Supercomputers on Dark Matter

A research team from Cyprus, Germany and Italy led by Constantia Alexandrou of the Computation-based Science and Technology Research Center of the Cyprus Institute and the Physics Department of the University of Cyprus in Nicosia, has now for the first time calculated the scalar quark content of the proton. [16]

Researchers propose that dark matter is a kind of invisible, intangible version of a pion, or a type of meson — a category of particles made up of quarks and antiquarks. [15]

A new theory says dark matter acts remarkably similar to subatomic particles known to science since the 1930s. [14]

How can the LHC experiments prove that they have produced dark matter? They can't… not alone, anyway. [13]

The race for the discovery of dark matter is on. Several experiments worldwide are searching for the mysterious substance and pushing the limits on the properties it may have. [12]

Dark energy is a mysterious force that pervades all space, acting as a "push" to accelerate the universe's expansion. Despite being 70 percent of the universe, dark energy was only discovered in 1998 by two teams observing Type Ia supernovae. A Type 1a supernova is a cataclysmic explosion of a white dwarf star. The best way of measuring dark energy just got better, thanks to a new study of Type Ia supernovae. [11]

Newly published research reveals that dark matter is being swallowed up by dark energy, offering novel insight into the nature of dark matter and dark energy and what the future of our Universe might be. [10]

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.

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Author: George Rajna

Supercomputers on the trail of dark matter

Almost all mass on Earth, humans included, derives from the atomic nuclei. These nuclei consist mainly of protons and neutrons, also called nucleons. Each nucleon in turn is made of three constituent quarks. However, the number of quark particles in the nucleon is actually much higher. This is due to what are known as quantum fluctuations, where pairs of particles and anti-particles form spontaneously in a vacuum and immediately disintegrate again. A research team from Cyprus, Germany and Italy led by Constantia Alexandrou of the Computation-based Science and Technology Research Center of the Cyprus Institute and the Physics Department of the University of Cyprus in Nicosia, has now for the first time calculated the scalar quark content of the proton. For the elaborate simulations in a CHRONOS (Computationally-Intensive, High-Impact Research On Novel Outstanding Science) project they made extensive use of the graphics processors (GPUs) of the CSCS supercomputer 'Piz Daint'. The researchers expect that their calculations will aid research into physical processes in particle physics and the as yet unknown dark matter that accounts for an estimated 21 percent of matter in the universe.

Quark condensates couple to the Higgs-boson

For every quark, there exists an anti-quark. A tightly coupled quark/anti-quark pair forms a condensate, similar to a water droplet on a pane of glass. This condensate is called the scalar quark content, and has a scalar quantum number. So the condensates can couple to the Higgs boson, which itself is a scalar particle. The Higgs boson – it is suspected – could interact with scalar particles of dark matter. "If we are to interpret experimental results as direct evidence for dark matter, then it is essential to know the numeric value we determined for the condensates and hence the exact proportion of scalar quark content in the nucleon, in particular what are known as strange quarks", says Alexandrou.

Quarks interact mutually via gluon particles, and quarks with gluons via their respective colour charges, which may be red, green or blue. The strong force acting and being transmitted by the gluons – called the strong interaction – is one of the four fundamental forces of physics along with the weak interaction, the electromagnetic interaction and gravitation. The research field of Alexandrou and her team is quantum chromodynamics (QCD), which theoretically describes the strong interaction between quarks and gluons, and hence explains the origin of the nucleon large mass as well as what binds together neutrons and protons in atomic nuclei. For without the strong interaction, protons, for example, with their similar electrical charges, would repel each other rather than sticking together in the nucleus. And that would negate the existence of matter as we now understand it.

Heavy mass from binding energy

The strong interaction is indeed so strong that the mass-equivalent of the binding energy represents to a substantial degree the mass of a nucleon: "While a quark weighs around 10 mega electron volts (MeV), a proton due to its binding energy weighs 1 GeV (giga electron volts), or 100 times more", says physicist Karl Jansen of the John von Neumann Institute for Computing at DESY in Zeuthen, Germany, who was involved with the study now published in Physical Review Letters. The force is so strong that quarks can never be extracted from protons experimentally. "That is a property that is characteristic for QCD and it is termed 'confinement'", says Alexandrou. Attempts to isolate quarks using large quantities of energy result in their behaving like a spring or an elastic band, where increasing energy must be given the further they are pulled apart. If the band is over-stretched, it 'rips' and a quark-antiquark is formed that immediately binds via the strong interaction, and leads to a new hadron (a composite particle of quarks) being formed.

Strong force with extremely short radius of action

However, the strong force acts only on a very small space inside the atomic nucleus and defies approximate calculation, because the coupling between particles can grow very strong. Thus, it is not possible to identify a sufficiently small parameter that would be necessary for a perturbation theory calculation, explains Jansen.

With the ground-breaking formulation of a theory of quarks and gluons in a four-dimensional space-time lattice, physicist and Nobel Prize winner Kenneth Wilson succeeded in 1974 with developing the lattice theory of quantum chromodynamics (lattice QCD) – a non-perturbative method. He thus laid the foundation for future numerical simulation.

