Bright and Dark Sides of Galaxies

Since dark matter is the main component of these galaxies—and thus the main determinant of galactic rotation—this finding implies that the distribution of conventional matter in the disk specifies the density profile of the surrounding dark matter halo. [18]

A new theory of gravity might explain the curious motions of stars in galaxies. Emergent gravity, as the new theory is called, predicts the exact same deviation of motions that is usually explained by invoking dark matter. Prof. Erik Verlinde, renowned expert in string theory at the University of Amsterdam and the Delta Institute for Theoretical Physics, published a new research paper today in which he expands his groundbreaking views on the nature of gravity. [17]

A theoretical particle that adapts to its surroundings could explain the accelerating expansion of our universe. [16]

Dark energy may not exist, new supernova analysis says. But, Cathal O'Connell writes, the 2011 Nobel physics laureates shouldn't return their prize just yet. [15]

A new study is providing evidence for the presence of dark matter in the innermost part of the Milky Way, including in our own cosmic neighborhood and the Earth's location. The study demonstrates that large amounts of dark matter exist around us, and also between us and the Galactic center. The result constitutes a fundamental step forward in the quest for the nature of dark matter. [14]

Researchers may have uncovered a way to observe dark matter thanks to a discovery involving X-ray emissions. [13]

Between 2009 and 2013, the Planck satellite observed relic radiation, sometimes called cosmic microwave background (CMB) radiation. Today, with a full analysis of the data, the quality of the map is now such that the imprints left by dark matter and relic neutrinos are clearly visible. [12]

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 Weak Interaction changes the temperature dependent Planck Distribution of the electromagnetic oscillations and changing the non-compensated dark matter rate, giving the responsibility to the sterile neutrino.

Contents

Author: George Rajna

Viewpoint: Connecting the Bright and Dark Sides of Galaxies

Compared to other types of galaxies, disk-shaped galaxies (disk galaxies) have the simplest dynamics. This makes them ideal for studying the relationship between gravitational forces and the motion of astrophysical bodies within galaxies. Stacy McGaugh and Federico Lelli of Case Western Reserve University, Ohio, and James Schombert of the University of Oregon, Eugene, have shown a simple relation between the rotational acceleration of these galaxies and the distribution of the ordinary (baryonic) matter they contain [1]. Since dark matter is the main component of these galaxies—and thus the main determinant of galactic rotation—this finding implies that the distribution of conventional matter in the disk specifies the density profile of the surrounding dark matter halo.

Many disk galaxies have rotational symmetry: the stars move with constant speed along circular orbits with constant gravitational potential. If these galaxies contained only conventional matter, the gravitational pull from matter should decrease with the radial distance from the galaxy's center, with a corresponding decrease in velocity. However, almost all disk galaxies exhibit rotational speeds that increase and eventually approach a constant value as the radius increases. This suggests there is more matter in these galaxies than we can see, matter we describe as dark matter. Disks with low mass density (known as low-surface-brightness galaxies) are the most extreme example. They can have hundreds of times more dark matter than ordinary matter, and their mass densities are dominated by dark matter at all radii.

The first observations that signaled the presence of dark matter in disk galaxies were made by Vera Rubin and Kent Ford [2] in the 1970s. Shortly after, Brent Tully and Richard Fisher [3] showed a connection between visible and dark matter: the luminosity of a disk galaxy, proportional to its mass in visible matter, depends as a power law on its rotational velocity at large radii, determined primarily by its dark matter content.

The connection between normal matter and dark matter goes further than the Tully-Fisher relation, however. McGaugh, Lelli, and Schombert have displayed a remarkably simple relation between the radial distribution of visible matter in disk galaxies and the radial dependence of the rotational velocity. The authors analyzed 153 disk galaxies spanning an unprecedented range of masses and densities. The data come from the SPARC (Spitzer Photometry and Accurate Rotation Curves) data set [4], acquired using NASA's Spitzer telescope, and they were combined with rotation curve measurements from many other sources. The team used infrared-wavelength observations to estimate the visible mass distribution within each galactic disk: the near-infrared luminosity at 3.6 [Math Processing Error]??m is a good tracer of the visible matter content. Then for each radius in a given disk, they computed two quantities: the centripetal acceleration expected from the gravitational pull of the visible matter and the actual centripetal acceleration determined from the measured rotational velocity.

From the 153 galaxies, the authors derive about 2700 data points of the predicted and actual acceleration at different radii within each galaxy's disk. When plotted against each other, the predicted and measured accelerations trace out a tight relation: if you know the centripetal acceleration at a given radius expected from the gravity of the visible matter in the disk, you then also know the actual acceleration at that radius, even though in many cases it is mostly determined by the dark matter. The authors show that data for all disk galaxies fall on the same curve (see Fig. 1, bottom). Individual galaxies fall along different sections of the curve, depending on their disk mass and surface brightness. This remarkable relation includes galaxies spanning factors of 10,000 in disk mass and 1000 in disk density.

