-reversal operation, which is akin to rewinding a video and observing the action backwards. The time-reversed action of a balloon inflating, for example, would be that same balloon deflating. In optics, the time-reversed counterpart of an amplifying gain medium is an absorbing loss medium.

A system that returns to its original configuration upon performing both parity and time-reversal operations is said to fulfill the condition for parity-time symmetry.

Soon after the discovery of the anti-laser, scientists had predicted that a system exhibiting parity-time symmetry could support both lasers and anti-lasers at the same frequency in the same space. In the device created by Zhang and his group, the magnitude of the gain and loss, the size of the building blocks, and the wavelength of the light moving through combine to create conditions of parity-time symmetry.

When the system is balanced and the gain and loss are equal, there is no net amplification or absorption of the light. But if conditions are perturbed such that the symmetry is broken, coherent amplification and absorption can be observed.

In the experiments, two light beams of equal intensity were directed into opposite ends of the device. The researchers found that by tweaking the phase of one light source, they were able to control whether the light waves spent more time in amplifying or absorbing materials.

Speeding up the phase of one light source results in an interference pattern favoring the gain medium and the emission of amplified coherent light, or a lasing mode. Slowing down the phase of one light source has the opposite effect, resulting in more time spent in the loss medium and the coherent absorption of the beams of light, or an anti-lasing mode.

If the phase of the two wavelengths are equal and they enter the device at the same time, there is neither amplification nor absorption because the light spends equal time in each region.

The researchers targeted a wavelength of about 1,556 nanometers, which is within the band used for optical telecommunications.

"This work is the first demonstration of balanced gain and loss that strictly satisfies conditions of parity-time symmetry, leading to the realization of simultaneous lasing and anti-lasing," said study co-author Liang Feng, former postdoctoral researcher in Zhang's Lab, and now an assistant professor of electrical engineering at the University of Buffalo. "The successful attainment of both lasing and anti-lasing within a single integrated device is a significant step towards the ultimate light control limit." [16]

Laser researchers boldly go into uncharted THz territory

Once the preferred weapon of B-movie madmen and space-fiction heroes alike, the laser—a device that generates an intense beam of coherent electromagnetic radiation by stimulating the emission of photons from excited atoms or molecules—has grown a bit domesticated of late.

These days, it has a steady job in industry, and spends its spare time printing documents in home offices and playing back movies in home theaters. Here and there it pops up in medical journals and military news, but it's basically been reduced to reading barcodes at the grocery checkout—a technology that's lost its mojo.

But lasers are still cool, insists Sushil Kumar of Lehigh University, with vast potential for innovation we've just begun to tap. And with support from the National Science Foundation (NSF), he's on a mission to prove it.

Kumar, an associate professor of electrical and computer engineering, focuses specifically on lasers that arise from a relatively unexploited region in the electromagnetic spectrum, the terahertz (THz), or far infrared, frequency. A researcher at the forefront of THz semiconductor 'quantum-cascade' laser technology, he and his colleagues have posted world-record results for high-temperature operation and other important performance characteristics of such lasers.

His goal is to develop devices that open up a wide array of possible applications: chemical and biological sensing, spectroscopy, detection of explosives and other contraband materials, disease diagnosis, quality control in pharmaceuticals, and even remote-sensing in astronomy to understand star and galaxy formation, just to name a few. (Pretty cool stuff... the folks back at the checkout line would be impressed.)

Yet despite the known benefits, Kumar says that terahertz lasers have been underutilized and underexplored; high cost and functional limitations have stymied the innovation that would lead to such usage. Kumar, however, believes he's on track to truly unleash the power of THz laser technology; he recently received a grant from the NSF, Phase-locked arrays of high-power terahertz lasers with ultra-narrow beams, with a goal of creating THz lasers that produce vastly greater optical intensities than currently possible—and potentially removing barriers to widescale research and commercial adoption.

Focusing on a solution

According to Kumar, the terahertz region of the electromagnetic spectrum is significantly underdeveloped due to lack of high-power sources of radiation. Existing sources feature low output power and other undesired spectral characteristics which makes them unsuitable for serious application. His current project aims to develop terahertz semiconductor lasers with precise emission frequency of up to 100 milliwatts of average optical power—an improvement of two orders of magnitude over current technology—in a narrow beam with signifcantly less than five degrees of angular divergence.

