Ultracold Quantum Particles Symmetry

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Researchers have, for the first time, identified the sufficient and necessary conditions that the low-energy limit of quantum gravity theories must satisfy to preserve the main features of the Unruh effect. [12]

Two teams of researchers working independently of one another have come up with an experiment designed to prove that gravity and quantum mechanics can be reconciled. [11]

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THREE WEEKS AGO, upon sifting through the aftermath of their protonsmashing experiments, physicists working at the Large Hadron Collider reported an unusual bump in their signal: the signature of two photons simultaneously hitting a detector. Physicists identify particles by reading these signatures, which result from the decay of larger, unstable particles that form during high-energy collisions. It's how they discovered the Higgs boson back in 2012. But this time, they had no idea where the photons came from. [9]

In 2012, a proposed observation of the Higgs boson was reported at the Large Hadron Collider in CERN. The observation has puzzled the physics community, as the mass of the observed particle, 125 GeV, looks lighter than the expected energy scale, about 1 TeV. [8]

'In the new run, because of the highest-ever energies available at the LHC, we might finally create dark matter in the laboratory,' says Daniela. 'If dark matter is the lightest SUSY particle than we might discover many other SUSY particles, since SUSY predicts that every Standard Model particle has a SUSY counterpart.' [7]

The problem is that there are several things the Standard Model is unable to explain, for example the dark matter that makes up a large part of the universe. Many particle physicists are therefore working on the development of new, more comprehensive models. [6]

They might seem quite different, but both the Higgs boson and dark matter particles may have some similarities. The Higgs boson is thought to be the particle that gives matter its mass. And in the same vein, dark matter is thought to account for much of the 'missing

mass' in galaxies in the universe. It may be that these mass-giving particles have more in common than was thought. [5]

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.

Contents

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Preface

Popular questions about the Higgs Field:

1.) If the Higgs field is responsible for imbuing particles with mass, and mass is responsible for gravity, is it possible that the Higgs field will provide the missing link between general relativity and quantum mechanics i.e. could the Higgs field be the basis of a quantum theory of gravity?

2.) Can the theoretical Higgs Field be used as the "cause" of relativistic momentum or relativistic kinetic energy of a moving body?

3.) Does Einstein's General Relativity need to be adjusted for the Higgs field?

4.) Since the Higgs field gives most particles mass, and permeates all space, then GR needs the Higgs field to be a theory of space?

5.) So where GR is highly curved, the Higgs field is also curved? And does a highly curved Higgs field affect the way particles acquire mass? For that matter, a curved space-time would also curve electromagnetic field?

How can we answer these questions?

There is an explanation of the magnetic effect caused by 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 charge distribution is lowering in the reference frame of the accelerating charges linearly: ds/dt = at (time coordinate), but in the reference frame of the current it is parabolic: $s = a/2\ t^2$ (geometric coordinate). The accelerating electrons explain not only the

Maxwell Equations and the Special Relativity, but the Heisenberg Uncertainty Relation, the wave particle duality and the electron’s spin also, building the bridge between the Classical and Quantum Theories. [1]

One origin of the Quantum Physics is the Planck Distribution Law of the electromagnetic oscillators, giving equal intensity for 2 different wavelengths on any temperature. Any of these two wavelengths will give equal intensity diffraction patterns, building different asymmetric constructions, for example proton - electron structures (atoms), molecules, etc. Since the particles are centers of diffraction patterns they also have particle – wave duality as the electromagnetic waves have. The Electroweak Interaction shows that the Weak Interaction is basically electromagnetic in nature. The arrow of time shows the entropy grows by changing the temperature dependent diffraction patterns of the electromagnetic oscillators. [2]

Ultracold quantum particles break classical symmetry

Many phenomena of the natural world evidence symmetries in their dynamic evolution which help researchers to better understand a system's inner mechanism. In quantum physics, however, these symmetries are not always achieved. In laboratory experiments with ultracold lithium atoms, researchers from the Center for Quantum Dynamics at Heidelberg University have proven for the first time the theoretically predicted deviation from classical symmetry. Their results were published in the journal *Science*.