The curve reveals two regimes that depend on the visible versus dark matter content ratio. For values larger than a characteristic acceleration of about [Math Processing Error]3×109m/s2, the observed acceleration equals the acceleration expected from the disk's visible mass. This corresponds to the inner regions of large galaxies with relatively dense disks, where visible matter dominates. Below this acceleration scale, the observed acceleration becomes systematically higher than that expected from the disk mass, with the difference increasing as the expected disk acceleration gets smaller. The difference is the signature of dark matter. It is worth noting that both the Tully-Fisher relation and the flatness of rotation curves at large radii are contained in the author's more general scaling relation.

Why should the visible matter in the disk have such a tight correlation with the distribution of surrounding dark matter, over a wide range of disk masses and densities? Some scaling relation connecting disk mass and total mass, like Tully-Fisher, might be expected from the standard cosmological model, because it is reasonable that more massive dark matter halos host more massive galaxy disks. However, the new general relationship, which encompasses both mass and density, is harder to understand. Why should disks of different density at constant mass follow the same scaling relation as disks of different masses at constant density? And why is acceleration the relevant scaling parameter?

No clear answers have been advanced, even though some aspects of this scaling relation have been known, with gradually improving errors, for many years. One possibility is that the observed relation is simply the natural end result of the astrophysical evolution of galaxy disks and dark matter. Cosmological simulations are only now attaining sufficient mass resolution and a sufficiently realistic astrophysical description to produce plausible-looking disk galaxies. The work by McGaugh, Lelli, and Schombert provides a clearly defined and easily computed benchmark for testing whether galaxies in simulations match observations. Current simulations seem to produce similar scaling relations between expected and measured acceleration [5, 6]. But it remains to be seen whether the simulations match the data in detail over the entire range of disk galaxies.

Any alternative explanation is more radical. Dark matter may have more complex physics than assumed by the simplest models, such as additional self-interactions or interactions with normal matter. Or Newtonian gravity may not hold: the scaling relationship could reflect a modification of the Newtonian gravitational force law rather than the presence of dark matter. Mordehai Milgrom has advocated this possibility since 1984 [7], and Jacob Bekenstein demonstrated one possible covariant theory containing such a modification [8]. The modification of Newtonian gravity sidesteps any difficulties in relating dark matter to visible matter in galaxies. But even if a modification of gravity can reproduce observed galaxy dynamics, it generally runs into serious difficulties matching observations on cosmological scales, including the growth of structure, galaxy clusters, gravitational lensing, and driven acoustic oscillations in the microwave background power spectrum.

The observed acceleration relation in disk galaxies presents a clear challenge for simulations of galaxy formation within the standard cosmological model. It will lead us to a deeper understanding of the astrophysical processes shaping galaxies, or—just possibly—to a substantial revision of fundamental physics theories.

This research is published in Physical Review Letters. [18]

New theory of gravity might explain dark matter

A new theory of gravity might explain the curious motions of stars in galaxies. Emergent gravity, as the new theory is called, predicts the exact same deviation of motions that is usually explained by invoking dark matter. Prof. Erik Verlinde, renowned expert in string theory at the University of Amsterdam and the Delta Institute for Theoretical Physics, published a new research paper today in which he expands his groundbreaking views on the nature of gravity.

In 2010, Erik Verlinde surprised the world with a completely new theory of gravity. According to Verlinde, gravity is not a fundamental force of nature, but an emergent phenomenon. In the same way that temperature arises from the movement of microscopic particles, gravity emerges from the changes of fundamental bits of information, stored in the very structure of spacetime.

Newton's law from information

In his 2010 article (On the origin of gravity and the laws of Newton), Verlinde showed how Newton's famous second law, which describes how apples fall from trees and satellites stay in orbit, can be derived from these underlying microscopic building blocks. Extending his previous work and work done by others, Verlinde now shows how to understand the curious behaviour of stars in galaxies without adding the puzzling dark matter.

The outer regions of galaxies, like our own Milky Way, rotate much faster around the centre than can be accounted for by the quantity of ordinary matter like stars, planets and interstellar gasses. Something else has to produce the required amount of gravitational force, so physicists proposed the existence of dark matter. Dark matter seems to dominate our universe, comprising more than 80 percent of all matter. Hitherto, the alleged dark matter particles have never been observed, despite many efforts to detect them.

