Testing Einstein's Equivalence Principle

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Scientists at the University of British Columbia have proposed a radical new theory to explain the exponentially increasing size of the universe. [10]

Researchers playing with a cloud of ultracold atoms uncovered behavior that bears a striking resemblance to the universe in microcosm. [9]

Gravitational waves may be produced in the heart of the galaxy, says a new study led by Ph.D. student Joseph Fernandez at Liverpool John Moores University. [8]

Using data from the first-ever gravitational waves detected last year, along with a theoretical analysis, physicists have shown that gravitational waves may oscillate between two different forms called "g" and "f"-type gravitational waves. [7]

Astronomy experiments could soon test an idea developed by Albert Einstein almost exactly a century ago, scientists say. [6]

It's estimated that 27% of all the matter in the universe is invisible, while everything from PB&J sandwiches to quasars accounts for just 4.9%. But a new theory of gravity proposed by theoretical physicist Erik Verlinde of the University of Amsterdam found out a way to dispense with the pesky stuff. [5]

The proposal by the trio though phrased in a way as to suggest it's a solution to the arrow of time problem, is not likely to be addressed as such by the physics community—it's more likely to be considered as yet another theory that works mathematically, yet still can't answer the basic question of what is time. [4]

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 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.

Author: George Rajna

Testing Einstein's equivalence principle near a supermassive black hole

The GRAVITY Collaboration, a team of researchers at several renowned institutes including the Max Planck Institute, LESIA Paris Observatory and the European Southern Observatory, has recently tested part of the Einstein Equivalence Principle, namely the local positon invariance (LPI), near the galactic center supermassive black hole. Their study, published on Physics Review Letters (PRL), investigated the dependency of different atomic transitions on the gravitational potential in order to give an upper limit on LPI violations.

"General relativity and in general all metric theories of gravity are based on the equivalence of inertial mass and gravitational mass, formalized in the Einstein equivalence principle," Maryam Habibi, one of the researchers who carried out the study, told Phys.org. "General relativity is the best theory of gravity that we have, however, there are still many unanswered puzzles that are closely tied to our incomplete understanding of gravity."

The equivalence principle, a crucial part of Einstein's general relativity theory, states that the gravitational force experienced in any small region of space-time is the same as the pseudo-force experienced by an observer in an accelerated frame of reference. Testing this principle is of key importance, as it could lead to interesting observations and broaden our current understanding of gravity.

"Einstein's equivalence principle consists of three main principles," Habibi explained. "One of them, called the local position invariance (LPI), states that non-gravitational measurements should be independent of the location in space time (characterized by gravitational potential) where they are carried out. The main part of our study focuses on testing the LPI principle."

Past observations suggest that most, if not all, massive galaxies contain a supermassive black hole, which is typically located at the center of a galaxy. The mass of the Milky Way's galactic center supermassive black hole is 4 million times greater than that of the sun. It thus generates the strongest gravitational field in the galaxy, which makes it the ideal place to hunt for unexplored phenomena and test general relativity principles.

Star S2, one of the brightest stars in the Milky Way's innermost region, has its closest encounter with the galactic center supermassive black hole at a distance of 16.3 light hours. In other words, the star takes 16 years to make a complete orbit around the black hole, which in astronomical time scales is extremely short. S2 moves in and out of the black hole's gravitational field, hence the GRAVITY collaboration team decided to use it to test part of Einstein's equivalence principle.

"As it was predicted, and we showed in a previous study published in June 2018, during the closest approach of the star S2 to the black hole we observe the 'gravitational redshift' in the light of the star," Habibi explained. "Gravitational redshift occurs because intense gravity on the star's surface slows the vibration of light waves, stretching them and making the star appear redder than normal from Earth."

To test Einstein's LPI principle, the researchers used two different types of atoms in S2's stellar atmosphere: hydrogen and helium atoms. The LPI principle states that the gravitational redshift seen in a star that is flying in and out of a strong gravitational field only depends on the gravitational potential and does not rely on other parameters, such as the internal structure of the atom.