Kumar works with quantum cascade lasers (QCLs). These devices were originally invented for emission of mid-infrared radiation. They have only recently begun to make a mark at THz frequencies, and in that range they suffer from several additional challenges. In this cutting-edge environment, Kumar's group is among a select few in the world making progress toward viable and low-cost production of these lasers.

Kumar's intended approach will significantly improve power output and beam quality from QCLs. A portable, electrically-operated cryocooler will provide the required temperature-cooling for the semiconductor laser chips; these will contain phase-locked QCL arrays emitting at a range of discrete terahertz frequencies determined by the desired application.

In previous work, Kumar and his group showed that THz lasers (emtting at a wavelength of approximately 100 microns) could emit a focused beam of light by utilizing a technique called distributed feedback. The light energy in their laser is confined inside a cavity sandwiched between two metallic plates separated by a distance of 10 microns. Using a box-shaped cavity measuring 10 microns by 100 microns by 1,400 microns (1.4 millimeters), the group produced a terahertz laser with a beam divergence angle of just 4 degrees by 4 degrees, the narrowest divergence yet achieved for such terahertz lasers.

Kumar believes most companies that currently employ mid-infrared lasers would be interested in powerful, affordable terahertz QCLs, and that the technology itself will spawn new solutions.

"The iPhone needed to exist before developers could write the 'killer apps' that made it a household product," he says. "In the same way, we are working toward a technology that could allow future researchers to change the world in ways that have yet to even be considered." [15]

New imaging technique stimulates particles to emit laser light, could create higher-resolution images

A new imaging technique developed by scientists at MIT, Harvard University, and Massachusetts General Hospital (MGH) aims to illuminate cellular structures in deep tissue and other dense and opaque materials. Their method uses tiny particles embedded in the material, that give off laser light.

The team synthesized these "laser particles" in the shape of tiny chopsticks, each measuring a small fraction of a human hair's width. The particles are made from lead iodide perovskite—a material that is also used in solar panels, and that efficiently absorbs and traps light. When the researchers shine a laser beam at the particles, the particles light up, giving off normal, diffuse fluorescent light. But if they tune the incoming laser's power to a certain "lasing threshold," the particles will instantly generate laser light.

The researchers, led by MIT graduate student Sangyeon Cho, demonstrated they were able to stimulate the particles to emit laser light, creating images at a resolution six times higher than that of current fluorescence-based microscopes.

"That means that if a fluorescence microscope's resolution is set at 2 micrometers, our technique can have 300-nanometer resolution—about a sixfold improvement over regular microscopes," Cho says. "The idea is very simple but very powerful and can be useful in many different imaging applications."

Cho and his colleagues have published their results in the journal Physical Review Letters. His co-authors include Seok Hyun Yun, a professor at Harvard; Nicola Martino, a research fellow at Harvard and MGH's Wellman Center for Photomedicine; and Matjaž Humar, a researcher at the Jozef Stefan Institute. The research was done as part of the Harvard-MIT Division of Health Sciences and Technology.

A light in the dark

When you shine a flashlight in a darkened room, that light appears as a relatively diffuse, hazy beam of white light, representing a jumble of different wavelengths and colors. In stark contrast, laser light is a pointedly focused, monochromatic beam of light, of a specific frequency and color.

In conventional fluorescence microscopy, scientists may inject a sample of biological tissue with particles filled with fluorescent dyes. They then point a laser beam through a lens that directs the beam through the tissue, causing any fluorescent particles in its path to light up.

But these particles, like microscopic flashlights, produce a relatively indistinct, fuzzy glow. If such particles were to emit more focused, laser-like light, they might produce sharper images of deep tissues and cells. In recent years, researchers have developed laser-light-emitting particles, but Cho's work is the first to apply these unique particles to imaging applications.

Chopstick lasers

The team first synthesized tiny, 6-micron-long nanowires from lead iodide perovskite, a material that does a good job of trapping and concentrating fluorescent light.

The particles' rod-shaped geometry—which Cho describes as "chopstick-like"—can allow a specific wavelength of light to bounce back and forth along the particles' length, generating a standing wave, or very regular, concentrated pattern of light, similar to a laser.

The researchers then built a simple optical setup, similar to conventional fluorescence microscopes, in which a laser beam is pumped from a light source, through a lens, and onto a sample platform containing the laser particles.

For the most part, the researchers found that the particles emitted diffuse fluorescent light in response to the laser stimulation, similar to conventional fluorescent dyes, at low pump power. However, when they tuned the laser's power to a certain threshold, the particles lit up considerably, emitting much more laser light.