"In the world of classical physics, the energy of an ideal gas rises proportionally with the pressure applied. This is a direct consequence of scale symmetry, and the same relation is true in every scale invariant system. In the world of quantum mechanics, however, the interactions between the quantum particles can become so strong that this classical scale symmetry no longer applies," explains Associate Professor Dr. Tilman Enss from the Institute for Theoretical Physics. His research group collaborated with Professor Dr. Selim Jochim's group at the Institute for Physics.

In their experiments, the researchers studied the behaviour of an ultracold, superfluid gas of lithium atoms. When the gas is moved out of its equilibrium state, it starts to repeatedly expand and contract in a "breathing" motion. Unlike classical particles, these quantum particles can bind into pairs and, as a result, the superfluid becomes stiffer the more it is compressed. The group headed by primary authors Dr. Puneet Murthy and Dr. Nicolo Defenu—colleagues of Prof. Jochim and Dr. Enss—observed this deviation from classical scale symmetry and thereby directly verified the quantum nature of this system. The researchers report that this effect gives a better insight into the behaviour of systems with similar properties such as graphene or superconductors, which have no electrical resistance when they are cooled below a certain critical temperature. [13]

A key piece to understanding how quantum gravity affects low-energy physics

Researchers have, for the first time, identified the sufficient and necessary conditions that the low-energy limit of quantum gravity theories must satisfy to preserve the main features of the Unruh effect.

In a new study, led by researchers from SISSA (Scuola Internazionale Superiore di Studi Avanzati, the Complutense University of Madrid and the University of Waterloo, a solid theoretical framework is provided to discuss modifications to the Unruh effect caused by the microstructure of space-time.

The Unruh effect, named after the Canadian physicist who theorized it in 1976, is the prediction that someone who has propulsion and hence accelerates would observe photons and other particles in a seemingly empty space while another person who is inertial would see a vacuum in that same area.

"Inertial and accelerated observers do not agree on the meaning of 'empty space,'" says Raúl Carballo-Rubio, a postdoctoral researcher at SISSA, Italy. "What an inertial observer carrying a particle detector identifies as a vacuum is not experienced as such by an observer accelerating through that same vacuum. The accelerated detector will find particles in thermal equilibrium, like a hot gas."

"The prediction is that the temperature recorded must be proportional to the acceleration. On the other hand, it is reasonable to expect that the microstructure of space-time or, more generally, any new physics that modifies the structure of quantum field theory at short distances, would induce deviations from this law. While probably anyone would agree that these deviations must be present, there is no consensus on whether these deviations would be large or small in a given theoretical framework. This is precisely the issue that we wanted to understand."

"What we've done is analyzed the conditions to have Unruh effect and found that contrary to an extended belief in a big part of the community thermal response for particle detectors can happen without a thermal state," said Eduardo Martin-Martinez, an assistant professor in Waterloo's Department of Applied Mathematics. "Our findings are important because the Unruh effect is in the boundary between quantum field theory and general relativity, which is what we know, and quantum gravity, which we are yet to understand."

"So, if someone wants to develop a theory of what's going on beyond what we know of quantum field theory and relativity, they need to guarantee they satisfy the conditions we identify in their low energy limits."

The researchers analyzed the mathematical structure of the correlations of a quantum field in frameworks beyond standard quantum field theory. This analysis was then used to identify the three necessary conditions that are sufficient to preserve the Unruh effect. These conditions can be used to determine the low-energy predictions of quantum gravity theories and the findings of this research provides the tools necessary to make these predictions in a broad spectrum of situations.

Having been able to determine how the Unruh effect is modified by alterations of the structure of quantum field theory, as well as the relative importance of these modifications, the researchers believe the study provides a solid theoretical framework to discuss and perhaps test this particular aspect as one of the possible phenomenological manifestations of quantum gravity. This is particularly important and appropriate even if the effect has not yet been measured experimentally, as it is expected to be verified in the not so distant future. [12]

A possible experiment to prove that gravity and quantum mechanics can be reconciled

Two teams of researchers working independently of one another have come up with an experiment designed to prove that gravity and quantum mechanics can be reconciled. The first team is a pairing of Chiara Marletto of the University of Oxford and Vlatko Vedral of National University of Singapore. The second is an international collaboration. In the papers, both published in *Physical Review Letters*, the teams describe their experiment and how it might be carried out.