In the lattice QCD theory, space-time is a four-dimensional lattice, a crystal with hyper-cubic symmetry. "By also moving from Minkowski to Euclidean time, we can consider the quantum field theory as a statistical physical system and carry out numerical simulations of that system", explains Jansen. Nevertheless, it took over 30 years until the first researchers managed in 2008 to calculate the weight of nucleons and other particles directly from lattice QCD. This was made possible by a spectacular further development of the simulation algorithm in use, together with continually improving and more powerful supercomputers, says Jansen. "Now, by further refining the existing techniques and developing new and better algorithms, we successfully determined the scalar quark content in a proton – another non-trivial step."

The research results of Alexandrou and her team are already finding use in experiments that look for evidence of an interaction between the Higgs boson and the scalar condensate inside the nucleon. In the involved researchers' view, the most recent results from 'Piz Daint' could thus push open a new window along the way to finally solving the mystery of dark matter. [16]

Dark Pion Particles May Explain Universe's Invisible Matter

Dark matter is the mysterious stuff that cosmologists think makes up some 85 percent of all the matter in the universe. A new theory says dark matter might resemble a known particle. If true, that would open up a window onto an invisible, dark matter version of physics.

The only way dark matter interacts with anything else is via gravity. If you poured dark matter into a bucket, it would go right through it because it doesn't react to electromagnetism (one reason you can stand on the ground is because the atoms in your feet are repelled by the atoms in the Earth). Nor does dark matter reflect or absorb light. It's therefore invisible and intangible.

Scientists were clued into its existence by the way galaxies behaved. The mass of the galaxies calculated from the visible stuff they contained wasn't enough to keep them bound to each other. Later, observations of gravitational lensing, in which light bends in the presence of gravity fields, showed there was something that made galaxy clusters more massive that couldn't be seen. [The 9 Biggest Unsolved Mysteries in Physics]

Invisible pions

Now, a team of five physicists has proposed that dark matter might be a kind of invisible, intangible version of a pion, a particle that was originally discovered in the 1930s. A pion is a type of meson — a category of particles made up of quarks and antiquarks; neutral pions travel between protons and neutrons and bind them together into atomic nuclei.

Most proposals about dark matter assume it is made up of particles that don't interact with each other much — they pass through each other, only gently touching.
The name for such particles is weakly interacting massive particles, or WIMPs. Another idea is that dark matter is made up of axions, hypothetical particles that could solve some unanswered questions about the Standard Model of particle physics. Axions wouldn't interact strongly with each other, either.

The new proposal assumes that the dark matter pions interact much more strongly with each other. When the particles touch, they partially annihilate and turn into normal matter. "It's a SIMP [strongly interacting massive particle]," said Yonit Hochberg, a postdoctoral researcher at Berkeley and lead author on the study.

"Strongly interacting with itself."

To annihilate into normal matter, the particles must collide in a "three-to-two" pattern, in which three dark matter particles meet. Some of the dark matter "quarks" that make up the particles annihilate and turn into normal matter, leaving some dark matter behind. With this ratio, the result would leave the right proportion of dark matter to normal matter in the current universe.

This new explanation suggests that in the early universe the dark pions would have collided with each other, reducing the amount of dark matter. But as the universe expanded the particles would collide less and less often, until now, when they are spread so thinly they hardly ever meet at all.

The interaction bears a close resemblance to what happens to charged pions in nature. These particles consist of an up quark and an anti-down quark. (Quarks come in six flavors, or types: up, down, top, bottom, charm and strange.) When three pions meet, they partially annihilate and become two pions. [7 Strange Facts About Quarks]

"[The theory] is based on something similar — something that already happens in nature," said Eric Kuflik, a postdoctoral researcher at Cornell University in New York and a co-author of the study.

Different kind of pion

For the new explanation to work, the dark matter pions would have to be made of something different from normal matter. That's because anything made of normal quarks simply wouldn't behave the way dark matter does, at least not in the group's calculations. (There are theories that strange quarks could make up dark matter).

Charged pions are made up of an up quark and an anti-down quark, or a down and anti-up quark, while neutral pions are made of an up quark plus an anti-up or a down quark plus an anti-down.

In the new hypothesis, dark matter pions are made up of dark matter quarks that are held together by dark matter gluons. (Ordinary quarks are held together by normal gluons.) The dark quarks wouldn't be like the familiar six types, and the dark gluon would, unlike ordinary gluons, have mass, according to the mathematics.

Dark pions and dwarf galaxies

Another co-author on the paper, Hitoshi Murayama, professor of physics at the University of California, Berkeley, said the new hypothesis would help explain the density of certain kinds of dwarf galaxies. Computer simulations show dwarf galaxies with very dense center regions, but that isn't what astronomers see in the sky.
"If SIMPs are spread out, the distribution is flatter — it works better," he said. [Gallery: Dark Matter Throughout the Universe]

Dan Hooper, a staff scientist at Fermi National Accelerator Laboratory in Illinois, said he isn't quite convinced that this model of dark matter is necessary to explain the dwarf galaxy conundrum.

"There's a handful of people who say dwarfs don't look like we expect," he said. "But do you need some other property to solve that?
People have showed it could be the heating of gas." That is, gas heated at the center of a dwarf galaxy would be less dense.

The Large Hadron Collider might soon offer some insight into which camp is correct; that strange new "dark pions" are dark matter or that they aren't and there's something else. Particle accelerators work by taking atomic nuclei -- usually hydrogen but sometimes heavier elements like lead —and smashing them together at nearly the speed of light. The resulting explosion scatters new particles, born of the energy of the collision. In that sense the particles are the "shrapnel."

