Superfluid in Magnetic Field

MIT physicists have created a superfluid gas, the so-called Bose-Einstein condensate, for the first time in an extremely high magnetic field. The magnetic field is a synthetic magnetic field, generated using laser beams, and is 100 times stronger than that of the world's strongest magnets. Within this magnetic field, the researchers could keep a gas superfluid for a tenth of a second—just long enough for the team to observe it. The researchers report their results this week in the journal Nature Physics. [9]

Phonons—the elemental particles that transmit both heat and sound—have magnetic properties, according to a landmark study supported by Ohio Supercomputer Center (OSC) services and recently published by a researcher group from The Ohio State University. [8]

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.

The changing acceleration of the electrons explains the created negative electric field of the magnetic induction, the changing relativistic mass and the Gravitational Force, giving a Unified Theory of the physical forces. Taking into account the Planck Distribution Law of the electromagnetic oscillators also, we can explain the electron/proton mass rate and the Weak and Strong Interactions.

Contents

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Preface

Surprisingly nobody found strange that by theory the electrons are moving with a constant velocity in the stationary electric current, although there is an accelerating force **F = q E**, imposed by the **E** electric field along the wire as a result of the **U** potential difference. The accelerated electrons are creating a charge density distribution and maintaining the potential change along the wire. This charge distribution also creates a radial electrostatic field around the wire decreasing along the wire. The moving external electrons in this electrostatic field are experiencing a changing electrostatic field causing exactly the magnetic effect, repelling when moving against the direction of the current and attracting when moving in the direction of the current. This way the **A** magnetic potential is based on the real charge distribution of the electrons caused by their acceleration, maintaining the **E** electric field and the **A** magnetic potential at the same time.

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 electromagnetic matter. If the charge could move faster than the electromagnetic field, this self maintaining electromagnetic property of the electric current would be failed.

More importantly the accelerating electrons can explain the magnetic induction also. The changing acceleration of the electrons will create a –**E** electric field by changing the charge distribution, increasing acceleration lowering the charge density and decreasing acceleration causing an increasing charge density.

Since the magnetic induction creates a negative electric field as a result of the changing acceleration, it works as a relativistic changing electromagnetic mass. If the mass is electromagnetic, then the gravitation is also electromagnetic effect. The same charges would attract each other if they are moving parallel by the magnetic effect.

Research team creates a superfluid in a record-high magnetic field

A superfluid is a phase of matter that only certain liquids or gases can assume, if they are cooled to extremely low temperatures. At temperatures approaching absolute zero, atoms cease their individual, energetic trajectories, and start to move collectively as one wave.

Superfluids are thought to flow endlessly, without losing energy, similar to electrons in a superconductor. Observing the behavior of superfluids therefore may help scientists improve the quality of superconducting magnets and sensors, and develop energy-efficient methods for transporting electricity.

But superfluids are temperamental, and can disappear in a flash if atoms cannot be kept cold or confined. The MIT team combined several techniques in generating ultracold temperatures, to create and maintain a superfluid gas long enough to observe it at ultrahigh synthetic magnetic fields.

"Going to extremes is the way to make discoveries," says team leader Wolfgang Ketterle, the John D. MacArthur Professor of Physics at MIT. "We use ultracold atoms to map out and understand the behavior of materials which have not yet been created. In this sense, we are ahead of nature."

A superfluid with loops

The team first used a combination of laser cooling and evaporative cooling methods, originally co-developed by Ketterle, to cool atoms of rubidium to nanokelvin temperatures. Atoms of rubidium are known as bosons, for their even number of nucleons and electrons. When cooled to near absolute zero, bosons form what's called a Bose-Einstein condensate—a superfluid state that was first co-discovered by Ketterle, and for which he was ultimately awarded the 2001 Nobel Prize in physics.

After cooling the atoms, the researchers used a set of lasers to create a crystalline array of atoms, or optical lattice. The electric field of the laser beams creates what's known as a periodic potential landscape, similar to an egg carton, which mimics the regular arrangement of particles in real crystalline materials.