Gravity is a tough nut to crack, there is just no doubt about it. In comparison, the strong, weak and electromagnetic forces are a walk in the park. Scientists still can't explain the nature of gravity, though how it works is rather well understood. The current best theory regarding gravity goes all the way back to Einstein's general theory of relativity, but there has been no way to reconcile it with quantum mechanics. Some physicists suggest it could be a particle called the graviton. But proving that such a particle exists has been frustrating, because it would be so weak that it would be very nearly impossible to measure its force. In this new effort, neither team is suggesting that their experiment could reconcile gravity and quantum mechanics. Instead, they are claiming that if such an experiment is successful, it would very nearly prove that it should be possible to do it.

The experiment essentially involves attempting to entangle two particles using their gravitational attraction as a means of confirming quantum gravity. In practice, it would consist of levitating two tiny diamonds a small distance from one another and putting each of them into a superposition of two spin directions. After that, a magnetic field would be applied to separate the spin components. At this point, a test would be made to see if each of the components is gravitationally attracted. If they are, the researchers contend, that will prove that gravity is quantum; if they are not, then it will not. The experiment would have to run many times to get an accurate assessment. And while a first look might suggest such an experiment could be conducted very soon, the opposite is actually true. The researchers suggest it will likely be a decade before such an experiment could be carried out due to the necessity of improving scale and the sensitivity involved in such an experiment. [11]

Quantum gravity could be probed by entangled masses

The elusive, yet seemingly inevitable, quantum nature of gravity may finally be demonstrated experimentally. Two separate groups in the UK; Chiara Marletto and Vlatko Vedral at the University of Oxford, and a team led by Sougato Bose from University College London, have proposed experiments that may for the first time reveal a link between the theories of quantum mechanics and general relativity.

Within their domains, both quantum mechanics and Einstein's general theory of relativity seem to work incredibly well, no matter what problems physicists throw at them. However, some of the physical rules overseeing the theories appear to be fundamentally incompatible, and a unified theory of quantum gravity which marries them together has become notoriously difficult to develop.

"A formidable problem is the immense weakness of the gravitational interaction in comparison to other fundamental forces in nature," Bose tells *Physics World*. "For example, even the electrostatic force between two electrons overtakes the gravitational force between two kilogram masses by several orders of magnitude."

Impossible to test

So far, theories about the quantum nature of gravity have seemed practically impossible to test experimentally. As such, theories ranging from quantum particles known as gravitons, which convey gravity in a similar way to photons for electromagnetic fields, to the all-encompassing ideas of string theory and loop quantum gravity, have all remained speculative.

Early steps to devise an experiment to test quantum gravity were taken by Richard Feynman. He proposed a thought experiment in which a test mass is prepared in a quantum superposition of two different locations, and then interacted with the gravitational field, causing the mass and the field to become entangled. If the two spatial states of the mass could then interfere; reverting the mass back to a single, definite spatial location, the coupling with the gravitational field would subsequently be reversed, showing that gravity has been coherently coupled to a quantum system.

Feynman hoped that this experiment would confirm the quantum nature of gravitational fields, but Marletto and Vedral believe it is not sophisticated enough. Since the interference of the two spatial states of the mass could occur even in the presence of classical gravitational fields, the experiment would not prove that the mass and the field were entangled, unless the entanglement could be measured directly. Therefore, the gravitational field need not be quantized. Bose explains, "Exactly what attribute of the masses to measure in order to conclude the quantum nature of the gravitational field was left open". Another approach was needed to witness its quantum features.

Entanglement between two masses

Bose, Marletto and their colleagues believe their proposals constitute an improvement on Feynman's idea. They are based on testing whether the mass could be entangled with a second identical mass via the gravitational field. To do this, the two masses would first be prepared using two adjacent, identical interferometers. These devices are typically used to split light waves into separate beams, which can then be interfered. When tiny masses are involved, however, their quantum wave functions can be split and interfered to superimpose multiple quantum states onto the mass.

"Our two teams took slightly different approaches to the proposal," Marletto explains to *Physics World*. "Vedral and I provided a general proof of the fact that any system that can mediate entanglement between two quantum systems must itself be quantum. On the other hand, Bose and his team discussed the details of a specific experiment, using two spin states to create the spatial superposition of the masses."