Kuflik said that if there's "missing" mass (more precisely, mass-energy) from the collision of particles that's a strong pointer to the kind of dark matter that the researchers are looking for. This is because mass and energy are conserved; if the products of a collision don't tally up to the same amount of mass and energy you started with, that means there might be a previously unknown particle that escaped detection somewhere.

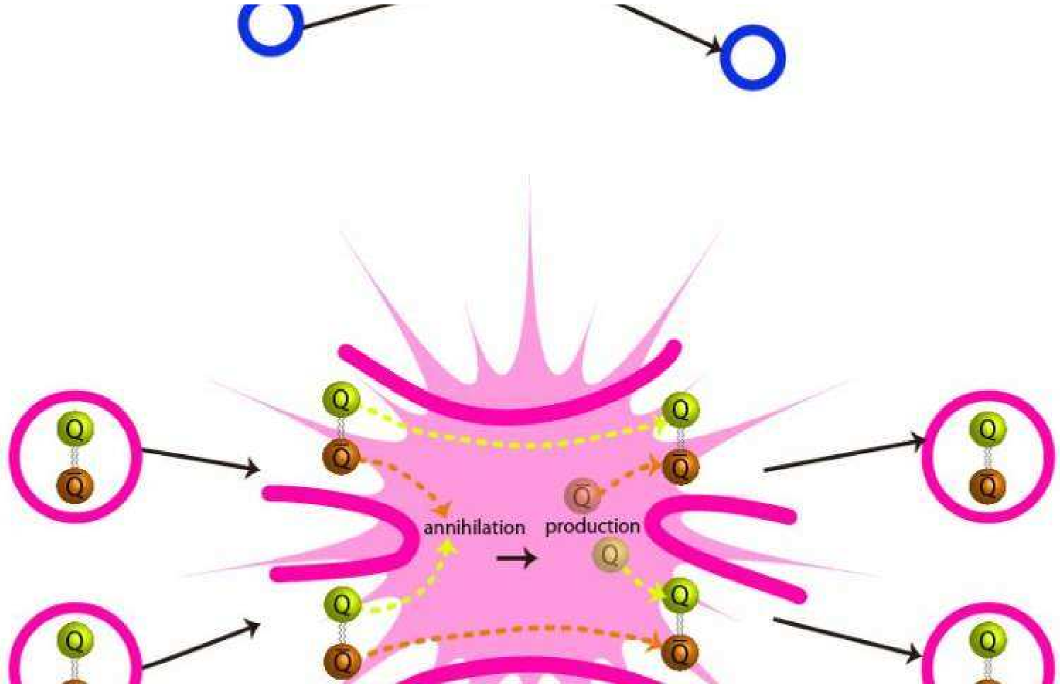
Such measurements are hard to do, though, so it will take a lot of sifting through data to see if that happens and what the explanation is.

Another way to track down dark matter particles might be in a detector made with liquid xenon or germanium, in which electrons would occasionally get knocked off an atom by a passing dark matter particle. There's already an experiment like that, though, the Large Underground Xenon (LUX) project in South Dakota. It didn't find anything yet, but it was focused on WIMPs (though it was able to rule out some types). A newer version of the experiment is planned; it might detect other kinds of dark matter particle.

The team is currently working on a paper outlining the kinds of observations that would detect this kind of dark matter. "We're currently working on writing up explicit ways these dark pions can interact with ordinary matter," Hochberg said.

The study appears in the July 10 issue of the journal Physical Review Letters. [15]

Déjà-vu, new theory says dark matter acts like well-known particle



Conventional theories predict that dark matter particles would not collide, rather they would slip past one another. Hochberg et al. predicts dark matter SIMPs would collide and interact with one another. Credit: Kavli IPMU

We owe a lot to dark matter – it is the thing keeping galaxies, stars, our solar system, and our bodies intact. Yet no one has been able to observe it, and it has often been regarded as a totally new exotic form of matter, such as a particle moving in extra dimensions of space or its quantum version, super-symmetry.

Now an international group of researchers has proposed a theory that dark matter is very similar to pions, which are responsible for binding atomic nuclei together. Their findings appear in the latest Physical Review Letters, published on July 10.

"We have seen this kind of particle before. It has the same properties – same type of mass, the same type of interactions, in the same type of theory of strong interactions that gave forth the ordinary pions. It is incredibly exciting that we may finally understand why we came to exist," says Hitoshi Murayama, Professor of Physics at the University of California, Berkeley, and Director of the Kavli Institute for the Physics and Mathematics of the Universe at the University of Tokyo.

The new theory predicts dark matter is likely to interact with itself within galaxies or clusters of galaxies, possibly modifying the predicted mass distributions. "It can resolve outstanding discrepancies between data and computer simulations," says Eric Kuflik, a postdoctoral researcher at Cornell University. University of California, Berkeley postdoctoral researcher Yonit Hochberg adds, "The key differences in these properties between this new class of dark matter theories and previous ideas have profound implications on how dark matter can be discovered in upcoming experimental searches."