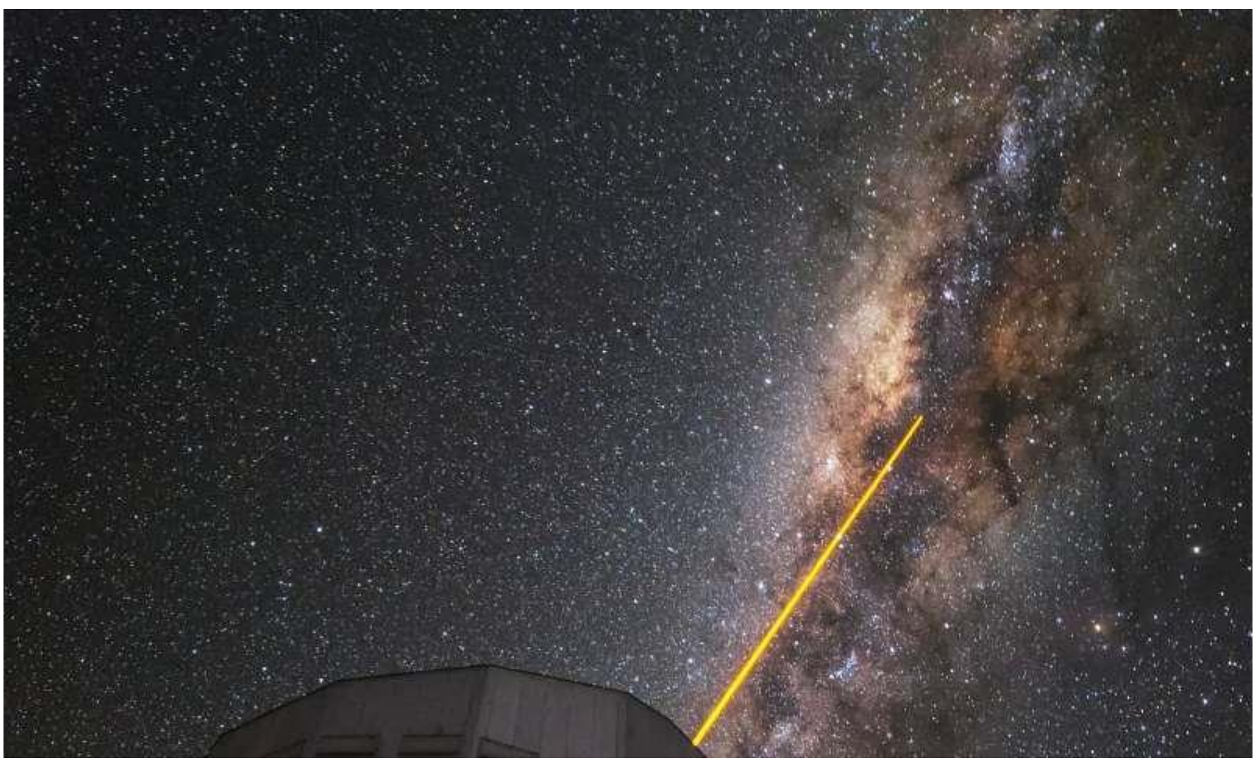


Image shows one of the Unit Telescopes of ESO’s Very Large Telescope (VLT) array, pointing a laser beam towards the Milky Way to create an artificial star. Credit: European Southern Observatory (ESO).

"We measured the frequency change of light from these atoms moving through a varying potential," Habibi said. "The vibration of light waves was measured by fitting the line-of-sight velocity of the S2's spectrum using the Hydrogen and Helium spectral lines separately. By measuring the difference in frequency change for both atoms we were able to give an upper limit on the LPI violation during the pericenter passage. If there was an obvious violation of LPI, we should have measured very different vibration of light waves, from the helium and hydrogen lines."

The equivalence principle and general relativity at large are merely theories, thus they need to be tested in order to ascertain their validity. So far, most researchers have carried out tests on Earth and in the solar system.

However, these theories should also be tested in extreme scenarios, as this can determine whether they still hold and lead to more conclusive evidence. Such tests could rule out some of the principles that shape our current understanding of gravity or identify violations from the theory of general relativity.

"Testing the equivalence principle in all different regimes is important as several alternative theories of gravitation predict a violation from it under extreme conditions," Felix Widmann, another researcher involved in the study, told Phys.org. "For me the most meaningful finding of our study is that we were able to test the equivalence principle in this most extreme case: close to a supermassive black hole that is over 20 thousand light years away. The limits we put on a violation are not very restrictive yet, but they are in a gravitational regime that was completely untested before."

Habibi, Widmann and their colleagues were among the first to test part of the equivalence principle near the Milky Way's central supermassive black hole. Their work provides valuable insight about the validity of general relativity, particularly the LPI principle.

"The past year was exceptionally successful for the GRAVITY collaboration," Widmann said. "For the first time, we observed relativistic effects in the orbit of a star around a supermassive black hole and used this star to test the Equivalence Principle. We also observed material orbiting very close to the black hole, another observation which would have been impossible without GRAVITY. However, this is more of a start than an end for us."

With the optimal season for galactic center observation just around the corner, the researchers at GRAVITY collaboration will continue to point their telescopes to S2 and the galactic center supermassive black hole. According to Widmann, the team might soon be able to detect subtler relativistic effects in the orbit of S2, which will allow them to test the theory of general relativity once again. In their future observations, the researchers also hope that they will see more flare activity around the black hole, as this would enable further studies aimed at broadening their understanding of the Milky Way's galactic center black hole and black holes in general.

"With future telescopes like the Extremely Large Telescope, which has a mirror of 39m in diameter, we will be able to perform similar experiments and look for 1 million times smaller effects of possible violations of LPI, compared to what it is possible today," Widmann added. "This will allow us to test the other part of Einstein's equivalence principle, called weak equivalence principle, which states that an object in gravitational free fall is physically equivalent to an object that is accelerating with the same amount of force in the absence of gravity. The galactic center is a unique observatory and with GRAVITY and future telescopes we want to learn as much about it as possible." [12]

Einstein's general theory of relativity passes a supermassive test

A key aspect of Einstein's general theory of relativity (GR) has been tested using the strongest gravitational field so far. The measurement was made by observing changes in optical absorption lines of a star orbiting close to Sagittarius A* – the supermassive black hole at the centre of the Milky Way.

The work was done by physicists working on the GRAVITY Collaboration, which uses the Very Large Telescope at the European Southern Observatory in Chile.

Since it was first proposed in 1915, GR has stood firm against every experimental challenge that physicists have come up with. Many of these tests have focused on an important tenet of GR called the Einstein equivalence principle (EEP). Detecting a breakdown of the EEP could point towards new physics beyond GR and could provide important clues about how to develop a quantum theory of gravity.