If gravitational fields are truly quantum in nature, both teams realized the gravitational attraction between the two masses would cause them to become entangled by the time they left their respective interferometers. As in Feynman's experiment, the first mass can be entangled with the gravitational field, but this time, no interaction with the gravitational field is required since the second mass could be used as a witness to the quantum properties of the first. This would allow the researchers to confirm that classical gravitational fields could not have been responsible for the interference of the masses.

Unwanted effects

Bose and Marletto's teams both acknowledge that the challenges posed by shortcomings in present-day technology mean that their proposed experiments have no guarantee of success. If the experiments are not carried out carefully enough, other stronger forces like the Casimir, Van der Waal's or other unwanted electromagnetic interactions could mimic the desired effects of gravity, entangling the two masses.

The masses could also fail to become entangled even if the gravitational field is quantized, should the nature of quantum gravity be even more subtle and complex than the researchers anticipated, meaning not witnessing entanglement would not be an inconclusive result. They also realize that their experiments still wouldn't confirm which of the many competing theories of quantum gravity are correct.

The proposals are described in two papers published in *Physical Review Letters*: C Marletto and V Vedral and Bose *et al*. [10]

Mysterious LHC Photons Have Physicists Searching for Answers

If—and at this point, it's a big, fat if—this bump is real and not a statistical anomaly, it is a gamechanger for physicists' understanding of the universe. The signature can't be explained by the Standard Model, the current rulebook for how all particles behave and interact. That could mean entirely new physics—though what kind, researchers don't yet know.

"We were like, 'Whoa, what is that?'" says Adam Martin, a physicist at the University of Notre Dame who recently submitted a paper theorizing about the bump to arXiv, the online, pre-peer review science repository. "What if it's a new particle? What if it's two?"

The physicists' excitement comes with a heavy dose of pragmatism. No one is claiming that the bump is a new particle yet because the data simply isn't good enough. "I can't tell you if this bump is going to break the books or just fade away," says Don Lincoln, a physicist at Fermilab who works with CMS, a group that detected the bump. Their measurement had a one in 10 chance of being a statistical fluke.

Those odds are no cause for fanfare, but CMS isn't the only team that measured the bump; another, Atlas, saw it too. Atlas's measurement had a one in 100 chance of being an anomaly—also not great, considering that the gold standard for a particle physics discovery is one in 3.5 million. But taken together, the two results were enough to get the field excited.

To improve those odds, physicists will attempt to confirm the signal during the LHC's next batch of collisions this upcoming April. But in the meantime, the theoreticians are cranking out explanations. If the bump is real, what could it be?

Competing Theories

One possibility is that the photons come from a graviton, a theorized particle that carries gravitational force the same way that photons carry electromagnetic force.

The current understanding is that gravitons should be massless, but this graviton would have mass— and because it has mass, it could indicate the existence of smaller dimensions invisible to everyday life.

Another possibility—one that Martin's paper develops—is that the photons indicate a heavy cousin of the Higgs boson. Many theories currently predict the existence of multiple Higgs bosons, but experiments have only revealed the one that nabbed the 2013 Nobel Prize in physics. The existence of certain Higgs bosons would support some theories of supersymmetry, an attractive hypothetical genre that could shed light on physics' big questions. Some supersymmetry theories could explain why the Higgs boson exists, or identify the source of dark matter in the rotation of galaxies.

Less likely, says Lincoln, is that the bump could come from a heavier particle that physicists have never seen before. Experimenters measured the bump after the LHC's highest-energy collisions yet, which means that they can produce those heavier particles.

But physicists aren't battling over these conflicting theories. It's more of a team effort, with each theorist presenting a potential piece of the puzzle. "It's not that theorists might think some theories are bad," Martin says. It's simply the name of the game, he says, to dig as many rabbit holes as possible to explain the physics.

And now they're burrowing down pathways that are consistent with the new measurement.

Martin says that some half dozen times during his career, he's worked to develop a theory around an exciting new experimental measurement—only for the measurement to evaporate into mythological artifact of statistical randomness. Or vice versa.