When charged particles are exposed to magnetic fields, their trajectories are bent into circular orbits, causing them to loop around and around. The higher the magnetic field, the tighter a particle's orbit becomes. However, to confine electrons to the microscopic scale of a crystalline material, a magnetic field 100 times stronger than that of the strongest magnets in the world would be required.

The group asked whether this could be done with ultracold atoms in an optical lattice. Since the ultracold atoms are not charged, as electrons are, but are instead neutral particles, their trajectories are normally unaffected by magnetic fields.

Instead, the MIT group came up with a technique to generate a synthetic, ultrahigh magnetic field, using laser beams to push atoms around in tiny orbits, similar to the orbits of electrons under a real magnetic field. In 2013, Ketterle and his colleagues demonstrated the technique, along with other researchers in Germany, which uses a tilt of the optical lattice and two additional laser beams to control the motion of the atoms. On a flat lattice, atoms can easily move around from site to site.
However, in a tilted lattice, the atoms would have to work against gravity. In this scenario, atoms could only move with the help of laser beams.

"Now the laser beams could be used to make neutral atoms move around like electrons in a strong magnetic field," added Kennedy.

Using laser beams, the group could make the atoms orbit, or loop around, in a radius as small as two lattice squares, similar to how particles would move in an extremely high magnetic field.

"Once we had the idea, we were really excited about it, because of its simplicity. All we had to do was take two suitable laser beams and carefully align them at specific angles, and then the atoms drastically change their behavior," Kennedy says.

MIT Professor Wolfgang Ketterle is an expert in trapping and cooling atoms to temperatures close to absolute zero. In 2001 he received a share of the Nobel Prize in physics for achieving Bose–Einstein condensation in dilute gases. Credit: Bryce Vickmark

"New perspectives to known physics"

After developing the tilting technique to simulate a high magnetic field, the group worked for a year and a half to optimize the lasers and electronic controls to avoid any extraneous pushing of the atoms, which could make them lose their superfluid properties.

"It's a complicated experiment, with a lot of laser beams, electronics, and magnets, and we really had to get everything stable," Burton says. "It took so long just to iron out all the details to eventually have this ultracold matter in the presence of these high fields, and keep them cold—some of it was painstaking work."

In the end, the researchers were able to keep the superfluid gas stable for a tenth of a second. During that time, the team took time-of-flight pictures of the distribution of atoms to capture the topology, or shape, of the superfluid. Those images also reveal the structure of the magnetic field—something that's been known, but never directly visualized until now.

"The main accomplishment is that we were able to verify and identify the superfluid state," Ketterle says. "If we can get synthetic magnetic fields under even better control, our laboratory could do years of research on this topic. For the expert, what it opens up is a new window into the quantum world, where materials with new properties can be studied."

Going forward, the team plans to carry out similar experiments, but to add strong interactions between ultracold atoms, or to incorporate different quantum states, or spins. Ketterle says such experiments would connect the research to important frontiers in material research, including quantum Hall physics and topological insulators.

"We are adding new perspectives to physics," Ketterle says. "We are touching on the unknown, but also showing physics that in principle is known, but at a new level of clarity." [9]

Researchers prove magnetism can control heat, sound

In a recent issue of the journal Nature Materials, the researchers describe how a magnetic field, roughly the size of a medical MRI, reduced the amount of heat flowing through a semiconductor by 12 percent. Simulations performed at OSC then identified the reason for it—the magnetic field induces a diamagnetic response in vibrating atoms known as phonons, which changes how they transport heat.

"This adds a new dimension to our understanding of acoustic waves," said Joseph Heremans, Ph.D., Ohio Eminent Scholar in Nanotechnology and a professor of mechanical engineering at Ohio State whose group performed the experiments. "We've shown that we can steer heat magnetically. With a strong enough magnetic field, we should be able to steer sound waves, too."

People might be surprised enough to learn that heat and sound have anything to do with each other, much less that either can be controlled by magnets, Heremans acknowledged. But both are expressions of the same form of energy, quantum mechanically speaking. So any force that controls one should control the other.