No need for dark matter

According to Erik Verlinde, there is no need to add a mysterious dark matter particle to the theory. In a new paper, which appeared today on the ArXiv preprint server, Verlinde shows how his theory of gravity accurately predicts the velocities by which the stars rotate around the center of the Milky Way, as well as the motion of stars inside other galaxies.

"We have evidence that this new view of gravity actually agrees with the observations, " says Verlinde. "At large scales, it seems, gravity just doesn't behave the way Einstein's theory predicts."

At first glance, Verlinde's theory presents features similar to modified theories of gravity like MOND (modified Newtonian Dynamics, Mordehai Milgrom (1983)). However, where MOND tunes the theory to match the observations, Verlinde's theory starts from first principles. "A totally different starting point," according to Verlinde.

Adapting the holographic principle

One of the ingredients in Verlinde's theory is an adaptation of the holographic principle, introduced by his tutor Gerard 't Hooft (Nobel Prize 1999, Utrecht University) and Leonard Susskind (Stanford University). According to the holographic principle, all the information in the entire universe can be described on a giant imaginary sphere around it. Verlinde now shows that this idea is not quite correct—part of the information in our universe is contained in space itself.

This extra information is required to describe that other dark component of the universe: Dark energy, which is believed to be responsible for the accelerated expansion of the universe. Investigating the effects of this additional information on ordinary matter, Verlinde comes to a stunning conclusion. Whereas ordinary gravity can be encoded using the information on the imaginary sphere around the universe, as he showed in his 2010 work, the result of the additional information in the bulk of space is a force that nicely matches that attributed to dark matter.

On the brink of a scientific revolution

Gravity is in dire need of new approaches like the one by Verlinde, since it doesn't combine well with quantum physics. Both theories, crown jewels of 20th century physics, cannot be true at the same time. The problems arise in extreme conditions: near black holes, or during the Big Bang. Verlinde says, "Many theoretical physicists like me are working on a revision of the theory, and some major advancements have been made. We might be standing on the brink of a new scientific revolution that will radically change our views on the very nature of space, time and gravity." [17]

Is there a dark energy particle?

A theoretical particle that adapts to its surroundings could explain the accelerating expansion of our universe.

Our universe grows a little bigger every day. Empty space is expanding, sweeping galaxies further and further apart. Even starlight traversing this swelling nothingness is stretched like a rubber band.

The astronomical evidence for the accelerating expansion of the universe is overwhelming. But what is pushing the universe apart?

Particle physicists endeavor to answer cosmic-sized questions like this using the most fundamental laws of nature. But this particular query has them in a pickle because it is unlike anything else.

“If we understand gravity correctly, then there is some other substance in the universe that makes up about two-thirds of the total energy density and that behaves totally differently from normal matter,” says theorist Amol Upadhye, a postdoc at the University of Wisconsin, Madison. “So the big mystery is, what is this stuff?”

This stuff is dark energy, but besides its ostensible pushing effect in the cosmos, scientists know little else. However, theorists like Upadhye suspect that if there really is something causing empty space to expand, there is a good chance that it produces a particle. But to mesh with the cosmological observation, a dark energy particle would require a series of perplexing properties. For one, it would need to behave like a chameleon—that is, it would need to alter its properties based on its surroundings.

Cosmic chameleon: You come and go

In the depths of empty space, a chameleon particle might be almost massless, minimizing its gravitational attraction to other particles. But here on Earth (and in any other densely populated regions of space), the chameleon would need to swell to a much larger mass. This would limit its ability to easily interact with ordinary matter and make it nearly invisible to most detectors.

“If matter were music, then ordinary matter would be like the keys on a piano,” Upadhye says. “Each particle has a discrete mass, just like each piano key plays a single note. But chameleon particles would be like the slide on a trombone and able to change their pitches based on the amount of background noise.”

In addition to a sliding mass, the chameleons would need to exert a negative pressure. Classically, pressure is the force particles exert on their container. When the container is made of matter (like the rubber of a balloon), it expands as the internal pressure increases, and relaxes back to normal when the pressure diminishes.

But when the container is made of nothing—that is, the container is spacetime itself—the reverse effect happens. For instance, when a birthday balloon fills with air, the surrounding empty space contracts slightly. But as the balloon releases air and the pressure diminishes, space relaxes back to normal.

All known particles contract space as their pressure increases and relax space as their pressure approaches zero. But to actually expand space, a particle would need to exert a negative pressure—an idea which is totally alien in our macroscopic physical world but not impossible on a subatomic scale.

“This was actually Einstein’s idea,” Upadhye says. “If you put in a substance with a negative pressure into the equations of general relativity you get this accelerating expansion of universe.”

A mass-shifting, space-expanding particle would be unlike anything else in physics. But physicists are hopeful that if such a particle exists, it would be abundant both in the depths of space and here in our own solar system.