Different systems

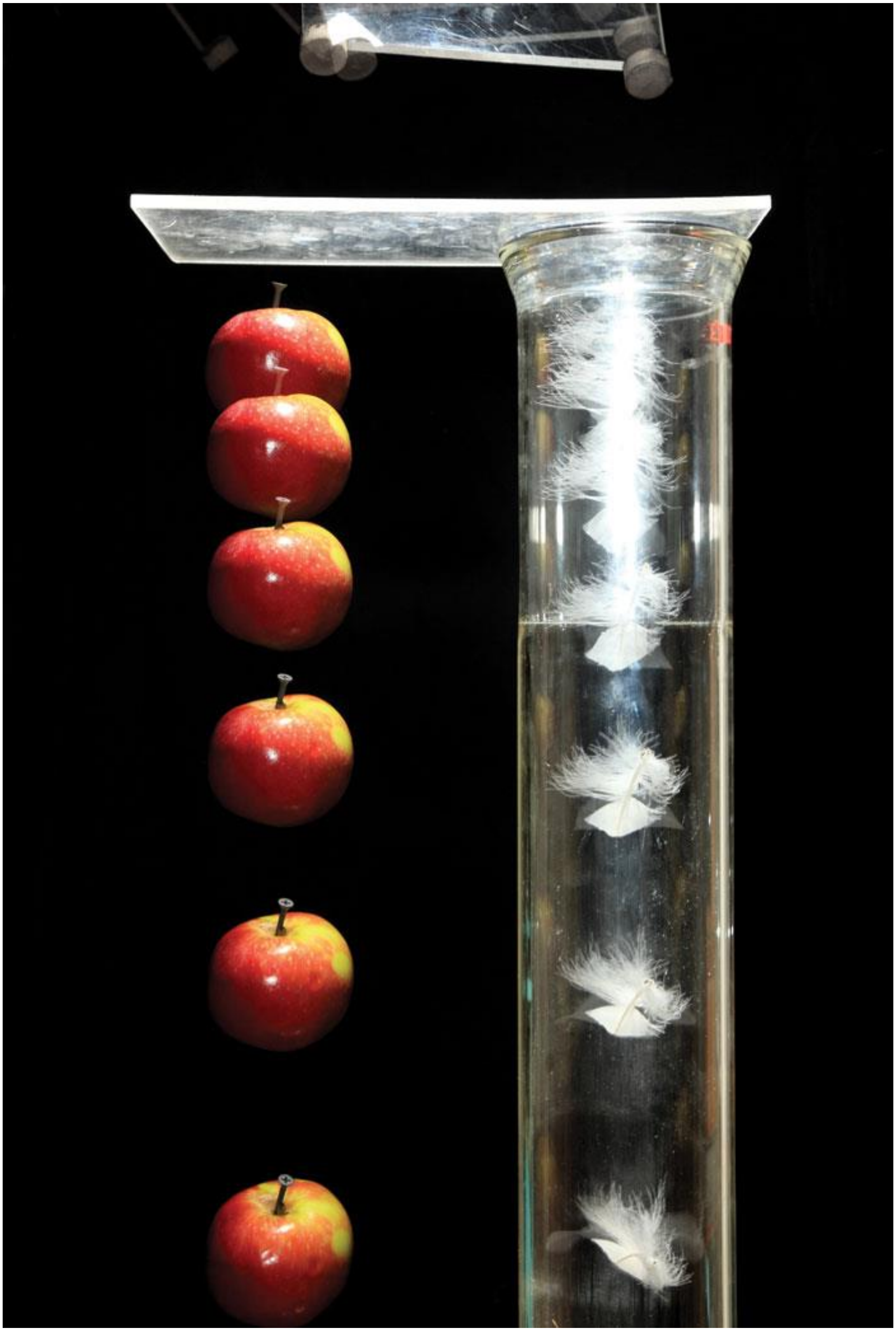
One key element of the EEP is local position invariance (LPI), which says that local nongravitational measurements on a system must be the same, no matter where they are measured in space-time. LPI has been tested by comparing the properties of two different systems as they both experience the same change in gravitational potential. If LPI holds, then the change in gravity should affect both systems in the same way. If LPI is violated, however, gravity would affect the systems differently and this could be detected.

One such test compared the timekeeping of two different types of atomic clock as the gravitational pull of the Sun changes throughout the year – a result of Earth's elliptical orbit. Another test involved looking at the colours of the light emitted from iron and nickel ions in white-dwarf stars and comparing it to the light emitted from the same ions on Earth – where gravity is much weaker. In both cases, the two systems changed in the same way and no violation of LPI has so-far been detected in these and other experiments.

This latest research by the GRAVITY Collaboration uses observations of the absorption spectra of hydrogen and helium atoms in a star called S2, which closely orbits Sagittarius A*. The supermassive black hole has a mass of more than 4 million times that of the Sun and S2 has a highly eccentric orbit. This means that S2 experiences a huge change in gravitational potential during its journey around Sagittarius A*.

Close encounter

The GRAVITY team measured the hydrogen and helium absorption lines from S2 over three years as it made its closest approach to Sagittarius A* in May 2018. Within the measurement's margin of error, the positions of the hydrogen and helium absorption lines shifted according to the predictions of GR with no evidence for LPI violation.



The descent of mass

The GRAVITY team says that their measurements were made in a gravitational field 1 million times stronger than that available on Earth and 10 times stronger than the white-dwarf observations. However, they expect this record to fall once the Extremely Large Telescope begins operation in Chile in 2024. This telescope should be able to study stars even closer to Sagittarius A* than S2, which would be subject to even larger fluctuations in gravitational potential.

The study is described in *Physical Review Letters*. [11]

New Research May Reconcile General Relativity and Quantum Mechanics

Scientists at the University of British Columbia have proposed a radical new theory to explain the exponentially increasing size of the universe. Ultimately, it seeks to reconcile two different concepts in physics: Quantum Mechanics and Einstein's Theory of General Relativity. the researchers argue that instead of dark energy causing the universe's growth, it could be explained by constant quantum fluctuations of vacuum energy.

In their work, the researchers argue that, instead of dark energy causing the universe's growth, it could be explained by constant quantum fluctuations of vacuum energy. The paper claims — if their findings are true — that "the old cosmological constant problem would be resolved." The press release notes the potentially transformative nature of the work: "Their calculations provide a completely different physical picture of the universe."

Similarly, Bill Unruh, the physics and astronomy professor who supervised P.H.D student Qingdi Wang's work, stated that the research offers an entirely new take on old problems: "This is a new idea in a field where there hasn't been a lot of new ideas that try to address this issue." In the end, their calculations provide a fundamentally different picture of the universe: one in which space-time is "constantly moving," fluctuating between contraction and expansion. It's the small net effect towards expansion, though, that drives the expansion of the universe.