The nature of the effect of the magnetic field initially was not understood and subsequently was investigated through computer simulations performed on OSC's Oakley Cluster by Oscar

Restrepo, Ph.D., a research associate, Nikolas Antolin, a doctoral student, and Wolfgang Windl, Ph.D., a professor, all of Ohio State's Department of Materials Science and Engineering. After painstakingly examining all possible magnetic responses that a non-magnetic material can have to an external field, they found that the effect is due to a diamagnetic response, which exists in all materials. This suggests then that the general effect should be present in any solid.

The implication: in materials such as glass, stone, plastic—materials which are not conventionally magnetic—heat can be controlled magnetically, if you have a powerful enough magnet. This development may have future impacts on new energy production processes.

But, there won't be any practical applications of this discovery any time soon: seven-tesla magnets like the one used in the study don't exist outside of hospitals and laboratories, and a semiconductor made of indium antimonide had to be chilled to -450 degrees Fahrenheit (-268 degrees Celsius)—very close to absolute zero—to make the atoms in the material slow down enough for the phonons' movements to be detectible.

To simulate the experiment, Windl and his computation team employed a quantum mechanical modeling strategy known as density functional theory (DFT). The DFT strategy was used to determine how the electron distribution changed when atoms vibrated with or without magnetic field. The motion of the electrons around their atoms changed in the field, creating diamagnetic moments when phonons were present. These moments then reacted to the field and slowed the heat transport, similar to an eddy current brake in a train.

The simulations were conducted on the Oakley Cluster, an HP/Intel Xeon system with more than 8,300 processor cores to provide researchers with a peak performance of 154 Teraflops—tech-speak for 154 trillion calculations per second. Since atoms can vibrate in many different ways, a large number of simulations were necessary, consuming approximately 1.5 million CPU hours even on a machine as powerful as Oakley. OSC engineers also helped the research team use OSC's high-throughput, parallel file system to handle the immense datasets generated by the DFT model.

"OSC offered us phenomenal support; they supported our compilation and parallel threading issues, helped us troubleshoot hardware issues when they arose due to code demands, and moved us to the Lustre high-performance file system after we jammed their regular file system," said Antolin, who is the expert for high-demand computations in Windl's group.

"Dr. Windl and his team are important OSC clients, and we're always pleased to support their research projects with our hardware, software and staff support services," said David Hudak, Ph.D., OSC's director of supercomputer services. "With the addition of the Ruby Cluster this past fall and another, much more powerful system upcoming this fall, OSC will continue to offer even larger, faster and more powerful services to support this type of discovery and innovation."

Next, the group plans to test whether they can deflect sound waves sideways with magnetic fields. [8]

Simple Experiment

Everybody can repeat my physics teacher's - Nándor Toth - middle school experiment, placing aluminum folios in form V upside down on the electric wire with static electric current, and seeing them open up measuring the electric potential created by the charge distribution, caused by the acceleration of the electrons.

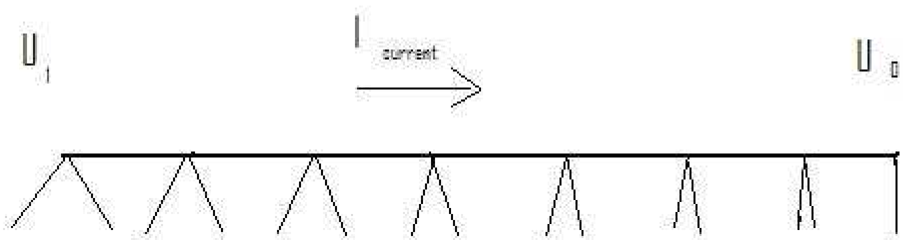

Figure 1.) Aluminium folios shows the charge distribution on the electric wire

He wanted to show us that the potential decreasing linearly along the wire and told us that in the beginning of the wire it is lowering harder, but after that the change is quite linear.