Several experiments have searched indirectly for chameleon particles by closely monitoring the properties of ordinary matter and looking for any chameleon-like affects. But the CERN Axion Solar Telescope, or CAST experiment, is hoping to catch chameleons directly as they radiate from the sun.

“The sun is our biggest source of particles,” says Konstantin Zioutas, the spokesperson for the CAST experiment. “If chameleons exist, then they could copiously be produced in the sun.”

The CAST experiment is a specialized telescope that looks for rare and exotic particles emanating from the sun and the early universe. Zioutas and his colleagues recently installed a special magnifying glass inside CAST which collects and focuses particles onto a highly sensitive membrane suspended in a resonant electromagnetic cavity. Their hope is that if chameleon particles exist and are produced by the sun, they’ll see the very tiny pressure these particles flux should exert as they are reflected off the membrane when the sun is in view.

So far they haven’t seen anything unexpected, but new upgrades this winter will make their experiment even more sensitive to both solar chameleons and other exotic cosmic-sprung phenomena.

“The dark energy mystery is the biggest challenge in physics, and nothing we currently understand can explain it,” Zioutas says. “We need to look at the exotic of the exotica for possible solutions.” [16]

Dark energy may not exist, new supernova analysis says

One of the most baffling results in modern physics was the discovery that the universe is tearing itself apart. In the late 1990s, astronomers realised the universe was expanding at an ever accelerating rate.

This led to the idea that the universe is dominated by mysterious “dark energy”, making up 68% of the universe.

Now, new research says that this idea, which has become a pillar of modern physics, may be built on shaky foundations.

An analysis of 740 exploding stars published in the journal Scientific Reports last week concluded the expansion of the universe may be constant after all.

“The evidence for accelerated expansion is marginal,” says Subir Sarkar at the University of Oxford in the UK, who led the study. If that’s the case, dark energy may not exist.

So should the winners of the 2011 physics Nobel – Adam Riess, Brian Schmidt and Saul Perlmutter – hand it back?

For most of the 20th century, we’ve thought the universe was expanding at a constant rate. Then in 1998, two independent teams found apparently conclusive evidence that the universe was expanding at an increasing rate.

The bottom line: something must be pushing galaxies apart from one another, though we have no idea know what this something is. As a placeholder, physicists call it “dark energy”.

The discovery of dark energy relied on a particular kind of exploding star – Type 1a supernovae – acting as a "standard candle".

Astronomers assume each supernova emits the same amount of light and so can be used as distance markers – a bit like gauging the distance to a town from the brightness of its streetlights.

Type 1a supernovae arise in twin star systems, when a white dwarf star feeds off its sibling until it reaches a critical mass and explodes. Because the tipping point is the same mass each time, the explosions are identical.

Or so goes the theory. In reality, important differences between these explosions can muddy the waters if not properly accounted for.

'THROWING THE BABY OUT WITH THE BATH WATER IS NOT THE WAY TO GO.'

Over the past decade, astronomers amassed a much larger database of supernovae than was available back in 1998. And on closer inspection, the evidence for an expanding universe (and hence dark energy) appears less solid.

While the work behind the 2011 Nobel prize in physics included data from just 50 such supernovae, astronomers in England, Italy and Denmark have now examined data from 740 such supernovae.

The new research still sees evidence of accelerated expansion, but at a much lower statistical significance than previously claimed. Indeed, their findings would be consistent with no acceleration at all – and hence no dark energy.

Although other evidence for dark energy exists, such as in the cosmic microwave background, Sarkar says these tests are indirect. Other solutions may account for all of them without requiring dark energy.

But Brad Tucker, an astronomer at the Australian National University in Canberra, disagrees. He argues that dark energy is part of a large self-consistent picture, assembled from multiple lines of evidence.

“We know that different cosmological probes tell us different things, and it is when they work together we understand what is going on – or try to,” he says.

“Throwing the baby out with the bath water is not the way to go.”

In contrast to Sarkar’s work, Tucker was part of a team that recently measured the acceleration of the universe to greater accuracy than ever before, and found it even higher than expected.

Meanwhile dark energy is not the only member of the dark side of the universe recently under question.

Last week, we reported on research led by Case Western Reserve University’s Stacy McGaugh showing that galaxy spin might be explained without invoking dark matter.