"I used to work on theories that had no Higgs boson," Martin says. "Too bad for me." So the physicists proceed with cautious excitement. [9]

Recent study predicts that Higgs particles are much heavier than earlier observation

Researchers at Aalto University in Finland now propose that there is more than one Higgs boson, and they are much heavier than the 2012 observation. The results were recently published in Nature Communications.

"Our recent ultra-low temperature experiments on superfluid helium (3He) suggest an explanation why the Higgs boson observed at CERN appears to be too light.

By using the superfluid helium analogy, we have predicted that there should be other Higgs bosons, which are much heavier (about 1 TeV) than previously observed," says Professor (emeritus) Grigory E. Volovik.

Prof. Volovik holds a position in the Low Temperature Laboratory at Aalto University and in Landau Institute, Moscow. He has received the international Simon Prize in 2004 for distinguished work in theoretical low temperature physics, and the Lars Onsager Prize in 2014 for outstanding research in theoretical statistical physics.

At the same time, the new CERN experiments have shown evidence of the second Higgs in just the suggested region (at 0.75 TeV). This evidence has immediately been commented and discussed in a large number of papers submitted to arXiv, an e-print service widely utilised by the physics community to distribute manuscripts of their unpublished work. [8]

Exploring the Higgs boson's dark side

Last month, after two years of preparation, the LHC began smashing its proton beams together at 13 Trillion electron Volts (TeV), close to double the energy achieved during its first run.

'We do not know what we will find next and that makes the new run even more exciting,' Daniela Bortoletto of Oxford University's Department of Physics, a member of the team running the LHC's ATLAS experiment, tells me. 'We hope to finally find some cracks in the Standard Model as there are many questions about our universe that it does not answer.'

One of the big questions concerns dark matter, the invisible 'stuff' that astrophysicists estimate makes up over 80% of the mass of the Universe. As yet nobody has identified particles of dark matter although physicists think it could be the lightest supersymmetric (SUSY) particle.

'In the new run, because of the highest-ever energies available at the LHC, we might finally create dark matter in the laboratory,' says Daniela. 'If dark matter is the lightest SUSY particle than we might discover many other SUSY particles, since SUSY predicts that every Standard Model particle has a SUSY counterpart.'

Then there's the puzzle of antimatter: in the early Universe matter and antimatter were created in equal quantities but now matter dominates the Universe.

'We still do not know what caused the emergence of this asymmetry,' Daniela explains. 'We have finally discovered the Higgs boson: this special particle, a particle that does not carry any spin, might decay to dark matter particles and may even explain why the Universe is matter dominated.'

Discovering the Higgs boson was a huge achievement but now the race is on to understand it: a prospect that Daniela is particularly excited about.

'This particle is truly fascinating,' she says. 'Spin explains the behaviour of elementary particles: matter particles like the electron have spin 1/2 while force particles

like the photon, which is responsible for the electromagnetic interaction, have spin 1. Spin 1/2 particles obey the Pauli principle that forbids electrons to be in the same quantum state.

'The Higgs is the first spin 0 particle, or as particle physicists would say the first 'scalar particle' we've found, so the Higgs is neither matter nor force.'

Because of its nature the Higgs could have an impact on cosmic inflation and the energy of a vacuum as well as explaining the mass of elementary particles.

Daniela tells me: 'Because of the Higgs the electron has mass, atoms can be formed, and we exist. But why do elementary particles have such difference masses?
The data of run 2 will enable us to study, with higher precision, the decays of the Higgs boson and directly measure the coupling of the Higgs to quarks. It will also enable us to search for other particles similar to the Higgs and determine if the Higgs decays to dark matter.'

Daniela is one of 13 academics at Oxford working on ATLAS supported by a team of postdoctoral fellows, postgraduate students and engineering, technical, and computing teams. The Oxford group plays a lead role in operating the SemiConductor Tracker (SCT), most of which was assembled in an Oxford lab. This provides information on the trajectories of the particles produced when the LHC's beams collide, which was crucial to the discovery of the Higgs boson.

Whilst the next few years will see the Oxford group busy with research that exploits the LHC's new high-energy run, the team are also looking ahead to 2025 when the intensity or 'luminosity' of the beams will be increased.