Unruh uses the sea as an analogy to explain why we cannot feel the effects: "It's similar to the waves we see on the ocean […] They are not affected by the intense dance of the individual atoms that make up the water on which those waves ride."

THE BIG WHY

Previous belief has held that the universe is expanding steadily due to dark energy pushing other matter further and further away. When we apply quantum theories to vacuum energy, it results in an increasing density which could in turn result in universal explosion — due to the gravitational effect *of* the density.

The discovery that the universe is expanding was made simultaneously by two independent teams in 1998: Supernova Cosmology Project and the High-Z Supernova Search Team. Three members of the two teams have since won Nobel prizes for their work, which measured light using 'standard candles.' Since that discovery was made, scientists have tried to work out exactly what this energy is that's driving the cosmos apart.

Despite the fact that it has been a compelling mystery for decades, there haven't been that many theories posed. So, while the work of Wang and Unruh may not provide the ultimate answer, they present a new, potential solution to one of the most fundamental problems in cosmology. [10]

Atoms may hum a tune from grand cosmic symphony

Researchers playing with a cloud of ultracold atoms uncovered behavior that bears a striking resemblance to the universe in microcosm. Their work, which forges new connections between atomic physics and the sudden expansion of the early universe, was published April 19 in *Physical Review X* and featured in *Physics*.

"From the atomic physics perspective, the experiment is beautifully described by existing theory," says Stephen Eckel, an atomic physicist at the National Institute of Standards and Technology (NIST) and the lead author of the new paper. "But even more striking is how that theory connects with cosmology."

In several sets of experiments, Eckel and his colleagues rapidly expanded the size of a doughnut-shaped cloud of atoms, taking snapshots during the process. The growth happens so fast that the cloud is left humming, and a related hum may have appeared on cosmic scales during the rapid expansion of the early universe—an epoch that cosmologists refer to as the period of inflation.

The work brought together experts in atomic physics and gravity, and the authors say it is a testament to the versatility of the Bose-Einstein condensate (BEC)—an ultracold cloud of atoms that can be described as a single quantum object—as a platform for testing ideas from other areas of physics.

"Maybe this will one day inform future models of cosmology," Eckel says. "Or vice versa. Maybe there will be a model of cosmology that's difficult to solve but that you could simulate using a cold atomic gas."

It's not the first time that researchers have connected BECs and cosmology. Prior studies mimicked black holes and searched for analogs of the radiation predicted to pour forth from their shadowy boundaries. The new experiments focus instead on the BEC's response to a rapid expansion, a process that suggests several analogies to what may have happened during the period of inflation.

The first and most direct analogy involves the way that waves travel through an expanding medium. Such a situation doesn't arise often in physics, but it happened during inflation on a grand scale. During that expansion, space itself stretched any waves to much larger sizes and stole energy from them through a process known as Hubble friction.

In one set of experiments, researchers spotted analogous features in their cloud of atoms. They imprinted a sound wave onto their cloud—alternating regions of more atoms and fewer atoms around the ring, like a wave in the early universe—and watched it disperse during expansion. Unsurprisingly, the sound wave stretched out, but its amplitude also decreased. The math revealed that this damping looked just like Hubble friction, and the behavior was captured well by calculations and numerical simulations.

"It's like we're hitting the BEC with a hammer," says Gretchen Campbell, the NIST co-director of the Joint Quantum Institute (JQI) and a coauthor of the paper, "and it's sort of shocking to me that these simulations so nicely replicate what's going on."

In a second set of experiments, the team uncovered another, more speculative analogy. For these tests they left the BEC free of any sound waves but provoked the same expansion, watching the BEC slosh back and forth until it relaxed.

In a way, that relaxation also resembled inflation. Some of the energy that drove the expansion of the universe ultimately ended up creating all of the matter and light around us. And although there are many theories for how this happened, cosmologists aren't exactly sure how that leftover energy got converted into all the stuff we see today.

In the BEC, the energy of the expansion was quickly transferred to things like sound waves traveling around the ring. Some early guesses for why this was happening looked promising, but they fell short of predicting the energy transfer accurately. So the team turned to numerical simulations that could capture a more complete picture of the physics.

What emerged was a complicated account of the energy conversion: After the expansion stopped, atoms at the outer edge of the ring hit their new, expanded boundary and got reflected back toward the center of the cloud. There, they interfered with atoms still traveling outward, creating a zone in the middle where almost no atoms could live. Atoms on either side of this inhospitable area had mismatched quantum properties, like two neighboring clocks that are out of sync.

The situation was highly unstable and eventually collapsed, leading to the creation of vortices throughout the cloud. These vortices, or little quantum whirlpools, would break apart and generate sound waves that ran around the ring, like the particles and radiation left over after inflation. Some vortices even escaped from the edge of the BEC, creating an imbalance that left the cloud rotating.

Unlike the analogy to Hubble friction, the complicated story of how sloshing atoms can create dozens of quantum whirlpools may bear no resemblance to what goes on during and after inflation. But Ted Jacobson, a coauthor of the new paper and a physics professor at the University of Maryland specializing in black holes, says that his interaction with atomic physicists yielded benefits outside these technical results.

"What I learned from them, and from thinking so much about an experiment like that, are new ways to think about the cosmology problem," Jacobson says. "And they learned to think about aspects of the BEC that they would never have thought about before. Whether those are useful or important remains to be seen, but it was certainly stimulating."

Eckel echoes the same thought. "Ted got me to think about the processes in BECs differently," he says, "and any time you approach a problem and you can see it from a different perspective, it gives you a better chance of actually solving that problem."