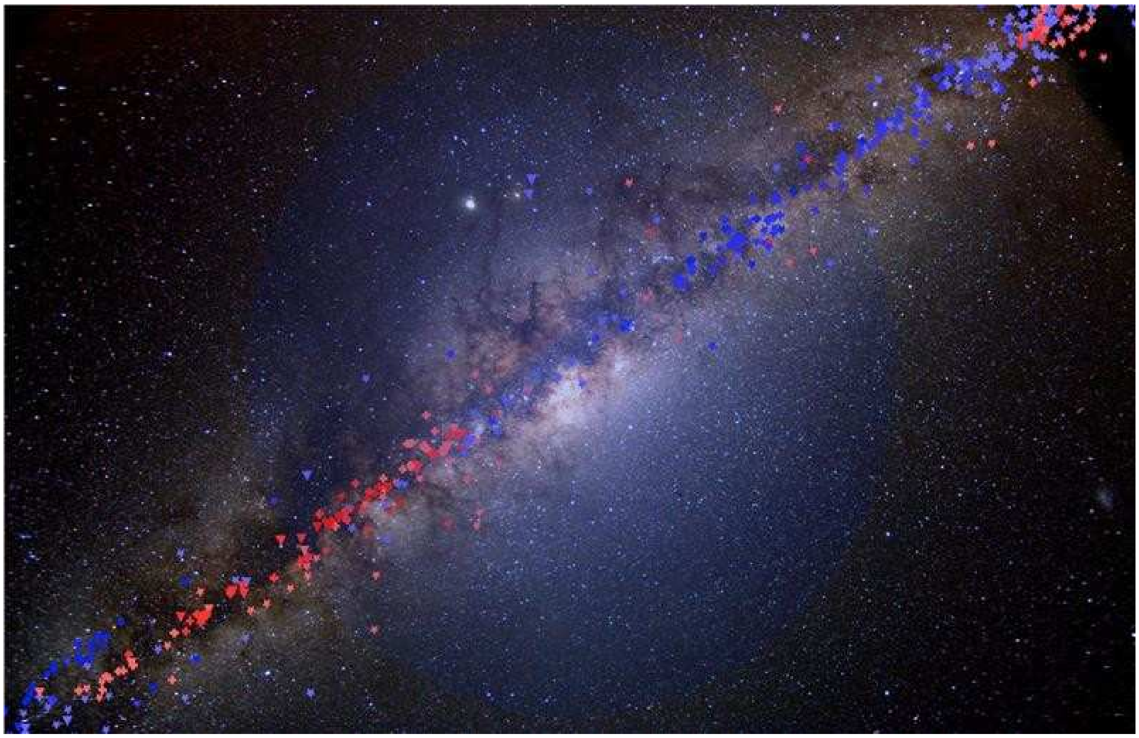
But already, a pair of astrophysicists at McMaster University in Canada performed a new study (uploaded to arXiv but not yet peer-reviewed) dismissing that interpretation.

They found McGaugh’s findings could be explained by a simulation incorporating the standard dark matter picture.

Challenging the prevailing theory is a normal part of the scientific process and the standard model of cosmology seems to emerge from these melees unscathed.

Our universe is still dominated by the dark side. [15]

Evidence for dark matter in the inner Milky Way



The rotation curve tracers used in the paper over a photo of the disc of the Milky Way as seen from the Southern Hemisphere. The tracers are color-coded in blue or red according to their relative motion with respect to the Sun. The spherically symmetric blue halo illustrates the dark matter distribution.

The existence of dark matter in the outer parts of the Milky Way is well established. But historically it has proven very difficult to establish the presence of dark matter in the innermost regions, where the Solar System is located. This is due to the difficulty of measuring the rotation of gas and stars with the needed precision from our own position in the Milky Way.

“In our new study, we obtained for the first time a direct observational proof of the presence of dark matter in the innermost part of the Milky Way. We have created the most complete compilation so far of published measurements of the motion of gas and stars in the Milky Way, and compared the measured rotation speed with that expected under the assumption that only luminous matter exists in the Galaxy. The observed rotation cannot be explained unless large amounts of dark matter exist around us, and between us and the Galactic centre”, says Miguel Pato at the Department of Physics, Stockholm University.

Dark matter is about five times more abundant than the matter that we are familiar with, made of atoms. Its existence in galaxies was robustly established in the 1970s with a variety of techniques, including the measurement of the rotation speed of gas and stars, which provides a way to effectively “weigh” the host galaxy and determine its total mass.

“Our method will allow for upcoming astronomical observations to measure the distribution of dark matter in our Galaxy with unprecedented precision. This will permit to refine our understanding of the structure and evolution of our Galaxy, and it will trigger more robust predictions for the many experiments worldwide that search for dark matter particles. The study therefore constitutes a fundamental step forward in the quest for the nature of dark matter", says Miguel Pato. [14]

Researchers may have uncovered a way to observe dark matter thanks to a discovery involving X-ray emissions.