You will see that the folios will draw a parabolic curve showing the charge distribution along the wire, since the way of the accelerated electrons in the wire is proportional with the square of time. The free external charges are moving along the wire, will experience this charge distribution caused electrostatic force and repelled if moving against the direction of the electric current and attracted in the same direction – the magnetic effect of the electric current.

Uniformly accelerated electrons of the steady current

In the steady current **I= dq/dt**, the **q** electric charge crossing the electric wire at any place in the same time is constant. This does not require that the electrons should move with a constant v velocity and does not exclude the possibility that under the constant electric force created by the **E = - dU/dx** potential changes the electrons could accelerating.

If the electrons accelerating under the influence of the electric force, then they would arrive to the **$x = 1/2\ at^2$** in the wire. The **dx/dt = at**, means that every second the accelerating q charge will take a linearly growing length of the wire. For simplicity if a=2 then the electrons would found in the wire at x = 1, 4, 9, 16, 25 …, which means that the dx between them should be 3, 5, 7, 9 …, linearly increasing the volume containing the same q electric charge. It means that the density of the electric charge decreasing linearly and as the consequence of this the U field is decreasing linearly as expected: **-dU/dx = E = const**.

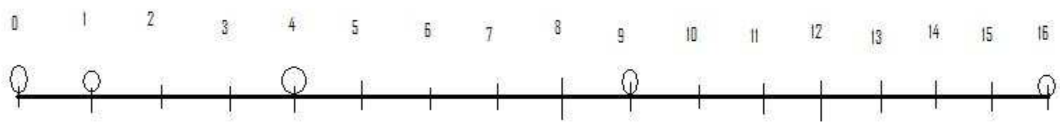

Figure 2.) The accelerating electrons created charge distribution on the electric wire

This picture remembers the Galileo's Slope of the accelerating ball, showed us by the same teacher in the middle school, some lectures before. I want to thank him for his enthusiastic and impressive lectures, giving me the associating idea between the Galileo's Slope and the accelerating charges of the electric current.

We can conclude that the electrons are accelerated by the electric **U** potential, and with this accelerated motion they are maintaining the linear potential decreasing of the **U** potential along they movement. Important to mention, that the linearly decreasing charge density measured in the referential frame of the moving electrons. Along the wire in its referential frame the charge density lowering parabolic, since the charges takes way proportional with the square of time.

The decreasing **U** potential is measurable, simply by measuring it at any place along the wire. One of the simple visualizations is the aluminum foils placed on the wire opening differently depending on the local charge density. The static electricity is changing by parabolic potential giving the equipotential lines for the external moving electrons in the surrounding of the wire.

Magnetic effect of the decreasing U electric potential

One **q** electric charge moving parallel along the wire outside of it with velocity v would experience a changing **U** electric potential along the wire. If it experiencing an emerging potential, it will repel the charge, in case of decreasing **U** potential it will move closer to the wire. This radial electric field will move the external electric charge on the parabolic curve, on the equipotential line of the accelerated charges of the electric current. This is exactly the magnetic effect of the electric current. A constant force, perpendicular to the direction of the movement of the matter will change its direction to a parabolic curve.