Cho says that the new optical technique, which they have named LAser particle Stimulated Emission (LASE) microscopy, could be used to image a specific focal plane, or a particular layer of biological tissue. Theoretically, he says, scientists can shine a laser beam into a three-dimensional sample of tissue embedded throughout with laser particles, and use a lens to focus the beam at a specific depth. Only those particles in the beam's focus will absorb enough light or energy to turn on as lasers themselves. All other particles upstream of the path's beam should absorb less energy and only emit fluorescent light.

"We can collect all this stimulated emission and can distinguish laser from fluorescent light very easily using spectrometers," Cho says. "We expect this will be very powerful when applied to biological tissue, where light normally scatters all around, and resolution is devastated. But if we use laser particles, they will be the narrow points that will emit laser light. So we can distinguish from the background and can achieve good resolution."

Giuliano Scarcelli, an assistant professor at the University of Maryland, says the technique's success will hinge on successfully implementing it on a standard fluorescence microscope. Once that is achieved, laser imaging's applications, he says, are promising.

"The fact that you have a laser versus fluorescence probably means you can measure deeper into tissue because you have a higher signal-to-noise ratio," says Scarcelli, who was not involved in the work. "We'll need to see in practice, but on the other hand, with optics, we have no good way of imaging deep tissue. So any research on this topic is a welcome addition."

To implement this technique in living tissue, Cho says laser particles would have to be biocompatible, which lead iodide perovskite materials are not. However, the team is currently investigating ways to manipulate cells themselves to glow like lasers.

"Our idea is, why not use the cell as an internal light source?" Cho says. "We're starting to think about that problem." [14]

Physicists use multicolored laser light to study atoms critical to medicine

UCLA physicists have shown that shining multicolored laser light on rubidium atoms causes them to lose energy and cool to nearly absolute zero. This result suggests that atoms fundamental to chemistry, such as hydrogen and carbon, could also be cooled using similar lasers, an outcome that would allow researchers to study the details of chemical reactions involved in medicine.

This research is published online today in the journal Physical Review X.

Physicists have known for several decades that shining laser light of a particular energy onto atoms can decrease their speeds and therefore energy. Small packets of light—photons—carry momentum with them, and this momentum is imparted to atoms as the photons are absorbed. By forcing atoms moving in one direction to absorb only photons traveling in the opposite direction, researchers can slow down the speeds of atoms from hundreds of meters per second to merely millimeters per second. This decrease in motion means that the atoms cool from room temperature to nearly absolute zero. Holding atoms at ultracold temperatures allows researchers to study their chemical reactions on the quantum mechanical level.

"Temperature is the main reason we don't experience many things that require quantum mechanics in our daily lives," said Wesley Campbell, a UCLA assistant professor of physics and astronomy, and co-author of the study. "At room temperature you don't really know the details of what's going on at the quantum scale. We can use these ultracold atoms to learn something about the chemistry that governs medicine and biology."

However, designing the powerful lasers necessary for this cooling—lasers that emit light of only one specific color and therefore energy—is an engineering challenge. The wavelength of the laser light has to be controlled to roughly one part in 100 million, which is like measuring the width of the United States to a precision of five centimeters. Furthermore, cooling biologically important atoms like hydrogen, oxygen, and carbon requires laser light that's in the very high-frequency ultraviolet part of the electromagnetic spectrum, and creating light this energetic is extremely difficult. In 1993, researchers in Italy successfully cooled hydrogen atoms using a laser, but the process was highly inefficient. "Nobody ever did it again," Campbell said.

Campbell and his team demonstrated a proof of concept to show that biologically important atoms could be reliably cooled using lasers. The researchers faced two challenges: creating laser light of a precise energy and showing that very high-frequency ultraviolet radiation could be reliably generated.

The researchers adopted a surprising approach that involved using an atypical kind of laser. Instead of a laser that emits a single color of light—what most people think of when they envision a laser—Campbell and his group tested a laser that emitted a range of colors, all shades of red. "It's a single laser, but it's lots of colors," said Xueping Long, a UCLA graduate student in Campbell's laboratory and a co-author of the paper.

The researchers were initially worried that all of the slightly different red wavelengths of light would be detrimental to their experiment. "If you have light on at the wrong color, it typically heats things and causes problems," said lead author Andrew Jayich, who was a UCLA postdoctoral researcher in Campbell's laboratory when this research was conducted and is now an assistant professor of physics at UC Santa Barbara.