Anyone with a passing knowledge of space and astronomy has heard of dark matter, a material believed to account for most of the known universe. We say "believed" because technically it hasn't been observed; the only reason we know it exists is because of gravitational effects on nearby objects, but otherwise it's completely invisible to light. But a major discovery this week suggests that invisibility doesn't extend to X-Ray emissions, which scientists may finally have used to detect dark matter in the universe.

It all happened when astronomers were reviewing data collected by the European Space Agency's XMM-Newton spacecraft and noticed a spike in X-Ray emissions. The anomaly came from two celestial objects - the Andromeda galaxy and Perseus galaxy cluster specifically - but didn't correspond to any known particle or atom. What the researchers did notice, however, was that it lined up perfectly with the theoretical behaviors of dark matter, allowing us to finally "see" it for the first time.

"With the goal of verifying our findings," said Alexey Boyarsky of Switzerland's École Polytechnique Fédérale de Lausanne, "we then looked at data from our own galaxy, the Milky Way, and made the same observations."

If the EPFL's findings hold up, this has huge implications for future astronomy research. Our current picture of space accounts for dark matter tangentially since we can't actually see it. But Boyarksy thinks it might be possible to develop technology to observe it directly, which could vastly change our perceptions of outer space.

"Confirmation of this discovery may lead to construction of new telescopes specially designed for studying the signals from dark matter particles," Boyarsky explain. "We will know where to look in order to trace dark structures in space and will be able to reconstruct how the universe has formed."

That also sounds handy if we ever get warp technology off the ground and need to chart a path around dark matter, but I'm probably getting ahead of myself on that score. [13]

New revelations on dark matter and relic neutrinos

The Planck collaboration, which notably includes the CNRS, CEA, CNES and several French universities, has disclosed, at a conference in Ferrara, Italy, the results of four years of observations from the ESA's Planck satellite. The satellite aims to study relic radiation (the most ancient light in the Universe). This light has been measured precisely across the entire sky for the first time, in both intensity and polarization, thereby producing the oldest image of the Universe. This primordial light lets us "see" some of the most elusive particles in the Universe: dark matter and relic neutrinos.

Between 2009 and 2013, the Planck satellite observed relic radiation, sometimes called cosmic microwave background (CMB) radiation. Today, with a full analysis of the data, the quality of the map is now such that the imprints left by dark matter and relic neutrinos are clearly visible.

Already in 2013, the map for variations in light intensity was released, showing where matter was in the sky 380,000 years after the Big Bang. Thanks to the measurement of the polarization of this light (in four of seven frequencies, for the moment), Planck can now see how this material used to move. Our vision of the primordial Universe has thus become dynamic. This new dimension, and the quality of the data, allows us to test numerous aspects of the standard model of cosmology. In particular, they illuminate the most elusive of particles: dark matter and neutrinos.

New constraints on dark matter

The Planck collaboration results now make it possible to rule out an entire class of models of dark matter, in which dark matter-antimatter annihilation is important. Annihilation is the process whereby a particle and its antiparticle jointly disappear, followed by a release in energy.

The basic existence of dark matter is becoming firmly established, but the nature of dark matter particles remains unknown. There are numerous hypotheses concerning the physical nature of this matter, and one of today's goals is to whittle down the possibilities, for instance by searching for the effects of this mysterious matter on ordinary matter and light. Observations made by Planck show that it is not necessary to appeal to the existence of strong dark matter-antimatter annihilation to explain the dynamics of the early universe. Such events would have produced enough energy to exert an influence on the evolution of the light-matter fluid in the early universe, especially around the time relic radiation was emitted. However, the most recent observations show no hints that this actually took place.

These new results are even more interesting when compared with measurements made by other instruments. The satellites Fermi and Pamela, as well as the AMS-02 experiment aboard the International Space Station, have all observed an excess of cosmic rays, which might be interpreted as a consequence of dark matter annihilation. Given the Planck observations, however, an alternative explanation for these AMS-02 or Fermi measurements—such as radiation from undetected pulsars—has to be considered, if one is to make the reasonable hypothesis that the properties of dark matter particles are stable over time.

Additionally, the Planck collaboration has confirmed that dark matter comprises a bit more than 26% of the Universe today (figure deriving from its 2013 analysis), and has made more accurate maps of the density of matter a few billion years after the Big Bang, thanks to measurements of temperature and B-mode polarization.

Neutrinos from the earliest instants detected

The new results from the Planck collaboration also inform us about another type of very elusive particle, the neutrino. These "ghost" particles, abundantly produced in our Sun for example, can pass through our planet with almost no interaction, which makes them very difficult to detect. It is therefore not realistic to directly detect the first neutrinos, which were created within the first second after the Big Bang, and which have very little energy. However, for the first time, Planck has unambiguously detected the effect these relic neutrinos have on relic radiation maps.