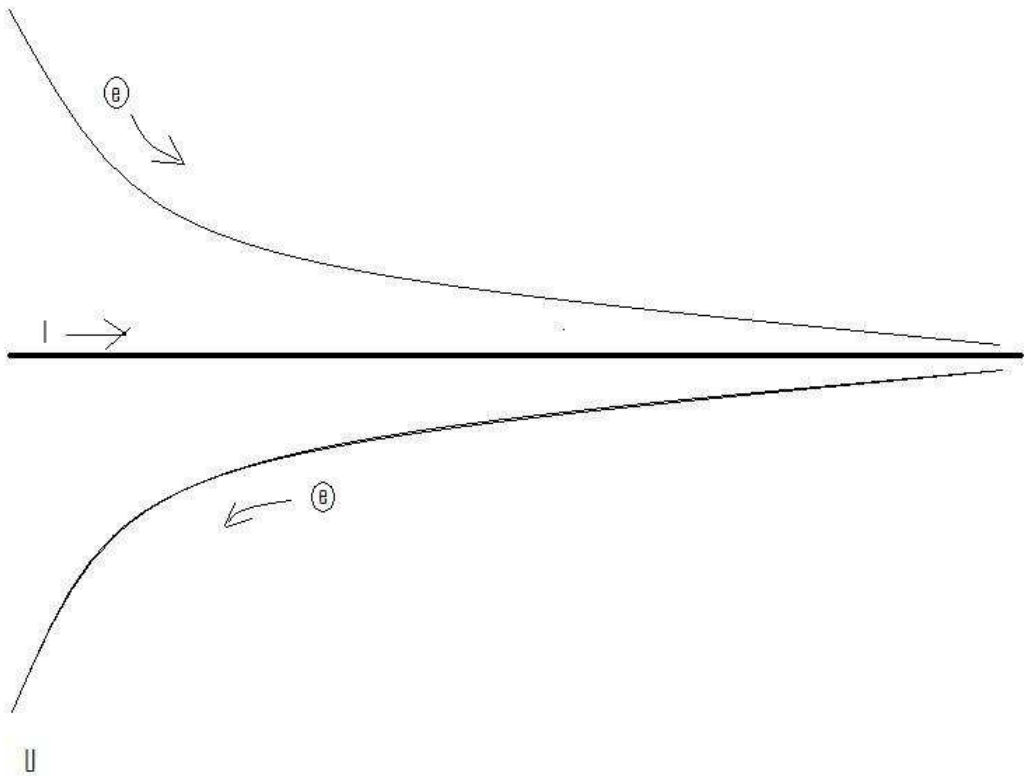

Figure 3.) Concentric parabolic equipotential surfaces around the electric wire causes the magnetic effect on the external moving charges

Considering that the magnetic effect is **F=q v x B**, where the **B** is concentric circle around the electric wire, it is an equipotential circle of the accelerating electrons caused charge distribution. Moving on this circle there is no electric and magnetic effect for the external charges, since **vxB=0**. Moving in the direction of the current the electric charges crosses the biggest potential change, while in any other direction – depending on the angle between the current and velocity of the external charge there is a modest electric potential difference, giving exactly the same force as the **v x B** magnetic force.

Getting the magnetic force from the **F = dp/dt** equation we will understand the magnetic field velocity dependency. Finding the appropriate trajectory of the moving charges we need simply get it from the equipotential lines on the equipotential surfaces, caused by the accelerating charges of the electric current. We can prove that the velocity dependent force causes to move the charges on the equipotential surfaces, since the force due to the potential difference according to the velocity angle – changing only the direction, but not the value of the charge's velocity.

The work done on the charge and the Hamilton Principle

One basic feature of magnetism is that, in the vicinity of a magnetic field, a moving charge will experience a force. Interestingly, the force on the charged particle is always perpendicular to the direction it is moving. Thus magnetic forces cause charged particles to change their direction of motion, but they do not change the speed of the particle. This property is used in high-energy particle accelerators to focus beams of particles which eventually collide with targets to produce new particles. Another way to understand this is to realize that if the force is perpendicular to the motion, then no work is done. Hence magnetic forces do no work on charged particles and cannot increase their kinetic energy. If a charged particle moves through a constant magnetic field, its speed stays the same, but its direction is constantly changing. [2]

In electrostatics, the work done to move a charge from any point on the equipotential surface to any other point on the equipotential surface is zero since they are at the same potential. Furthermore, equipotential surfaces are always perpendicular to the net electric field lines passing through it. [3]

Consequently the work done on the moving charges is zero in both cases, proving that they are equal forces, that is they are the same force.

The accelerating charges self-maintaining potential equivalent with the Hamilton Principle and the Euler-Lagrange equation. [4]

The Magnetic Vector Potential

Also the **A** magnetic vector potential gives the radial parabolic electric potential change of the charge distribution due to the acceleration of electric charges in the electric current.