The next step will be to put this theory to the test using experiments such as the Large Hadron Collider and the new SuperKEK-B, and a proposed experiment SHiP. [14]

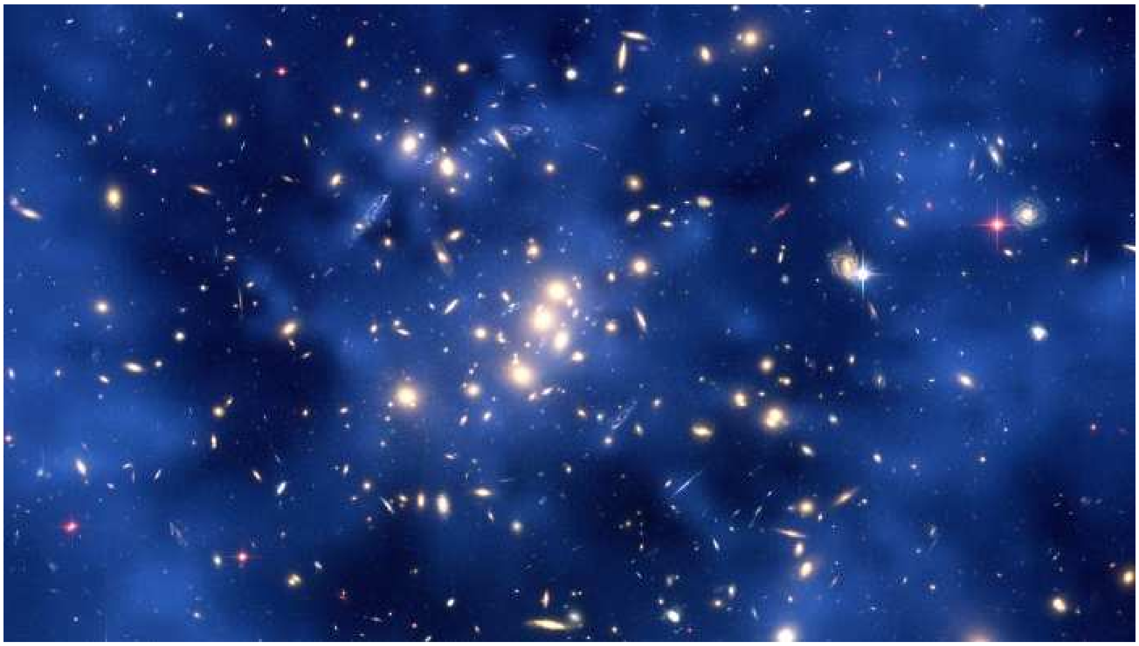
Even If LHC Discovers New Undetectable Particles, Are They Really Dark Matter Particles?

How can the LHC experiments prove that they have produced dark matter? They can't… not alone, anyway. Even if they have made a new type of undetectable particle, they will have to partner with at least one other experiment that can directly check whether the dark matter itself — the stuff found abundantly in the universe — is actually made from LHC's new particles. Simply knowing that the type of particle exists doesn't prove that it makes up most of the matter in the universe. Just like neutrinos, it might make up only a small amount of the matter in the universe. Or it might even make up none, if the new particles are unstable (as is the case for most types of particles), and have a lifetime long enough to travel out of the LHC detectors unseen before they decay, but short enough that they disappeared from the universe shortly after the Big Bang.

To say it more succinctly: even if the LHC makes and discovers a new class of undetectable particles, there's no way for LHC experimenters to figure out how many of these particles, if any, remain in the universe today. The LHC is the wrong machine for that purpose.

So what's to be done? Well, the LHC can be used to figure out some of the properties of the new particles, subject to some assumptions (which can be tested later.) For instance, in the previous section I gave you three examples (and there are many more) of how new undetectable particles could be discovered. In each case, the new particles were produced in a distinct and distinctive way, and other particles accompanied them that gave an indication as to how they were produced. For instance, if the new particles were produced alone, discovery occurred in collisions that made a single recoiling jet. If they were produced in Higgs decays, discovery could occur in events with two high-energy jets from two distinctive quarks. If they were produced in the decay of a new charged particle, discovery could occur in events with a charged lepton and a charged anti-lepton (charged lepton = electron, muon or tau.) So by looking at what accompanies the new particles, and going even deeper into the details of how much missing transverse momentum is typically produced, scientists can potentially begin to put together one or more hypotheses regarding the nature of these new particles. Those hypotheses will be put into the form of equations, which can be used to make predictions. [13]

Seeing dark matter without seeing



Scientists know that dark matter exists because it has a gravitational effect on visible objects made of ordinary matter. And they know that there is a lot of it; dark matter is thought to be about five times as prevalent as other matter in the universe. Yet, dark matter has managed to evade detection so far.

Similar to normal matter, dark matter is commonly believed to be composed of particles. Scientists' current best guess is that these particles are WIMPs: weakly interacting massive particles. These particles would pass right through ordinary matter. That's because they would interact only through the weak nuclear force—which works only over short distances—and gravity.

Scientists are trying to create WIMPs in collisions at the Large Hadron Collider. But it could be that they are too massive to produce in such an accelerator. Scientists are also trying to find WIMPs with detectors deep underground. But so far they haven't appeared.

That's why scientists also search for dark matter indirectly—rather than trying to catch the WIMPs themselves, they look for other signs that they're around. These signs could come in the form of extra gamma rays, cosmic rays or neutrinos, or in patterns imprinted on the cosmic microwave background radiation left over from just after the big bang.

Gamma rays in space

It could be that WIMPs are their own antimatter partners. That means that if one dark matter particle meets another dark matter particle, the two could annihilate, leaving behind a host of lighter particles and gamma rays.