The relic neutrinos detected by Planck were released about one second after the Big Bang, when the Universe was still opaque to light but already transparent to these particles, which can freely escape from environments that are opaque to photons, such as the Sun's core. 380,000 years later, when relic radiation was released, it bore the imprint of neutrinos because photons had gravitational interaction with these particles. Observing the oldest photons thus made it possible to confirm the properties of neutrinos.

Planck observations are consistent with the standard model of particle physics. They essentially exclude the existence of a fourth species of neutrinos, previously considered a possibility based on the final data from the WMAP satellite, the US predecessor of Planck. Finally, Planck makes it possible to set an upper limit to the sum of the mass of neutrinos, currently established at 0.23 eV (electron-volt).

The full data set for the mission, along with associated articles that will be submitted to the journal Astronomy & Astrophysics (A&A), will be available December 22 on the ESA web site. [12]

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!?

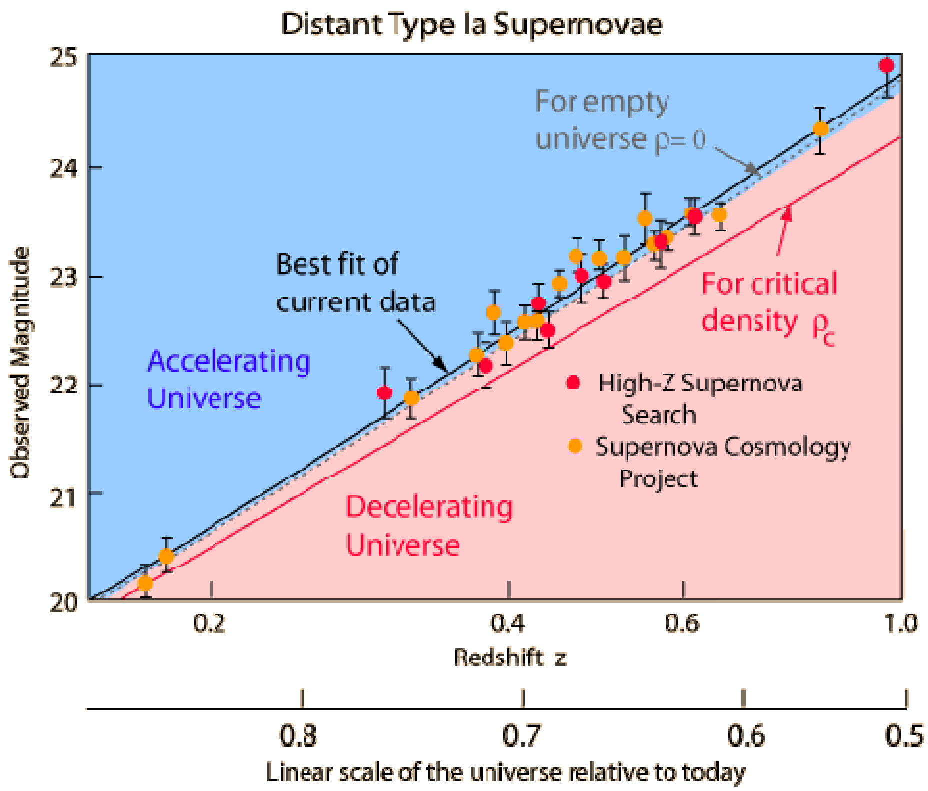
The gravitational force attracting the matter, causing concentration of the matter in a small space and leaving much space with low matter concentration: dark matter and energy.

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.

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

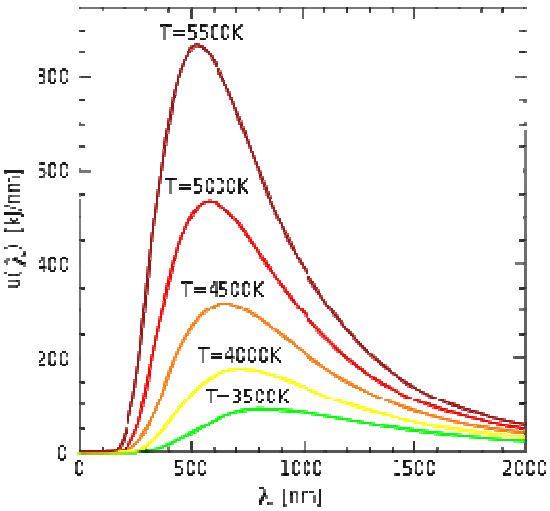
Dark matter is a type of matter hypothesized in astronomy and cosmology to account for a large part of the mass that appears to be missing from the universe. Dark matter cannot be seen directly with telescopes; evidently it neither emits nor absorbs light or other electromagnetic radiation at any significant 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 $E = hv$ and $E = mc^2$, $m = hv /c^2$ that is the m depends only on the v frequency. It means that the mass of the proton and electron are electromagnetic and the result of the electromagnetic induction, caused by the changing acceleration of the spinning and moving charge! It could be that the m_o inertial mass is the result of the spin, since this is the only accelerating motion of the electric charge. Since the accelerating motion has different frequency for the electron in the atom and the proton, they masses are different, also as the wavelengths on both sides of the diffraction pattern, giving equal intensity of radiation.