Necessary to mention that the **A** magnetic vector potential is proportional with a, the acceleration of the charges in the electric current although this is not the only parameter.

The **A** magnetic vector potential is proportional with I**=dQ/dt** electric current, which is proportional with the strength of the charge distribution along the wire. Although it is proportional also with the U potential difference I=U/R, but the R resistivity depends also on the cross-sectional area, that is bigger area gives stronger I and **A**. [7] This means that the bigger potential differences with smaller cross-section can give the same **I** current and **A** vector potential, explaining the gauge transformation.

Since the magnetic field B is defined as the curl of **A**, and the curl of a gradient is identically zero, then any arbitrary function which can be expressed as the gradient of a scalar function may be added to A without changing the value of B obtained from it. That is, A' can be freely substituted for A where

$$\vec{A'} = \vec{A} + \vec{\nabla}\phi$$

Such transformations are called gauge transformations, and there have been a number of "gauges" that have been used to advantage is specific types of calculations in electromagnetic theory. [5]

Since the potential difference and the vector potential both are in the direction of the electric current, this gauge transformation could explain the self maintaining electric potential of the accelerating electrons in the electric current. Also this is the source of the special and general relativity.

The Constant Force of the Magnetic Vector Potential

Moving on the parabolic equipotential line gives the same result as the constant force of gravitation moves on a parabolic line with a constant velocity moving body.

Electromagnetic four-potential

The electromagnetic four-potential defined as:

SI units	**cgs units**
$A^\alpha = (\phi/c, \mathbf{A})$	$A^\alpha = (\phi, \mathbf{A})$

in which ϕ is the electric potential, and **A** is the magnetic vector potential. [6] This is appropriate with the four-dimensional space-time vector (T, **R**) and in stationary current gives that the potential difference is constant in the time dimension and vector potential (and its curl, the magnetic field) is constant in the space dimensions.

Magnetic induction

Increasing the electric current **I** causes increasing magnetic field **<u>B</u>** by increasing the acceleration of the electrons in the wire. Since l=at, if the acceleration of electrons is growing, than the charge density **dQ/dl** will decrease in time, creating a **–<u>E</u>** electric field. Since the resistance of the wire is constant, only increasing U electric potential could cause an increasing electric current **I=U/R=dQ/dt**. The charge density in the static current changes linear in the time coordinates. Changing its value in time will causing a static electric force, negative to the accelerating force change. This explains the relativistic changing mass of the charge in time also.

Necessary to mention that decreasing electric current will decrease the acceleration of the electrons, causing increased charge density and **<u>E</u>** positive field.

The electric field is a result of the geometric change of the **U** potential and the timely change of the **A** magnetic potential:

E = - dA/dt - dU/dr

$$\mathbf{B} = \nabla \times \mathbf{A}\,, \quad \mathbf{E} = -\nabla\phi - \frac{\partial \mathbf{A}}{\partial t}\,,$$

The acceleration of the electric charges proportional with the A magnetic vector potential in the electric current and also their time dependence are proportional as well. Since the A vector potential is appears in the equation, the proportional **a** acceleration will satisfy the same equation.

Since increasing acceleration of charges in the increasing electric current the result of increasing potential difference, creating a decreasing potential difference, the electric and magnetic vector potential are changes by the next wave - function equations:

$$\frac{1}{c^2}\frac{\partial^2\varphi}{\partial t^2} - \nabla^2\varphi = \frac{\rho}{\varepsilon_0}$$

$$\nabla^2\mathbf{A} - \frac{1}{c^2}\frac{\partial^2\mathbf{A}}{\partial t^2} = -\mu_0\mathbf{J}$$

The simple experiment with periodical changing **U** potential and **I** electric current will move the aluminium folios with a moving wave along the wire.