It could also be that unstable dark matter particles produce gamma rays as they decay.

Either way, one would expect that an area dense with dark matter would be marked by a higher-than-usual amount of these energetic rays. Many recent studies claim to have found hints of the existence of dark matter in gamma rays, but not all scientists are convinced.

One area that should be dense with dark matter is the center of our own galaxy, the Milky Way. That's where scientists are looking for excess gamma rays using the Large Area Telescope on NASA's Fermi Gamma-ray Space Telescope spacecraft, which has been orbiting the Earth since 2008.

Last year, the Fermi-LAT collaboration reported its latest analysis of the galactic center, in which the scientists saw a gamma-ray excess similar to other groups before. However, the researchers have not ruled out interpretations due to sources other than dark matter.

The center of the galaxy is an extremely complex region, says Fermi-LAT researcher Troy Porter of the Kavli Institute for Particle Astrophysics and Cosmology, a joint institute of Stanford University and SLAC National Accelerator Laboratory.

"The galactic center is very active and it contains many different gamma-ray sources, some of which we don't even know yet," he says. "In order to be able to identify any potential dark matter signal, we must first know the level of gamma rays from all other possible sources very precisely."

Other locations to search for dark matter signals are dwarf satellite galaxies that orbit the Milky Way, says Fermi-LAT researcher Matthew Wood at KIPAC, who was the co-leader of two recent analyses of 15 known dwarf galaxies and eight new dwarf galaxy candidates discovered by scientists of the Dark Energy Survey and University of Cambridge in the UK.

"Dwarf galaxies are dominated by dark matter and don't contain any known gamma-ray sources," he says. "These objects, which have more than a million times fewer stars than our own galaxy, are ideal targets for indirect dark matter searches."

In March, researchers from Carnegie Mellon University, Brown University and the University of Cambridge published an analysis claiming to have found excess gamma rays in one of these dwarf galaxy candidates. The Fermi-LAT and DES collaborations, however, found no definitive sign of such an excess.

Gamma rays on Earth

The Fermi-LAT instrument can detect gamma rays with energies of up to several hundred billion electronvolts. However, the gamma rays produced by WIMPs could be even more energetic.

This is where ground-based gamma-ray observatories come in.

"To detect gamma rays with an energy of a trillion electronvolts or larger, we need detectors with a large surface area—larger than what we can possibly accommodate aboard a spacecraft," says physicist Gernot Maier, who leads a group at the German research center DESY that is searching for high-energy gamma rays on the VERITAS experiment in Arizona.

VERITAS, along with MAGIC on the Canary Islands and H.E.S.S. in Namibia, uses an array of telescopes that detect particle showers caused by gamma rays as they travel through the Earth's atmosphere. None of them have spotted signs of dark matter yet.

Next year, a new ground-based gamma-ray observatory will begin construction. The Cherenkov Telescope Array will consist of about 100 telescopes and will be 10 times as sensitive to high-energy gamma rays from dark matter interactions.

Cosmic rays

Cosmic rays are extremely energetic radiation composed of charged particles. Just as dark matter annihilations or decays could produce gamma rays, they could also produce cosmic rays. So an unexplained excess of this type of radiation might point to the presence of dark matter.

This is the way the Alpha Magnetic Spectrometer experiment, run by MIT physicist and Nobel Prize winner Sam Ting, hopes to discover dark matter.

For the past four years, AMS has studied cosmic rays from its perch on the side of the International Space Station.

“So far the data are totally consistent with WIMP annihilations,” Ting says of the AMS measurements of electrons and positrons in cosmic rays.

AMS isn’t the only experiment to spot a possible sign of dark matter in cosmic rays. In 2009, the PAMELA satellite experiment reported a surplus of cosmic-ray positrons—a result that Fermi-LAT researchers confirmed in 2011.

Ting says the AMS collaboration plans to release their next results this month.

Neutrinos from the sun

Dark matter annihilations could also produce almost massless particles called neutrinos.

Experiments that search for signs of dark matter in neutrinos use the sun as a dark matter detector. WIMPs could get gravitationally trapped in the center of the massive star. Once the density of WIMPs there became large enough, they could annihilate and produce neutrinos.

Scientists use observatories such as ANTARES under the Mediterranean Sea, the Lake Baikal Neutrino Telescope in Russia, Super-Kamiokande in Japan and IceCube at the South Pole to look for such an event.

“Only neutrinos are able to escape from the center of the sun,” says IceCube leader Francis Halzen of the University of Wisconsin, Madison. “If we ever find such a high-energy neutrino signal, there will be no debate as to whether we have found a dark matter signature or not.”

Unlike gamma or cosmic rays, which can have several astrophysical origins, high-energy neutrinos emerging from the center of the sun could be produced only in dark matter annihilations.

Caught in the afterglow

The Cosmic Microwave Background is the afterglow of the big bang 14 billion years ago. It exists as a faint pattern of light on the sky. If WIMPs existed in the early universe, they should have left their fingerprint on this radiation.

From 2009 to 2013, the European Space Agency’s Planck space telescope recorded a precise map of this light.

“We measured the dark matter content of the young universe, when it was only 380,000 years old,” says Planck project scientist Jan Tauber.

Planck’s latest publication, released in February, put constraints on the properties of hypothetical WIMPs that are in conflict with the interpretation of positron-excess data from PAMELA, AMS and Fermi-LAT.