However, when the UCLA scientists pointed their multicolored laser beam toward roughly 10 million atoms, they successfully demonstrated that pairs of photons emitted by the laser could be simultaneously absorbed by atoms. When absorbed in tandem, these pairs of photons mimicked light with precisely the energy necessary to cool the atoms. "Two photons play the role of one photon with twice the energy," Jayich said.

The researchers showed, for the first time, that pairs of photons could be used to reliably cool atoms. The final temperature of the atoms was 0.000057 degrees above absolute zero.

By combining red photons, the researchers demonstrated a method that can be used to create the energy of very high-frequency ultraviolet light, without the difficulties of actually generating such photons. "We've done something that sounds like it shouldn't work at all," Campbell said.

The scientists demonstrated their technique with rubidium, a heavy atom with 37 protons. "Rubidium is the easiest atom to work with; it's nature's gift to atomic physicists," Campbell said. But he and his team are looking forward to how their technique can be adapted for use with more common elements such as hydrogen, carbon, oxygen and nitrogen.

"These atoms are what you and I are made of, what the planet is made of, and what stars are made of," Campbell said. "We're interested in getting access to these atoms that atomic physicists have basically given up on." [13]

Physicists discover 'smoke rings' made of laser light

Most basic physics textbooks describe laser light in fairly simple terms: a beam travels directly from one point to another and, unless it strikes a mirror or other reflective surface, will continue traveling along an arrow-straight path, gradually expanding in size due to the wave nature of light. But these basic rules go out the window with high-intensity laser light.

Powerful laser beams, given the right conditions, will act as their own lenses and "self-focus" into a tighter, even more intense beam. University of Maryland physicists have discovered that these self-focused laser pulses also generate violent swirls of optical energy that strongly resemble smoke rings. In these donut-shaped light structures, known as "spatiotemporal optical vortices," the light energy flows through the inside of the ring and then loops back around the outside.

The vortices travel along with the laser pulse at the speed of light and control the energy flow around it. The newly discovered optical structures are described in the September 9, 2016 issue of the journal Physical Review X.

The researchers named the laser smoke rings "spatiotemporal optical vortices," or STOVs. The light structures are ubiquitous and easily created with any powerful laser, given the right conditions. The team strongly suspects that STOVs could explain decades' worth of anomalous results and unexplained effects in the field of high-intensity laser research.

"Lasers have been researched for decades, but it turns out that STOVs were under our noses the whole time," said Howard Milchberg, professor of physics and electrical and computer engineering at UMD and senior author of the research paper, who also has an appointment at the UMD Institute for Research in Electronics and Applied Physics (IREAP). "This is a robust, spontaneous feature that's always there. This phenomenon underlies so much that's been done in our field for the past 30-some years."

More conventional spatial optical vortices are well-known from prior research—chief among them "orbital angular momentum" (OAM) vortices, where light energy circulates around the beam propagation direction much like water rotates around a drain as it empties from a washbasin. Because these vortices can influence the shape of the central beam, they have proven useful for advanced applications such as high-resolution microscopy.

Spatiotemporal optical vortices, or STOVs (thin, gray ringlike objects), are newly described three-dimensional light structures that strongly resemble smoke rings. Unlike other laser vortices, STOVs are time dynamic, which means that they travel along with the central laser pulse. Compared to other laser vortices, STOVs could prove more broadly useful for engineering applications.

"Conventional optical vortices have been studied since the late 1990s as a way to improve telecommunications, microscopy and other applications. These vortices allow you to control what gets illuminated and what doesn't, by creating small structures in the light itself," said the paper's lead author Nihal Jhajj, a physics graduate student who conducted the research at IREAP.

"The smoke ring vortices we discovered may have even broader applications than previously known optical vortices, because they are time dynamic, meaning that they move along with the beam instead of remaining stationary," Jhajj added. "This means that the rings may be useful for manipulating particles moving near the speed of light."

Jhajj and Milchberg acknowledge that much more work needs to be done to understand STOVs, including their physical and theoretical implications. But they are particularly excited for new opportunities that will arise in basic laser research following their discovery of STOVs.

"All the evidence we've seen suggests that STOVs are universal," Jhajj said. "Now that we know what to look for, we think that looking at a high-intensity laser pulse propagating through a medium and not seeing STOVs would be a lot like looking at a river and not seeing eddies and currents."

Eventually, STOVs might have useful real-world applications, like their more conventional counterparts. For example, OAM vortices have been used in the design of more powerful stimulated emission depletion (STED) microscopes. STED microscopes are capable of much higher resolution than traditional confocal microscopes, in part due to the precise illumination offered by optical vortices.

