

Electromagnetic Dark Matter in LHC

According to a new model, dark matter may be composed of clusters of electrically charged particles bound by a yet-unknown strong interaction. [13]

Other scientists hope to create them in powerful particle collisions at CERN's Large Hadron Collider. "Most supersymmetric theories estimate the mass of the lightest WIMP to be somewhere above 100 gigaelectronvolts, which is well within LHC's energy regime," Tait says. "I myself and others are very excited about the recent LHC restart. There is a lot of hope to create dark matter in the lab." [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.

In particle physics and astrophysics, weakly interacting massive particles, or WIMPs, are among the leading hypothetical particle physics candidates for dark matter.

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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!?

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New model suggests dark matter is made of electrically charged particles

Scientists at the Lawrence Livermore National Laboratory (LLNL) believe that dark matter may be composed of electrically charged particles that are bound by a yet-unknown force and have somehow managed to escape detection. The theory could be verified with the help of the Large Hadron Collider (LHC) particle accelerator.

Dark matter makes up over 80 percent of the mass in our universe, but we know little about its nature. Astrophysicists know it must exist from its gravitational effects on large clusters of galaxies, but they have been unable to spot it because this elusive substance interacts weakly with both ordinary matter and itself. In fact, so little is known about dark matter that scientists are still speculating as to what it's even made of.

Through a combination of computer simulations and theoretical results, researchers Pavlos Vranas and colleagues have now developed a "stealth dark matter" model that could help unravel the mystery of why dark matter behaves like it does, what particles make it up, and what force binds them. Crucially, the model offers assumptions that physicists should be able to test using CERN's Large Hadron Collider (LHC) particle accelerator.

The stealth dark matter model predicts that dark matter is stable, but also produces large quantities of electrically charged, unstable nuclear particles. These short-lived particles, now long decayed, would have left a definite mark in the very early universe, with the extremely high plasma temperatures forcing them to interact with ordinary matter.

"These interactions in the early universe are important because ordinary and dark matter abundances today are strikingly similar in size, suggesting this occurred because of a balancing act performed between the two before the universe cooled," says Vranas.

As temperatures slowly dropped, dark matter would have then started to bond under the influence of a new and still unknown form of strong interaction, growing into electrically neutral clusters several hundred times heavier than a proton.

According to the Vranas and colleagues, the LHC is powerful enough to roll back the clock and reproduce the conditions that would have led to the crucial early interaction between dark matter and ordinary matter. Though the charged particles wouldn't be observed directly, the world's largest particle accelerator could detect a telltale electrical signature that would validate this theory.

Dark matter is currently thought to be completely inert to electromagnetic radiation, so it would be remarkable to discover that it is in fact composed of electrically charged particles which have somehow managed to avoid detection.

A paper describing the advance will be published in an upcoming edition of the journal *Physical Review Letters*. [13]

Miraculous WIMPs

Invisible dark matter accounts for 85 percent of all matter in the universe, affecting the motion of galaxies, bending the path of light and influencing the structure of the entire cosmos. Yet we don't know much for certain about its nature.

Most dark matter experiments are searching for a type of particles called WIMPs, or weakly interacting massive particles.

"Weakly interacting" means that WIMPs barely ever "talk" to regular matter. They don't often bump into other matter and also don't emit light—properties that could explain why researchers haven't been able to detect them yet.

Created in the early universe, they would be heavy ("massive") and slow-moving enough to gravitationally clump together and form structures observed in today's universe.

Scientists predict that dark matter is made of particles. But that assumption is based on what they know about the nature of regular matter, which makes up only about 4 percent of the universe.

WIMPs advanced in popularity in the late 1970s and early 1980s when scientists realized that particles that naturally pop out in models of Supersymmetry could potentially explain the seemingly unrelated cosmic mystery of dark matter.

Supersymmetry, developed to fill gaps in our understanding of known particles and forces, postulates that each fundamental particle has a yet-to-be-discovered superpartner. It turns out that the lightest one of the bunch has properties that make it a top contender for dark matter.

"The lightest supersymmetric WIMP is stable and is not allowed to decay into other particles," says theoretical physicist Tim Tait of the University of California, Irvine.

"Once created in the big bang, many of these WIMPs would therefore still be around today and could have gone unnoticed because they rarely produce a detectable signal."

When researchers use the properties of the lightest supersymmetric particle to calculate how many of them would still be around today, they end up with a number that matches closely the amount of dark matter experimentally observed—a link referred to as the "WIMP miracle." Many researchers believe it could be more than coincidence.

"But WIMPs are also popular because we know how to look for them," says dark matter hunter Thomas Shutt of Stanford University and SLAC National Accelerator Laboratory. "After years of developments, we finally know how to build detectors that have a chance of catching a glimpse of them."

Shutt is co-founder of the LUX experiment and one of the key figures in the development of the next-generation LUX-ZEPLIN experiment. He is one member of the group of scientists trying to detect WIMPs as they traverse large, underground detectors.

Other scientists hope to create them in powerful particle collisions at CERN's Large Hadron Collider. "Most supersymmetric theories estimate the mass of the lightest WIMP to be somewhere above 100

gigaelectronvolts, which is well within LHC's energy regime," Tait says. "I myself and others are very excited about the recent LHC restart. There is a lot of hope to create dark matter in the lab."

A third way of searching for WIMPs is to look for revealing signals reaching Earth from space. Although individual WIMPs are stable, they decay into other particles when two of them collide and annihilate each other. This process should leave behind detectable amounts of radiation. Researchers therefore point their instruments at astronomical objects rich in dark matter such as dwarf satellite galaxies orbiting our Milky Way or the center of the Milky Way itself.