Future experiments may study the complicated transfer of energy during expansion more closely, or even search for further cosmological analogies. "The nice thing is that from these results, we now know how to design experiments in the future to target the different effects that we hope to see," Campbell says. "And as theorists come up with models, it does give us a testbed where we could actually study those models and see what happens." [9]

Gravitational waves created by black holes in the centre of most galaxies

Gravitational waves may be produced in the heart of the galaxy, says a new study led by Ph.D. student Joseph Fernandez at Liverpool John Moores University. He sets out the work in a presentation on 3rd April at the European Week of Astronomy and Space Science in Liverpool.

Gravitational waves are small ripples in space-time that spread throughout the universe. When there is a change in air pressure on Earth, this change moves outwards in the form of sound waves. Analogously, when pairs of compact objects like black holes or neutron stars form binaries and rotate around one another, the gravitational field around them changes, producing gravity waves that also move outwards.

This phenomenon was predicted by Albert Einstein in 1915. The amplitude of these ripples was predicted to be so small that Einstein thought they would never be detected. However in 2015, a century after making the prediction, gravity waves were observed directly for the first time

These originated from a pair of stellar mass black holes (around 30 times the mass of the sun each), which fell together, and eventually merged.

Since then, another four confirmed observations of gravity waves have been reported to originate from these systems, and with the LIGO and VIRGO improvements currently underway, we expect to see many more in the near future.

These observations show that black hole mergers are commonplace in the universe. However, researchers are still not sure how these sort of binary systems form. This is because they need to be on very close or very eccentric orbits in order to collapse in such a way that gravity waves are observable.

Fernandez and colleagues, including another Ph.D. student Brown, have shown that the orbits of binaries can be changed by the black hole that lies in the centre of most galaxies, including our own.

A massive black hole results in very intense gravitational fields and extreme physics. If a compact binary were to have a close encounter with one, then in most cases it would be disrupted and its component black holes or stars would be separated.

However, this isn't always the case.

Binaries can emerge from the tidal encounter undisrupted under certain conditions, with their orbits suffering severe modifications. By using Monte Carlo simulations, Fernandez has shown that surviving black hole binary systems can become tight and eccentric, reducing the merger time by over a factor of 100 in 10 percent of cases.

This could be sufficient to force binaries that wouldn't merge within the lifetime of the universe to do so sooner, leading to observable gravitational waves.

This process can also flip the binary system orbital plane, making the black holes orbit in the opposite direction to their initial conditions. This can lead to negative effective spin values, which could be used to distinguish this mechanism from others. [8]

Gravitational waves may oscillate, just like neutrinos

Using data from the first-ever gravitational waves detected last year, along with a theoretical analysis, physicists have shown that gravitational waves may oscillate between two different forms called "g" and "f"-type gravitational waves. The physicists explain that this phenomenon is analogous to the way that neutrinos oscillate between three distinct flavors—electron, muon, and tau. The oscillating gravitational waves arise in a modified theory of gravity called bimetric gravity, or "bigravity," and the physicists show that the oscillations may be detectable in future experiments.

The researchers, Kevin Max, a PhD student at Scuola Normale Superiore di Pisa and INFN Pisa, Italy; Moritz Platscher, a PhD student at the Max Planck Institute for Nuclear Physics, Germany; and Juri Smirnov, a postdoc at the University of Florence, Italy, have published a paper on their analysis of gravitational wave oscillations in a recent issue of Physical Review Letters.

As the physicists explain, the work may help answer the question of what "the other 95%" of the universe is made of, by suggesting that the answer may lie in modifications to gravity rather than new particles.

"Only 5% of matter is of a type we think to understand properly," Smirnov told Phys.org. "To address the question of what our universe is made of ('dark matter' and 'dark energy'), most authors discuss alternative particle physics models with new particles. However, experiments such as the ones at the LHC [Large Hadron Collider] haven't detected any exotic particles, yet. This raises the question if maybe the gravitational side needs to be modified.

"In our work, we ask what signals we could expect from a modification of gravity, and it turns out that bigravity features a unique such signal and can therefore be discriminated from other theories. The recent detection of gravitational waves by LIGO [Laser Interferometer Gravitational-Wave Observatory] has opened a new window on the dark sectors of the universe for us. Whether Nature has chosen general relativity, bigravity, or any other theory is a different question in the end. We can only study possible signals for experimentalists to look for."

Two gravitons instead of one

Currently, the best theory of gravity is Einstein's theory of general relativity, which uses a single metric to describe spacetime. As a result, gravitational interactions are mediated by a single hypothetical particle called a graviton, which is massless and so travels at the speed of light.

The main difference between general relativity and bigravity is that bigravity uses two metrics, g and f. Whereas g is a physical metric and couples to matter, f is a sterile metric and does not couple to matter. In bigravity, gravitational interactions are mediated by two gravitons, one of which has mass and the other of which is massless. The two gravitons are composed of different combinations (or superpositions) of the g and f metrics, and so they couple to the surrounding matter in different ways. The existence of two metrics (and two gravitons) in the bigravity framework eventually leads to the oscillation phenomenon.

As the physicists explain, the idea that there might exist a graviton with mass has been around since almost as long general relativity itself.

"Einstein's theory of general relativity predicts one mediator (the 'graviton') of the gravitational interactions, which travels at the speed of light, i.e., which is massless," Max said. "Back in the late 1930s, people were already trying to find a theory containing a mediator that has a mass, and thus travels at a speed less than the speed of light. This turned out to be a very difficult task and was only recently accomplished in 2010. Bigravity is a variation of this 2010 framework, which features not one, but two dynamical metrics. Only one of them couples to matter while the other doesn't; and a linear combination of them becomes massive (slower than the speed of light) while the other is massless (speed of light)."