Tauber says the Planck collaboration will release more data early next year.

The search goes on

No one knows which method, if any, will lead to the discovery of dark matter. But one thing is clear: Dark matter is quickly losing places to hide. [12]

Best way to measure dark energy just got better

A Type Ia supernova occurs when a white dwarf accretes material from a companion star until it exceeds the Chandrasekhar limit and explodes. By studying these exploding stars, astronomers can measure dark energy and the expansion of the universe. CfA scientists have found a way to correct for small variations in the appearance of these supernovae, so that they become even better standard candles. The key is to sort the supernovae based on their color.

Dark energy is a mysterious force that pervades all space, acting as a "push" to accelerate the Universe's expansion. Despite being 70 percent of the Universe, dark energy was only discovered in

1998 by two teams observing Type Ia supernovae. A Type 1a supernova is a cataclysmic explosion of a white dwarf star.

These supernovae are currently the best way to measure dark energy because they are visible across intergalactic space. Also, they can function as "standard candles" in distant galaxies since the intrinsic brightness is known. Just as drivers estimate the distance to oncoming cars at night from the brightness of their headlights, measuring the apparent brightness of a supernova yields its distance (fainter is farther). Measuring distances tracks the effect of dark energy on the expansion of the Universe.

The best way of measuring dark energy just got better, thanks to a new study of Type Ia supernovae led by Ryan Foley of the Harvard-Smithsonian Center for Astrophysics. He has found a way to correct for small variations in the appearance of these supernovae, so that they become even better standard candles. The key is to sort the supernovae based on their color.

"Dark energy is the biggest mystery in physics and astronomy today. Now, we have a better way to tackle it," said Foley, who is a Clay Fellow at the Center. He presented his findings in a press conference at the 217th meeting of the American Astronomical Society.

The new tool also will help astronomers to firm up the cosmic distance scale by providing more accurate distances to faraway galaxies.

Type Ia supernovae are used as standard candles, meaning they have a known intrinsic brightness. However, they're not all equally bright. Astronomers have to correct for certain variations. In particular, there is a known correlation between how quickly the supernova brightens and dims (its light curve) and the intrinsic peak brightness.

Even when astronomers correct for this effect, their measurements still show some scatter, which leads to inaccuracies when calculating distances and therefore the effects of dark energy. Studies looking for ways to make more accurate corrections have had limited success until now.

"We've been looking for this sort of 'second-order effect' for nearly two decades," said Foley.

Foley discovered that after correcting for how quickly Type Ia supernovae faded, they show a distinct relationship between the speed of their ejected material and their color: the faster ones are slightly redder and the slower ones are bluer.

Previously, astronomers assumed that redder explosions only appeared that way because of intervening dust, which would also dim the explosion and make it appear farther than it was. Trying to correct for this, they would incorrectly calculate that the explosion was closer than it appeared. Foley's work shows that some of the color difference is intrinsic to the supernova itself.

The new study succeeded for two reasons. First, it used a large sample of more than 100 supernovae. More importantly, it went back to "first principles" and reexamined the assumption that Type Ia supernovae are one average color. [11]

The Big Bang

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.

Study Reveals Indications That Dark Matter is Being Erased by Dark Energy

Researchers in Portsmouth and Rome have found hints that dark matter, the cosmic scaffolding on which our Universe is built, is being slowly erased, swallowed up by dark energy.

The findings appear in the journal Physical Review Letters, published by the American Physical Society. In the journal cosmologists at the Universities of Portsmouth and Rome, argue that the latest astronomical data favors a dark energy that grows as it interacts with dark matter, and this appears to be slowing the growth of structure in the cosmos.

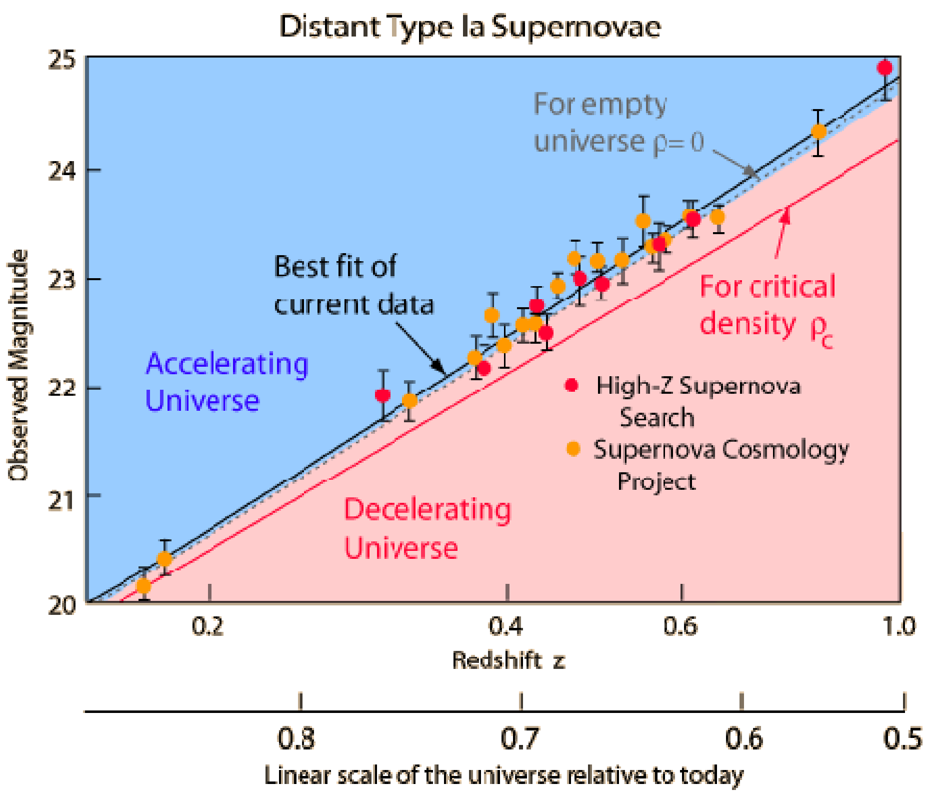
“Dark matter provides a framework for structures to grow in the Universe. The galaxies we see are built on that scaffolding and what we are seeing here, in these findings, suggests that dark matter is evaporating, slowing that growth of structure.”