If the mass is electromagnetic, then the gravitation is also electromagnetic effect caused by the 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

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

The frequency dependence of mass

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

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.

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.

The Sterile Neutrino

By definition the sterile neutrino does not participate in the electromagnetic and weak interactions, only the gravitational force gives its mass. There should be one strange neutrino that changes the diffraction patterns of the electromagnetic oscillations leaving the low frequencies side of the Planck Distribution Law with non-compensated high frequency side. Since the neutrino oscillation and the general weak interaction this sterile neutrino can be oscillate to another measurable neutrino.

The change of the temperature at the Big Bang was the main source for this asymmetry and the creation of the dark matter by the Baryogenesis.[10] Later on also the weak interaction can change the rate of the dark matter, but less influencing it, see the temperature changes of the dark side in the Planck Distribution Law.

The Weak Interaction basically an electric dipole change and transferring the electric charge from one side of the diffraction pattern to the other side. If there is no other side (dark matter), the neutrino oscillation helps to change the frequency of the electromagnetic oscillations, causing real diffraction patterns and leaving the non – compensated side of the Planck Distribution curve for the invisible 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]

Conclusions

A new study is providing evidence for the presence of dark matter in the innermost part of the Milky Way, including in our own cosmic neighborhood and the Earth's location. The study demonstrates that large amounts of dark matter exist around us, and also between us and the Galactic centre. The result constitutes a fundamental step forward in the quest for the nature of dark matter. [14]
If the EPFL's findings hold up, this has huge implications for future astronomy research. Our current picture of space accounts for dark matter tangentially since we can't actually see it. But Boyarksy thinks it might be possible to develop technology to observe it directly, which could vastly change our perceptions of outer space. [13]
Between 2009 and 2013, the Planck satellite observed relic radiation, sometimes called cosmic microwave background (CMB) radiation. Today, with a full analysis of the data, the quality of the map is now such that the imprints left by dark matter and relic neutrinos are clearly visible. [12]
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] The sterile neutrino [11] disappears in the neutrino oscillation.

References

[1] 3 Dimensional String Theory

Author: George Rajna

Publisher: Academia.edu
http://www.academia.edu/3834454/3_Dimensional_String_Theory

[2] Graviton Production By Two Photon and Electron-Photon Processes In Kaluza-Klein Theories With Large Extra Dimensions

http://arxiv.org/abs/hep-ph/9909392

[3] Higgs Field and Quantum Gravity

Author: George Rajna

Publisher: Academia.edu
http://www.academia.edu/4158863/Higgs_Field_and_Quantum_Gravity

[4] The Magnetic field of the Electric current

Author: George Rajna

Publisher: Academia.edu
https://www.academia.edu/3833335/The_Magnetic_field_of_the_Electric_current

[5] http://en.wikipedia.org/wiki/Einstein_field_equations

[6] http://en.wikipedia.org/wiki/Dark_matter

[7] http://en.wikipedia.org/wiki/Cosmic_microwave_background

[8] http://en.wikipedia.org/wiki/Thermal_radiation

[9] http://hyperphysics.phy-astr.gsu.edu/hbase/astro/univacc.html

[10] http://en.wikipedia.org/wiki/Baryogenesis

[11] http://en.wikipedia.org/wiki/Sterile_neutrino

[12] http://phys.org/news/2014-12-revelations-dark-relic-neutrinos.html

[13] http://www.escapistmagazine.com/news/view/139054-Dark-Matter-May-Finally-Have-Been-Observed-In-Space-Via-X-Ray

[14] Evidence for dark matter in the inner Milky Way
http://www.sciencedaily.com/releases/2015/02/150209113046.htm

[15] Dark energy may not exist, new supernova analysis says
https://cosmosmagazine.com/physics/dark-energy-may-not-exist-new-supernova-analysis-says

[16] Is there a dark energy particle?
http://www.symmetrymagazine.org/article/is-there-a-dark-energy-particle

[17] New theory of gravity might explain dark matter
http://phys.org/news/2016-11-theory-gravity-dark.html

[18] Viewpoint: Connecting the Bright and Dark Sides of Galaxies
http://physics.aps.org/articles/v9/130