The LHC is filled with 1,380 bunches of protons each containing almost a billion protons and colliding 40 million times per second. This means that every time two bunches of protons cross they generate not one collision but many, an effect called 'pile-up'.

'After this luminosity upgrade the LHC will operate at collision rates five to ten times higher than it does at present,' Daniela explains. 'In run 1 of the LHC we had a maximum of 37 pile-up collisions per crossing but with the upgrade to the High Luminosity LHC, or 'HL-LHC', this will increase to an average of 140 pile-up events in each bunch crossing.'

With the HL-LHC generating many more collisions, the international Oxford-led team are designing and prototyping parts of a new semiconductor tracker that will be needed to help reconstruct particles from the complex web of decay trails they leave inside the machine.

As the LHC ramps up both its energy and luminosity it promises to give scientists working on experiments such as ATLAS answers to some of the biggest questions in physics. One thing is certain: this new physics will also lead to a whole set of new questions about the matter that makes up us and the Universe around us. [7]

The Higgs particle can disintegrate into particles of dark matter, according to new model

The problem is that there are several things the Standard Model is unable to explain, for example the dark matter that makes up a large part of the universe. Many particle physicists are therefore working on the development of new, more comprehensive models.

One of them is Christoffer Petersson, who carries out research in theoretical particle physics at Chalmers University of Technology in Sweden and the Université Libre in Belgium. Together with two research colleagues he has proposed a particle model based on what is known as supersymmetry.

This model contains more elementary particles than the Standard Model, including dark matter particles. In addition, the model gives the Higgs particle different properties than the Standard Model predicts. The model proposes that the Higgs particle can distintegrate into a photon (a particle of light) and particles of dark matter. However, these properties are quite difficult to discover – you have to look for them specifically to have a chance of finding them.

But Christoffer Petersson is fortunate – his model has met with a response at CERN. Two independent experimental stations – Atlas and CMS – at the Large Hadron Collider are now looking for the very properties of the Higgs particle his model predicts. If the properties are there, it is a clear indication that the model fits.

“It’s a dream for a theorist in particle physics. LHC is the only place where the model can be tested. It’s even nicer that two independent experiments are going to do it,” says Christoffer Petersson.

In the first studies the volume of data was unfortunately too small for it to be possible to either confirm or reject Petersson’s model.

A Higgs particle has been created in an LHC detector and has then disintegrated into four muons (the four red lines). According to Christoffer Petersson’s model the Higgs particle can also disintegrate into a photon and particles of dark matter. Picture: CERN