Cosmology underwent a paradigm shift in 1998 when researchers announced that the rate at which the Universe was expanding was accelerating. The idea of a constant dark energy throughout space-time (the “cosmological constant”) became the standard model of cosmology, but now the Portsmouth and Rome researchers believe they have found a better description, including energy transfer between dark energy and dark matter. [10]

Evidence for an accelerating universe

One of the observational foundations for the big bang model of cosmology was the observed expansion of the universe. [9] Measurement of the expansion rate is a critical part of the study, and it has been found that the expansion rate is very nearly "flat". That is, the universe is very close to the critical density, above which it would slow down and collapse inward toward a future "big crunch". One of the great challenges of astronomy and astrophysics is distance measurement over the vast distances of the universe. Since the 1990s it has become apparent that type Ia supernovae offer a unique opportunity for the consistent measurement of distance out to perhaps 1000 Mpc. Measurement at these great distances provided the first data to suggest that the expansion rate of the universe is actually accelerating. That acceleration implies an energy density that acts in opposition to gravity which would cause the expansion to accelerate. This is an energy density which we have not directly detected observationally and it has been given the name "dark energy".

The type Ia supernova evidence for an accelerated universe has been discussed by Perlmutter and the diagram below follows his illustration in Physics Today.



The data summarized in the illustration above involve the measurement of the redshifts of the distant supernovae. The observed magnitudes are plotted against the redshift parameter z. Note that there are a number of Type 1a supernovae around z=.6, which with a Hubble constant of 71 km/s/mpc is a distance of about 5 billion light years.

Equation

The cosmological constant Λ appears in Einstein's field equation [5] in the form of

$$R_{\mu\nu} - \frac{1}{2}R\,g_{\mu\nu} + \Lambda\,g_{\mu\nu} = \frac{8\pi G}{c^4}T_{\mu\nu}\,,$$

where *R* and *g* describe the structure of spacetime, *T* pertains to matter and energy affecting that structure, and *G* and *c* are conversion factors that arise from using traditional units of measurement.

When Λ is zero, this reduces to the original field equation of general relativity. When *T* is zero, the field equation describes empty space (the vacuum).

The cosmological constant has the same effect as an intrinsic energy density of the vacuum, ρ_{vac} (and an associated pressure). In this context it is commonly moved onto the right-hand side of the equation, and defined with a proportionality factor of 8π: $\Lambda = 8\pi\rho_{vac}$, where unit conventions of general relativity are used (otherwise factors of *G* and *c* would also appear). It is common to quote values of energy density directly, though still using the name "cosmological constant".

A positive vacuum energy density resulting from a cosmological constant implies a negative pressure, and vice versa. If the energy density is positive, the associated negative pressure will drive an accelerated expansion of the universe, as observed. (See dark energy and cosmic inflation for details.)

Explanatory models

Models attempting to explain accelerating expansion include some form of dark energy, dark fluid or phantom energy. The most important property of dark energy is that it has negative pressure which is distributed relatively homogeneously in space. The simplest explanation for dark energy is that it is a cosmological constant or vacuum energy; this leads to the Lambda-CDM model, which is generally known as the Standard Model of Cosmology as of 2003-2013, since it is the simplest model in good agreement with a variety of recent observations.

Dark Matter and Energy

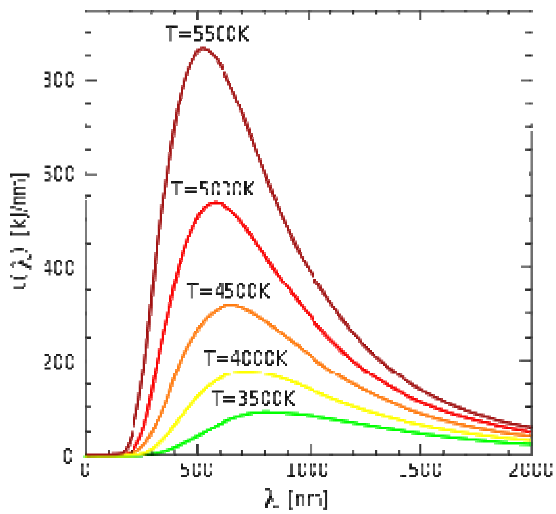
Dark matter is a type of matter hypothesized in astronomy and cosmology to account for a large part of the mass that appears to be missing from the universe. Dark matter cannot be seen directly with telescopes; evidently it neither emits nor absorbs light or other electromagnetic radiation at any significant level. It is otherwise hypothesized to simply be matter that is not reactant to light. Instead, the existence and properties of dark matter are inferred from its gravitational effects on visible matter, radiation, and the large-scale structure of the universe. According to the Planck mission team, and based on the standard model of cosmology, the total mass–energy of the known universe contains 4.9% ordinary matter, 26.8% dark matter and 68.3% dark energy. Thus, dark matter is estimated to constitute 84.5% of the total matter in the universe, while dark energy plus dark matter constitute 95.1% of the total content of the universe. [6]