With the potential to travel with the central beam at the speed of light, STOVs could have as-yet unforeseen advantages in technological applications, including the potential to expand the effective bandwidth of fiber-optic communication lines.

"A STOV is not just a spectator to the laser beam, like an angel's halo," explained Milchberg, noting the ability of STOVs to control the central beam's shape and energy flow. "It is more like an electrified angel's halo, with energy shooting back and forth between the halo and the angel's head. We're all very excited to see where this discovery will take us in the future." [12]

Electrons fingerprint the fastest laser pulses

Analyzing ultrafast chemical processes requires ultrafast lasers—light pulses lasting for mere attoseconds (10-18 second)—to act as a "stop-motion" strobe camera. Physicists at the University of

Nebraska-Lincoln are analyzing how ultrafast laser pulses interact with matter. Their study of how two attosecond laser pulses would interact with a helium atom produced an electron momentum distribution that displays an unexpected two-armed vortex pattern, resembling a spiral galaxy.

Attosecond-duration laser pulses provide a new tool with the potential to provide key insights on ultrafast chemical processes and ultimately to control processes that underlie energy-relevant technologies, such as solar energy conversion and catalysis. But before this new tool can meet its full potential, the pulses themselves and their fundamental interactions with matter must be understood. In this case, the researchers reveal vortex patterns produced by attosecond laser pulses can serve as an excellent diagnostic tool for characterizing the electron-manipulating laser pulses. For example, the pattern can be used to determine the intensity of the pulses and the time delay between them.

When interrogating matter with a laser pulse, the duration of the pulse plays a major role in determining the information that can be acquired. In general, the process that is being studied must occur on the same time scale as the laser pulse. For this reason, chemical dynamics processes, which often occur on the femtosecond-to-attosecond time scale, are difficult to study. Recent technological developments are beginning to make attosecond laser pulses a reality, but a great deal of mystery still surrounds the processes that these laser pulses could unveil. Scientists will often use computer simulations, based on quantum mechanical principles, to predict the ultrafast laser interactions they seek to replicate experimentally.

Physicists at the University of Nebraska-Lincoln have taken this approach and simulated the interaction of a helium atom with two time-delayed attosecond laser pulses of opposite circular polarization. The resulting electron momentum distribution displays an unexpected two-armed vortex pattern. The team's first pulse of circularly polarized light rotated in one direction, with the second rotating the opposite way. These orientations dictate whether the resulting spiral pattern appears to swirl left or right. The time delay between the pulses determines the number of windings of the two spiral arms, whereas the duration of the pulses corresponds to the width of the arms. This pattern is significant because it has been observed previously in the interaction of laser beams, but never with electrons. The similarity of the vortex pattern highlights the wave-particle duality of the electron, which describes how it behaves both as a particle and as a wave.

Additionally, the discovery of the vortex pattern has many potential practical applications. Due to the extreme sensitivity of the vortex pattern to the time delay between the two pulses, analyzing the pattern could help characterize the time delay and intensity of attosecond laser pulses. Similarly, the vortex pattern could be used as a "stopwatch" to determine the duration of ultrafast processes. Also, the ability to produce a specific momentum pattern with this interaction demonstrates a new way to control electron motion with laser pulses. [11]

Superfast light pulses able to measure response time of electrons to light

A team of researchers with members from Germany, the U.S. and Russia has found a way to measure the time it takes for an electron in an atom to respond to a pulse of light. In their paper published in the journal Nature, the team describes their use of a light field synthesizer to create pulses of light so fast that they were able to reveal the time it took for electrons in an atom to respond when struck. Kyung Taec Kim with the Gwangju Institute of Science offers a News & Views piece on the work done by the team in the same journal issue, outlining their work and noting one issue that still needs to be addressed with such work.

As scientists have begun preparing for the day when photons will replace electrons in high speed computers, work is being done to better understand the link between the two. One important aspect of this is learning what happens when photons strike electrons that remain in their atom (rather than being knocked out of them), specifically, how long does it take them to respond.

To find this answer, the researchers used what has come to be known as a light-field synthesizer—it is a device that is able to produce pulses of light that are just half of a single wavelength long—something many had thought was impossible not too long ago. The pulses are of such short duration that they only last for the time it takes to travel that half wavelength, which in this case, was approximately 380 attoseconds.