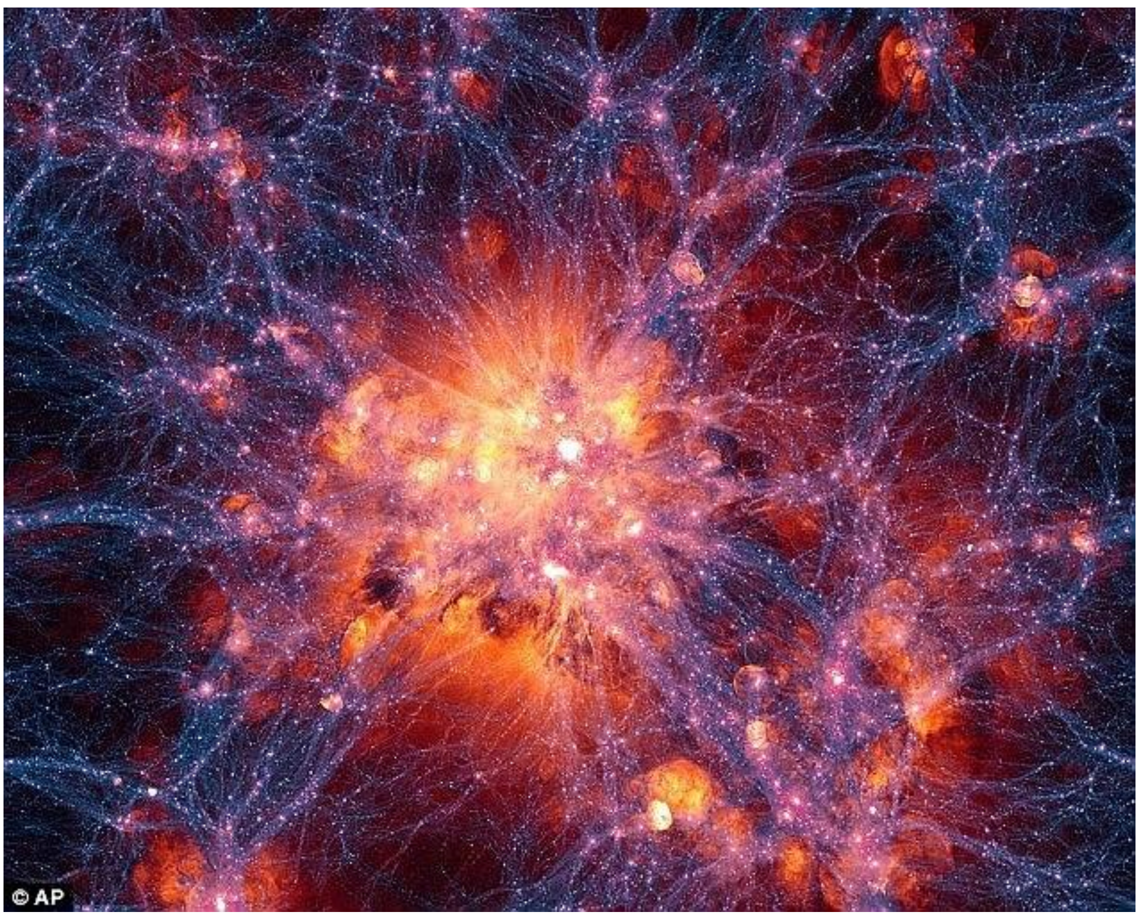
A Higgs particle has been created in an LHC detector and has then disintegrated into four muons (the four red lines). According to Christoffer Petersson’s model the Higgs particle can also disintegrate into a photon and particles of dark matter.

“But we are already in full swing with new analyses in which we are testing his model in other ways and with more data. We congratulate Christoffer Petersson for having done an important job,” says Zeynap Demiragli at the CMS experiment at CERN.

After being closed down for a time for an upgrade, LHC will start up again in the spring of 2015. With higher energies in the accelerator, the experiments will finally gather sufficient data to evaluate
Petersson's model properly. He is on tenterhooks awaiting the results. [6]

Will the Large Hadron Collider find dark matter?

Atom smasher could soon solve one the universe's greatest mysteries, claims scientist. Dr Monica Dunford worked at Cern in Switzerland up until 2013. She was directly involved in the detection of the Higgs boson in 2012. Speaking to Mail Online she said of the time leading up to its discovery: 'I don't think there will be another time like that in my career for sure'. But she said that the Large Hadron Collider could find dark matter. And if it did it would be a 'bigger discovery' than the Higgs boson. In March 2015 the LHC will be restarted at double its previous power.



'One of the things I'm most interested in is creating and discovering dark matter,' Dr Dunford said. 'We know from measurements of cosmology that 25 per cent of the universe is dark matter and we have absolutely no idea what that is.' An illustration of dark matter in the universe is shown.

When physicists study the dynamics of galaxies and the movement of stars, they are confronted with a mystery.

If they only take visible matter into account, their equations simply don't add up: the elements that can be observed are not sufficient to explain the rotation of objects and the existing gravitational forces. There is something missing.

From this they deduced that there must be an invisible kind of matter that does not interact with light, but does, as a whole, interact by means of the gravitational force. Called 'dark matter', this substance appears to make up at least 80 per cent of the universe. Finding the Higgs boson was one of the primary goals of the LHC - but perhaps the LHC's most important moment is yet to come.

'One of the things I'm most interested in is creating and discovering dark matter,' Dr Dunford said. We know from measurements of cosmology that 25 per cent of the universe is dark matter and we have absolutely no idea what that is. For comparison, what we do know, electrons and protons, only count for four per cent. You have this huge chunk of a pie and no idea what it consists of.