The Lorentz gauge says exactly that the accelerating charges are self maintain their accelerator fields and the divergence (source) of the A vector potential is the timely change of the electric potential.

$$\nabla \cdot \vec{A} + \frac{1}{c^2}\frac{\partial\varphi}{\partial t} = 0.$$

Or

$$\vec{E} = -\nabla\,\varphi - \frac{\partial\vec{A}}{\partial t}.$$

The timely change of the A vector potential, which is the proportionally changing acceleration of the charges will produce the negative electric field.

Lorentz transformation of the Special Relativity

In the referential frame of the accelerating electrons the charge density lowering linearly because of the linearly growing way they takes every next time period. From the referential frame of the wire there is a parabolic charge density lowering.

The difference between these two referential frames, namely the referential frame of the wire and the referential frame of the moving electrons gives the relativistic effect. Important to say that the moving electrons presenting the time coordinate, since the electrons are taking linearly increasing way every next time period, and the wire presenting the geometric coordinate.

The Lorentz transformations are based on moving light sources of the Michelson - Morley experiment giving a practical method to transform time and geometric coordinates without explaining the source of this mystery.

The real mystery is that the accelerating charges are maintaining the accelerating force with their charge distribution locally. The resolution of this mystery that the charges are simply the results of the diffraction patterns, that is the charges and the electric field are two sides of the same thing. Otherwise the charges could exceed the velocity of the electromagnetic field.

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

Heisenberg Uncertainty Relation

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

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

Wave – Particle Duality

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

Atomic model

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

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 = dx dp** or **1/2 h = dt dE**, that is the value of the basic energy status, consequently related to the m_o inertial mass of the fermions.

The photon's 1 spin value and the electric charges 1/2 spin gives us the idea, that the electric charge and the electromagnetic wave two sides of the same thing, 1/2 – (-1/2) = 1.

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 the 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, since **E = mc²**.

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.

Planck Distribution Law

The Planck distribution law explains the different frequencies of the proton and electron, giving equal intensity to different lambda wavelengths! The weak interaction transforms an electric charge in the diffraction pattern from one side to the other side, causing an electric dipole momentum change, which violates the CP and time reversal symmetry.

The 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.

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. [1]

Electromagnetic inertia and Gravitational attraction

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

It looks clear that the growing acceleration results the relativistic growing mass - limited also with the velocity of the electromagnetic wave.

The negatively changing acceleration causes a positive electric field, working as a decreasing mass.

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

If the mass is electromagnetic, then the gravitation is also electromagnetic effect caused by the magnetic effect between the same charges, they would attract each other if they are moving parallel by the magnetic effect.

The Planck distribution law explains the different frequencies of the proton and electron, giving equal intensity to different lambda wavelengths. Also since the particles are diffraction patterns they have some closeness to each other – can be seen as the measured effect of the force of the gravitation, since the magnetic effect depends on this closeness. This way the mass and the magnetic attraction depend equally on the wavelength of the electromagnetic waves.

Conclusions

Needless to say that the accelerating electrons of the steady stationary current are a simple demystification of the magnetic field, by creating a decreasing charge distribution along the wire, maintaining the decreasing U potential and creating the **A** vector potential experienced by the electrons moving by **v** velocity relative to the wire. This way it is easier to understand also the time dependent changes of the electric current and the electromagnetic waves as the resulting fields moving by c velocity.

There is a very important law of the nature behind the self maintaining **E** accelerating force by the accelerated electrons. The accelerated electrons created electromagnetic fields are so natural that they occur as electromagnetic waves traveling with velocity c. It shows that the electric charges are the result of the electromagnetic waves diffraction.

One of the most important conclusions is that the electric charges are moving in an accelerated way and even if their velocity is constant, they have an intrinsic acceleration anyway, the so called spin, since they need at least an intrinsic acceleration to make possible they movement . The bridge between the classical and quantum theory is based on this intrinsic acceleration of the spin, explaining also the Heisenberg Uncertainty Principle. The particle – wave duality of the electric charges and the photon makes certain that they are both sides of the same thing. Basing the gravitational force on the magnetic force and the Planck Distribution Law of the electromagnetic waves caused diffraction gives us the basis to build a Unified Theory of the physical interactions.

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