The light-field synthesizer works by combining several pulses of light brought together but slightly out of phase, allowing for canceling and ultimately, a single very short pulse. In their experiments, the researchers fired their super-short pulses at krypton atoms held inside of a vacuum. In so doing, they found that it took the electrons 115 attoseconds to respond—the first such measurement of the response time of an electron to a visible light pulse.

The team plans to continue their work by looking at how electrons behave in other materials, and as Kim notes, finding a way to characterize both the amplitude and phase of radiation from atoms driven by a light field. [10]

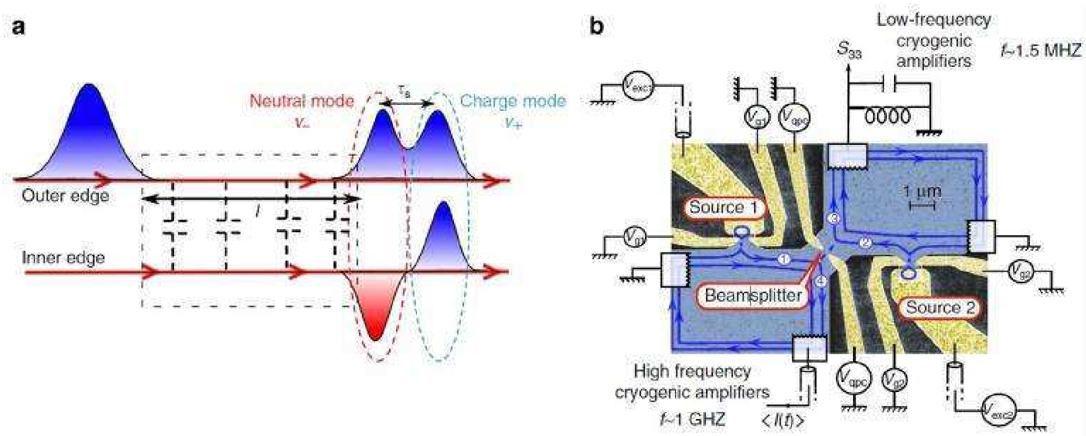
When an electron splits in two

Now in a new paper published in Nature Communications, a team of physicists led by Gwendal Fève at the Ecole Normale Supérieure in Paris and the Laboratory for Photonics and Nanostructures in Marcoussis have applied an experiment typically used to study photons to investigate the underlying mechanisms of electron fractionalization. The method allows the researchers to observe single-electron fractionalization on the picosecond scale.

"We have been able to visualize the splitting of an electronic wavepacket into two fractionalized packets carrying half of the original electron charge," Fève told Phys.org. "Electron fractionalization has been studied in previous works, mainly during roughly the last five years. Our work is the first to combine single-electron resolution—which allows us to address the fractionalization process at the elementary scale—with time resolution to directly visualize the fractionalization process."

The technique that the researchers used is called the Hong-Ou-Mandel experiment, which can be used to measure the degree of resemblance between two photons, or in this case electron charge pulses, in an interferometer. This experiment also requires a single-electron emitter, which some of the same researchers, along with many others, have recently been developing.

The researchers first analyzed the propagation of a single electron in the interferometer's outer one-dimensional wire, and then when that electron fractionalized, they could observe the interaction between its two charge pulses in the inner one-dimensional wire. As the researchers explain, when the original electron travels along the outer wire, Coulomb interactions (interactions between charged particles) between excitations in the outer and inner wires produce two types of excitation pairs: two pulses of the same sign (carrying a net charge) and two pulses of opposite signs (which together are neutral). The two different excitation pairs travel at different velocities, again due to Coulomb interactions, which causes the original electron to split into two distinct charge pulses.



(a) An electron on the outer channel fractionalizes into two pulses. (b) A modified scanning electron microscope picture of the sample. Credit: Freulon, et al. ©2015 Nature

The experiment reveals that, when a single electron fractionalizes into two pulses, the final state cannot be described as a single-particle state, but rather as a collective state composed of several excitations. For this reason, the fractionalization process destroys the original electron particle. Electron destruction can be measured by the decoherence of the electron's wave packet.

Gaining a better understanding of electron fractionalization could have a variety of implications for research in condensed matter physics, such as controlling single-electron currents in one-dimensional wires.

"There has been, during the past years, strong efforts to control and manipulate the propagation of electrons in electronic conductors," Fève said. "It bears many analogies with the manipulations of the quantum states of photons performed in optics. For such control, one-dimensional conductors are useful, as they offer the possibility to guide the electrons along a one-dimensional trajectory. However, Coulomb interactions between electrons are also very strong in one-dimensional wires, so strong that electrons are destroyed: they fractionalize. Understanding fractionalization is understanding the destruction mechanism of an elementary electron in a one-dimensional wire. Such understanding is very important if one wants to control electronic currents at the elementary scale of a single electron."