Oscillations

The physicists show that, in the framework of bigravity, as gravitational waves are produced and propagate through space, they oscillate between the g- and f-types—though only the g-type can be detected. Although previous research has suggested that these oscillations might exist, it appeared to lead to unphysical results, such as a violation of energy conservation. The new study shows that the oscillations can theoretically emerge in a realistic physical scenario when considering graviton masses that are large enough to be detected by current astrophysical tests.

In order to understand these oscillations, the scientists explain that in many ways they resemble neutrino oscillations. Although neutrinos come in three flavors (electron, muon, and tau), typically the neutrinos produces in nuclear reactions are electron neutrinos (or electron anti-neutrinos) because the others are too heavy to form stable matter. In a similar way, in bigravity only the g metric couples to matter, so the gravitational waves produced by astrophysical events, such as black hole mergers, are g-type since f-type gravitational waves do not couple to matter.

"The key to understanding the oscillation phenomenon is that electron neutrinos do not have a definite mass: they are a superposition of the three neutrino mass eigenstates," Platscher explained. "More mathematically speaking, the mass matrix is not diagonal in the flavor (electron-muon-tau) basis. Therefore, the wave equation that describes how they move through space will mix them up and therefore they 'oscillate.'

"The same is true in bigravity: g is a mixture of the massive and the massless graviton, and therefore as the gravitational wave travels through the Universe, it will oscillate between g- and f-type gravitational waves. However, we can only measure the former with our detectors (which are made of matter), while the latter would pass through us unseen! This would, if bigravity is a correct description of Nature, leave an important imprint in the gravitational wave signal, as we have shown."

As the physicists note, the similarity between neutrinos and gravitational waves holds even though neutrino oscillation is a quantum mechanical phenomenon that is described by the Schrödinger wave equation, whereas gravitational wave oscillation is not a quantum effect and instead is described by a classical wave equation.

One particular effect that the physicists predict is that gravitational wave oscillations lead to larger strain modulations compared to those predicted by general relativity. These results suggest a path toward experimentally detecting gravitational wave oscillations and finding support for bigravity.

"Since bigravity is a very young theory, there is still a lot to be done, and its potential to address our theories' shortcomings needs to be explored," Smirnov said. "There has been some work along these lines, but certainly a lot is yet to be done and we hope to contribute in the future as well!" [7]

Quest to settle riddle over Einstein's theory may soon be over

Astronomy experiments could soon test an idea developed by Albert Einstein almost exactly a century ago, scientists say.

Tests using advanced technology could resolve a longstanding puzzle over what is driving the accelerated expansion of the Universe.

Researchers have long sought to determine how the Universe's accelerated expansion is being driven. Calculations in a new study could help to explain whether dark energy- as required by Einstein's theory of general relativity - or a revised theory of gravity are responsible.

Einstein's theory, which describes gravity as distortions of space and time, included a mathematical element known as a Cosmological Constant. Einstein originally introduced it to explain a static universe, but discarded his mathematical factor as a blunder after it was discovered that our Universe is expanding.

Research carried out two decades ago, however, showed that this expansion is accelerating, which suggests that Einstein's Constant may still have a part to play in accounting for dark energy. Without dark energy, the acceleration implies a failure of Einstein's theory of gravity across the largest distances in our Universe.

Scientists from the University of Edinburgh have discovered that the puzzle could be resolved by determining the speed of gravity in the cosmos from a study of gravitational waves -space-time ripples propagating through the universe.

The researchers' calculations show that if gravitational waves are found to travel at the speed of light, this would rule out alternative gravity theories, with no dark energy, in support of Einstein's Cosmological Constant. If however, their speed differs from that of light, then Einstein's theory must be revised.

Such an experiment could be carried out by the Laser Interferometer Gravitational-Wave Observatory (LIGO) in the US, whose twin detectors, 2000 miles apart, directly detected gravitational waves for the first time in 2015.

Experiments at the facilities planned for this year could resolve the question in time for the 100th anniversary of Einstein's Constant.

The study, published in Physics Letters B, was supported by the UK Science Technology Facilities Council, the Swiss National Science Foundation, and the Portuguese Foundation of Science and Technology.

Dr Lucas Lombriser, of the University of Edinburgh's School of Physics and Astronomy, said: "Recent direct gravitational wave detection has opened up a new observational window to our Universe. Our results give an impression of how this will guide us in solving one of the most fundamental problems in physics." [6]

NEW THEORY OF GRAVITY DOES AWAY WITH NEED FOR DARK MATTER

Let's be honest. Dark matter's a pain in the butt. Astronomers have gone to great lengths to explain why is must exist and exist in huge quantities, yet it remains hidden. Unknown. Emitting no visible energy yet apparently strong enough to keep galaxies in clusters from busting free like wild horses, it's everywhere in vast quantities. What is the stuff – axions, WIMPS, gravitinos, Kaluza Klein particles?

It's estimated that 27% of all the matter in the universe is invisible, while everything from PB&J sandwiches to quasars accounts for just 4.9%. But a new theory of gravity proposed by theoretical physicist Erik Verlinde of the University of Amsterdam found out a way to dispense with the pesky stuff.

Unlike the traditional view of gravity as a fundamental force of nature, Verlinde sees it as an emergent property of space. Emergence is a process where nature builds something large using small, simple pieces such that the final creation exhibits properties that the smaller bits don't. Take a snowflake. The complex symmetry of a snowflake begins when a water droplet freezes onto a tiny dust particle. As the growing flake falls, water vapor freezes onto this original crystal, naturally arranging itself into a hexagonal (six-sided) structure of great beauty. The sensation of temperature is another emergent phenomenon, arising from the motion of molecules and atoms.

So too with gravity, which according to Verlinde, emerges from entropy. We all know about entropy and messy bedrooms, but it's a bit more subtle than that. Entropy is a measure of disorder in a system or put another way, the number of different microscopic states a system can be in. One of the coolest descriptions of entropy I've heard has to do with the heat our bodies radiate. As that energy dissipates in the air, it creates a more disordered state around us while at the same time decreasing our own personal entropy to ensure our survival. If we didn't get rid of body heat, we would eventually become disorganized (overheat!) and die.