One thing we could possibly produce would be a dark matter candidate via its decay products. Being able to produce it at the LHC would be a huge connection between our astronomical measurements and what we can produce in the laboratory. [5]

The Classical Relativistic effect

The moving charges are self maintain the electromagnetic field locally, causing their movement and this is the result of their acceleration under the force of this field.
In the classical physics the charges will distributed along the electric current so that the electric potential lowering along the current, by linearly increasing the way they take every next time period because this accelerated motion. [1]

The Relativistic Quantum Mechanics

The same thing happens on the atomic scale giving a dp impulse difference and a dx way difference between the different part of the not point like particles.

Commonly accepted idea that the relativistic effect on the particle physics it is the fermions' spin - another unresolved problem in the classical concepts. If the electric charges can move only with accelerated motions in the self maintaining electromagnetic field, once upon a time they would reach the velocity of the electromagnetic field. The resolution of this problem is the spinning particle, constantly accelerating and not reaching the velocity of light because the acceleration is radial.

The Heisenberg Uncertainty Relation

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

The General Relativity - Electromagnetic inertia and mass

Electromagnetic Induction

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

Relativistic change of mass

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

The frequency dependence of mass

Since $E = hv$ 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. [2]

Electron – Proton mass rate

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. In the maximum intensity no diffraction patterns with equal intensity that is no fermions only bosons. 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 Planck distribution law explains the different frequencies of the proton and electron, giving equal intensity to different lambda wavelengths! Also since the particles are diffraction patterns they have some closeness to each other – can be seen as a gravitational force.

In Quantum Field Theory (QFT), particles are described by excitations of a quantum field that satisfies the appropriate quantum mechanical field equations.
The excitations of the quantum field mean diffraction patterns in my theory. [2]

Higgs Field

The Higgs mechanism is a result of something called a field that extends throughout space, even where no particles are present. This notion is probably most familiar to you from a magnetic field. You feel a force between a magnet and your refrigerator even when “nothing” is there. A field can fill “empty” space. The Higgs field extends throughout space. Elementary particles acquire their masses by interacting with this field. It is kind of like space is charged and particles get mass through their interactions with this charge.

The Higgs boson is not directly responsible for mass. The Higgs field is. The boson is a particle that tells us our understanding of this mechanism is correct. It also is a big clue as to where that field came from in the first place. Its discovery tells us that what we expected to be true was indeed correct, and it gives us clues as to what else might underlie the Standard Model. [4]

The Higgs boson

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

In my opinion, the best explanation of the Higgs mechanism for a lay audience is the one invented by David Miller. You can find it here: http://www.strings.ph.qmul.ac.uk/~jmc/epp/higgs3.html . The field must come first. The boson is an excitation of the field. So no field, no excitation. On the other hand in quantum field theory it is difficult to separate the field and the excitations. The Higgs field is what gives particles their mass.
There is a video that gives an idea as to the Higgs field and the boson. It is here: http://www.youtube.com/watch?v=RIg1Vh7uPyw . Note that this analogy isn't as good as the Miller one, but as is usually the case, if you look at all the analogies you'll get the best understanding of the situation.

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 Weak Interaction

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

Higgs mechanism

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

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

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

In the Standard Model, the phrase "Higgs mechanism" refers specifically to the generation of masses for the $W^{\pm}$, and Z weak gauge bosons through electroweak symmetry breaking. The Large Hadron Collider at CERN announced results consistent with the Higgs particle on July 4, 2012 but stressed that further testing is needed to confirm the Standard Model.

Gravity from the point of view of quantum physics

The Gravitational force

The gravitational attractive force is basically a magnetic force.

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

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

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

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

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

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

The 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]

Conclusions

“If the model is found to fit, it would completely change our understanding of the fundamental building blocks of nature. If not, just the fact that they are willing to test my model at CERN is great,” he says. [6]

On whether it would be the LHC’s most important discovery to date, she said: ‘Personally yes. It would be a bigger discovery than the Higgs boson. ‘For the Higgs we had a very good concrete theoretical prediction; for dark matter we really have no idea what it would be.’

She added: ‘There is no particle that we know of today that can explain dark matter, let alone what dark energy might be. So if we could directly produce dark matter particles at the LHC this would be a huge step forward in our understanding of the composition of the universe!’ [5]

The electric currents causing self maintaining electric potential is the source of the special and general relativistic effects. The Higgs Field is the result of the electromagnetic induction. The Graviton is two photons together.

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