In the future, the researchers plan to perform further experiments with the Hong-Ou-Mandel interferometer in order to better understand why fractionalization leads to electron destruction, and possibly how to suppress fractionalization.

"The Hong-Ou-Mandel interferometer can be used to picture the temporal extension (or shape) of the electronic wavepackets, which is what we used to visualize the fractionalization process," Fève said. "It can also be used to capture the phase relationship (or phase coherence) between two components of the electronic wavepacket.

"This combined information fully defines the single-electron state, offering the possibility to visualize the wavefunction of single electrons propagating in a one-dimensional conductor. This would first provide a complete understanding of the fractionalization mechanism and in particular how it leads to the decoherence of single-electron states. It would also offer the possibility to test if single electrons can be protected from this decoherence induced by Coulomb interaction. Can we suppress (or reduce) the fractionalization process by reducing the strength of the Coulomb interaction? We would then be able to engineer and visualize pure single-electron states, preserved from Coulomb interaction.

"The next natural step is then to address few-particle states and electron entanglement in quantum conductors. Again, the question of the destruction of such states by Coulomb interaction effects will be a crucial one." [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) $M_p = n^2 M_e$

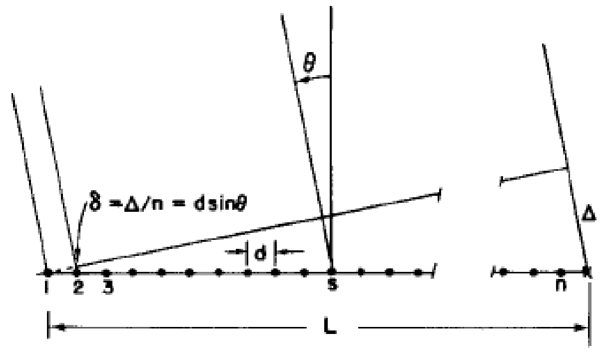


Fig. 30–3. A linear array of *n* equal oscillators, driven with phases $\alpha_s = s\alpha$.

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) $d \sin \theta = m \lambda$

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) $2 (m+1) = n$

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:

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

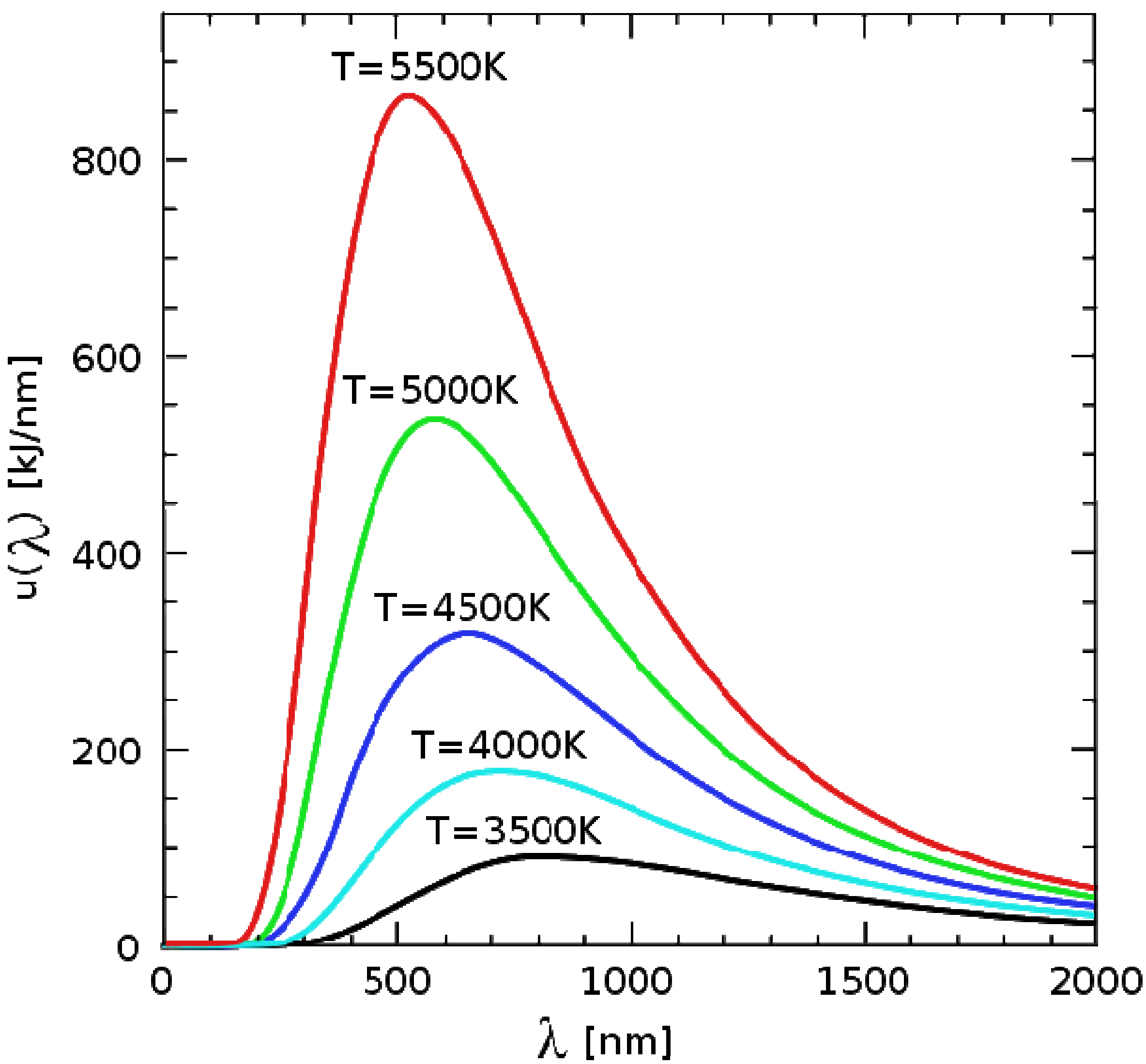


Figure 2. The distribution law for different T temperatures

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) $$\lambda_{\mathrm{max}} = \frac{b}{T}$$

> 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 $2.8977685(51)\times10^{-3}$ m·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 $d<10^{-13}$ 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 1/2spin 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. [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 h = d x d p or 1/2 h = d t d 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 1/2spin 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 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 week 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 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 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 dx and raising the dp. 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 rate since the dx is much less requiring bigger dp 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 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 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 h = dx dp or 1/2 h = dt dE, 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 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 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 *λν* = *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

"The next natural step is then to address few-particle states and electron entanglement in quantum conductors. Again, the question of the destruction of such states by Coulomb interaction effects will be a crucial one." [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 rate 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.

References

[1] http://www.academia.edu/3834454/3_Dimensional_String_Theory

[2] http://www.academia.edu/3833335/The_Magnetic_field_of_the_Electric_current

[3] http://www.academia.edu/4158863/Higgs_Field_and_Quantum_Gravity

[4] http://www.academia.edu/4196521/The_Electro-Strong_Interaction

[5] http://www.academia.edu/4221717/General_Weak_Interaction

[6] The Feynman Lectures on Physics p. 274 (30.6)
Author: Richard Phillips Feynman
Publisher: Addison Wesley Longman (January 1970)
ISBN-10: **0201021153** | ISBN-13: **978-0201021158**

[7] Path Integral Formulation of Quantum Mechanics

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

[8] https://www.academia.edu/4215078/Accelerated_Relativity

[9] When an electron splits in two

http://phys.org/news/2015-05-electron.html

[10] Superfast light pulses able to measure response time of electrons to light

http://phys.org/news/2016-02-superfast-pulses-response-electrons.html

[11] Electrons fingerprint the fastest laser pulses

http://phys.org/news/2016-09-electrons-fingerprint-fastest-laser-pulses.html

[12] Physicists discover 'smoke rings' made of laser light

http://phys.org/news/2016-09-physicists-laser.html

[13] Physicists use multicolored laser light to study atoms critical to medicine

http://phys.org/news/2016-10-physicists-multicolored-laser-atoms-critical.html

[14] New imaging technique stimulates particles to emit laser light, could create higher-resolution images

http://phys.org/news/2016-11-imaging-technique-particles-emit-laser.html

[15] Laser researchers boldly go into uncharted THz territory

http://phys.org/news/2016-10-laser-boldly-uncharted-thz-territory.html

[16] Lasers + anti-lasers: Marriage opens door to development of single device with exceptional range of optical capabilities

http://phys.org/news/2016-11-lasers-anti-lasers-marriage-door-device.html