The more massive the object, the more it distorts space-time, shown here as the green mesh. Earth orbits the Sun by rolling around the dip created by the Sun's mass in the fabric of space-time. It doesn't fall into the Sun because it also possesses forward momentum. Credit: LIGO/T. Pyle

Emergent or entropic gravity, as the new theory is called, predicts the exact same deviation in the rotation rates of stars in galaxies currently attributed to dark matter. Gravity emerges in Verlinde's view from changes in fundamental bits of information stored in the structure of space-time, that four-dimensional continuum revealed by Einstein's general theory of relativity. In a word, gravity is a consequence of entropy and not a fundamental force.

Space-time, comprised of the three familiar dimensions in addition to time, is flexible. Mass warps the 4-D fabric into hills and valleys that direct the motion of smaller objects nearby. The Sun doesn't so much "pull" on the Earth as envisaged by Isaac Newton but creates a great pucker in space-time that Earth rolls around in.

In a 2010 article, Verlinde showed how Newton's law of gravity, which describes everything from how apples fall from trees to little galaxies orbiting big galaxies, derives from these underlying microscopic building blocks.

His latest paper, titled Emergent Gravity and the Dark Universe, delves into dark energy's contribution to the mix. The entropy associated with dark energy, a still-unknown form of energy responsible for the accelerating expansion of the universe, turns the geometry of spacetime into an elastic medium.

"We find that the elastic response of this 'dark energy' medium takes the form of an extra 'dark' gravitational force that appears to be due to 'dark matter'," writes Verlinde. "So the observed dark matter phenomena is a remnant, a memory effect, of the emergence of spacetime together with the ordinary matter in it."

Rotation curve of the typical spiral galaxy M 33 (yellow and blue points with errorbars) and the predicted one from distribution of the visible matter (white line). The discrepancy between the two curves is accounted for by adding a dark matter halo surrounding the galaxy. Credit: Public domain / Wikipedia

This diagram shows rotation curves of stars in M33, a typical spiral galaxy. The vertical scale is speed and the horizontal is distance from the galaxy's nucleus. Normally, we expect stars to slow down the farther they are from galactic center (bottom curve), but in fact they revolve much faster (top curve). The discrepancy between the two curves is accounted for by adding a dark matter halo surrounding the galaxy.

I'll be the first one to say how complex Verlinde's concept is, wrapped in arcane entanglement entropy, tensor fields and the holographic principal, but the basic idea, that gravity is not a fundamental force, makes for a fascinating new way to look at an old face.

Physicists have tried for decades to reconcile gravity with quantum physics with little success. And while Verlinde's theory should be rightly be taken with a grain of salt, he may offer a way to combine the two disciplines into a single narrative that describes how everything from falling apples to black holes are connected in one coherent theory. [5]

Identification of a Gravitational Arrow of Time

The proposal by the trio though phrased in a way as to suggest it's a solution to the arrow of time problem, is not likely to be addressed as such by the physics community—it's more likely to be considered as yet another theory that works mathematically, yet still can't answer the basic question of what is time.

For all the advances made in understanding the world around us, there are still two very basic fundamental concepts that have defied explanation: time and gravity. Though we have progressed greatly in measuring both and using both to understand other concepts, we still today are no closer to understanding either than we were when we first conceptualized them. Such an acknowledgment suggests that we likely have a major flaw in our understanding of the universe. In considering such a possibility, the three physicists with this new effort suggest we might look at time in a completely new way—by dividing a dynamically closed universe (ala the Newtonian N-body problem) into two halves with shape complexity growing from a single point—each solution to the problem can then be considered as having one past but two distinctly futures. In such a scenario, an observer would of necessity have to exist on one side or the other, and thus would only ever have that perspective. Critical to this idea is that the all of the energy and angular momentum in such a system would have to be zero.

In essence, the team has removed time from mathematical functions that describe the energy of the universe—that's what allows for splitting the equations that have been created to describe the evolution of the universe into two parts, with both having initial low complexity moving to higher complexity (similar in some respects to theories of time based on entropy).

The proposal by the trio though phrased in a way as to suggest it's a solution to the arrow of time problem, is not likely to be addressed as such by the physics community—it's more likely to be considered as yet another theory that works mathematically, yet still can't answer the basic question of what is time. [4]

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) $I = I_0 \sin^2 n\ \varphi/2\ \mathbf{/}\ \sin^2 \varphi/2$

If φ is infinitesimal so that $\sin\varphi = \varphi$ than

(2) $\iota = n^2\ \iota_0$

This gives us the idea of

(3) $M_p = n^2 M_e$

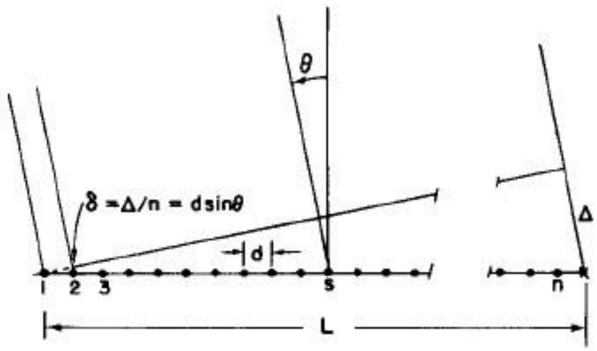


Fig. 30–3. A linear array of n equal oscillators, driven with phases $\alpha_s = s\alpha$.