Cosmic microwave background

The cosmic microwave background (CMB) is the thermal radiation assumed to be left over from the "Big Bang" of cosmology. When the universe cooled enough, protons and electrons combined to form neutral atoms. These atoms could no longer absorb the thermal radiation, and so the universe became transparent instead of being an opaque fog. [7]

Thermal radiation

Thermal radiation is electromagnetic radiation generated by the thermal motion of charged particles in matter. All matter with a temperature greater than absolute zero emits thermal radiation. When the temperature of the body is greater than absolute zero, interatomic collisions cause the kinetic energy of the atoms or molecules to change. This results in charge-acceleration and/or dipole oscillation which produces electromagnetic radiation, and the wide spectrum of radiation reflects the wide spectrum of energies and accelerations that occur even at a single temperature. [8]



Electromagnetic Field and Quantum Theory

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

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

One of the most important conclusions is that the electric charges are moving in an accelerated way and even if their velocity is constant, they have an intrinsic acceleration anyway, the so called spin, since they need at least an intrinsic acceleration to make possible they movement .

The bridge between the classical and quantum theory is based on this intrinsic acceleration of the spin, explaining also the Heisenberg Uncertainty Principle. The particle – wave duality of the electric charges and the photon makes certain that they are both sides of the same thing. Basing the gravitational force on the accelerating Universe caused magnetic force and the Planck Distribution Law of the electromagnetic waves caused diffraction gives us the basis to build a Unified Theory of the physical interactions. [4]

Lorentz transformation of the Special Relativity

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

The difference between these two referential frames, namely the referential frame of the wire and the referential frame of the moving electrons gives the relativistic effect. Important to say that the moving electrons presenting the time coordinate, since the electrons are taking linearly increasing way every next time period, and the wire presenting the geometric coordinate. The Lorentz transformations are based on moving light sources of the Michelson - Morley experiment giving a practical method to transform time and geometric coordinates without explaining the source of this mystery.

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

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

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.

Electromagnetic inertia and Gravitational attraction

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

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

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

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

The Planck distribution law explains the different frequencies of the proton and electron, giving equal intensity to different lambda wavelengths! Also since the particles are diffraction patterns they have some closeness to each other – can be seen as a gravitational force.

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

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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.

Electron – Proton mass rate

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. [1]

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.

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 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. [2]

Dark Matter and Plank Distribution Law

The Ultraviolet Catastrophe resolved by the Planck Distribution Law, but born a new problem of the Dark Matter and Energy. Part of the UV radiation has no compensating Infrared radiation on the same intensity level giving diffraction patterns that is real matter constructions. Increasing the temperature increases the uncompensated UV radiation so it looks like there is a weak interaction changing the charge distribution between the diffraction sides of the Planck curve. This gives the idea of WIMP and the Sterile Neutrinos, thinking also about chunks of Dark Matter. Since charge is not moving from one side of the diffraction pattern to the other side it could not be weak interaction. Since matter is disappearing with the increasing temperature we could think about annihilation of matter involving also anti matter. It is happening on the peak of the Planck curve but not on the sides of the UV and Infrared oscillation. This means that there is a matter to energy conversation with the increasing temperature. Of course there would be new diffraction patterns also on higher temperature and we would be seen in the LHC some new diffraction patterns, but surely no Dark Matter and of course more Dark Energy.

Conclusions

Another way to track down dark matter particles might be in a detector made with liquid xenon or germanium, in which electrons would occasionally get knocked off an atom by a passing dark matter particle. There's already an experiment like that, though, the Large Underground Xenon (LUX) project in South Dakota. It didn't find anything yet, but it was focused on WIMPs (though it was able to rule out some types). A newer version of the experiment is planned; it might detect other kinds of dark matter particle.

The team is currently working on a paper outlining the kinds of observations that would detect this kind of dark matter. "We're currently working on writing up explicit ways these dark pions can interact with ordinary matter," Hochberg said. [15]

The next step will be to put this theory to the test using experiments such as the Large Hadron Collider and the new SuperKEK-B, and a proposed experiment SHiP. [14]

No one knows which method, if any, will lead to the discovery of dark matter. But one thing is clear: Dark matter is quickly losing places to hide. [12]

The discovery provides a better physical understanding of Type Ia supernovae and their intrinsic differences. It also will allow cosmologists to improve their data analysis and make better measurements of dark energy -- an important step on the road to learning what this mysterious force truly is, and what it means for the future of the cosmos. [11]

Newly published research reveals that dark matter is being swallowed up by dark energy, offering novel insight into the nature of dark matter and dark energy and what the future of our Universe might be.

The changing temperature of the Universe will change the proportionality of the dark energy and the corresponding dark matter by the Planck Distribution Law, giving the base of this newly published research.

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 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. [3]

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