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:

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

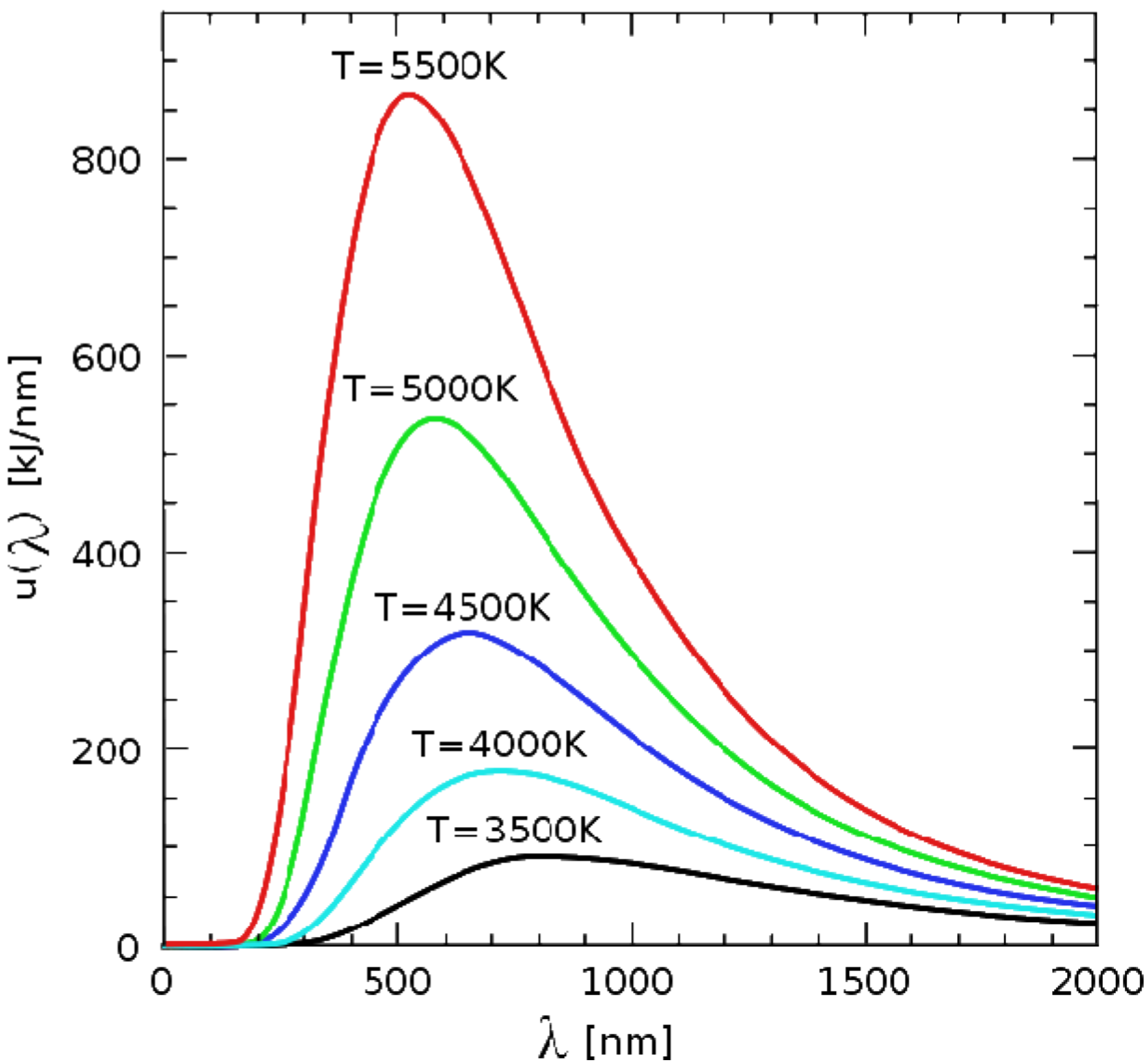


Figure 2. The distribution law for different T temperatures

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

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 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 order, because they are different geometrical constructions, the u is 2 dimensional and positively charged and the d is 1 dimensional and negatively charged. It needs also a time reversal, because anti particle (anti neutrino) is involved.

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

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

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

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

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

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

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

The General Weak Interaction

The Weak Interactions T-asymmetry is in conjunction with the T-asymmetry of the Second Law of Thermodynamics, meaning that locally lowering entropy (on extremely high temperature) causes for example the Hydrogen fusion. The arrow of time by the Second Law of Thermodynamics shows the increasing entropy and decreasing information by the Weak Interaction, changing the temperature dependent diffraction patterns. A good example of this is the neutron decay, creating more particles with less known information about them.
The neutrino oscillation of the Weak Interaction shows that it is a general electric dipole change and it is possible to any other temperature dependent entropy and information changing diffraction pattern of atoms, molecules and even complicated biological living structures.

We can generalize the weak interaction on all of the decaying matter constructions, even on the biological too. This gives the limited lifetime for the biological constructions also by the arrow of time. There should be a new research space of the Quantum Information Science the 'general neutrino oscillation' for the greater then subatomic matter structures as an electric dipole change.
There is also connection between statistical physics and evolutionary biology, since the arrow of time is working in the biological evolution also.
The Fluctuation Theorem says that there is a probability that entropy will flow in a direction opposite to that dictated by the Second Law of Thermodynamics. In this case the Information is growing that is the matter formulas are emerging from the chaos. So the Weak Interaction has two directions, samples for one direction is the Neutron decay, and Hydrogen fusion is the opposite direction.

Fermions and Bosons

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

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.

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 $\lambda\nu = c$, the Planck relation can also be expressed as

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

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

The expression of the fine-structure constant becomes the abbreviated

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

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

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

Conclusions

In essence, the team has removed time from mathematical functions that describe the energy of the universe—that's what allows for splitting the equations that have been created to describe the evolution of the universe into two parts, with both having initial low complexity moving to higher complexity (similar in some respects to theories of time based on entropy). [4]

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. 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. 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.

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