"Dark matter interacts with regular matter through gravitation, impacting structure formation in the universe," says Risa Wechsler, a researcher at Stanford and SLAC. "If dark matter is made of WIMPs, our predictions of the distribution of dark matter based on this assumption must also match our observations."

Wechsler and others calculate, for example, how many dwarf galaxies our Milky Way should have and participate in research efforts under way to determine if everything predicted can also be found experimentally.

So how would researchers know for sure that dark matter is made of WIMPs? "We would need to see conclusive evidence for WIMPs in more than one experiment, ideally using all three ways of detection," Wechsler says.

In the light of today's mature detection methods, dark matter hunters should be able to find WIMPs in the next five to 10 years, Shutt, Tait and Wechsler say. Time will tell if scientists have the right idea about the nature of dark matter. [12]

Dark matter composition research - WIMP

The WIMP (Weakly interactive massive particles) form a class of heavy particles, interacting slightly with matter, and constitute excellent candidates with the nonbaryonic dark matter. The neutralino postulated by the supersymmetric extensions of the standard model of particle physics. The idea of supersymmetry is to associate each boson to a fermion and vice versa. Each particle is then given a super-partner, having identical properties (mass, load), but with a spin which differs by $1/2$. Thus, the number of particles is doubled. For example, the photon is accompanied by a photino, the graviton by a gravitino, the electron of a selectron, etc. Following the impossibility to detect a 511 keV boson (the electron partner), the physicists had to re-examine the idea of an exact symmetry. Symmetry is 'broken' and superpartners have a very important mass. One of these superparticles called LSP (Lightest Supersymmetric Particle) is the lightest of all. In most of the supersymmetric theories (without violation of the R-parity) the LSP is a stable particle because it cannot disintegrate in a lighter element. It is of neutral color and electric charge and is then only sensitive to weak interaction (weak nuclear force). It is then an excellent candidate for the not-baryonic dark matter. [11]

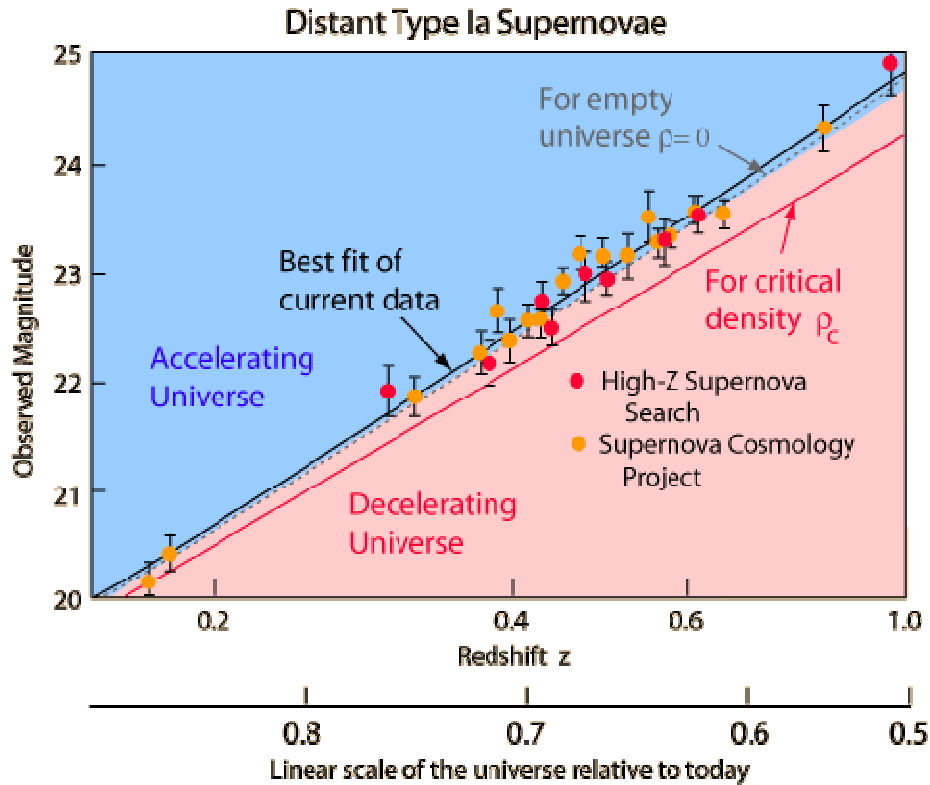
Weakly interacting massive particles

In particle physics and astrophysics, weakly interacting massive particles, or WIMPs, are among the leading hypothetical particle physics candidates for dark matter. The term "WIMP" is given to a dark matter particle that was produced by falling out of thermal equilibrium with the hot dense plasma of the early universe, although it is often used to refer to any dark matter candidate that interacts with standard particles via a force similar in strength to the weak nuclear force. Its name comes from the fact that obtaining the correct abundance of dark matter today via thermal production requires a self-annihilation cross section, which is roughly what is expected for a new particle in the 100 GeV mass range that interacts via the electroweak force. This apparent coincidence is known as the "WIMP miracle". Because supersymmetric extensions of the standard model of particle physics readily predict a new particle with these properties, a stable supersymmetric partner has long been a prime WIMP candidate. However, recent null results from direct detection experiments including LUX and SuperCDMS, along with the failure to produce evidence of supersymmetry in the Large Hadron Collider (LHC) experiment has cast doubt on the simplest WIMP hypothesis. Experimental efforts to detect WIMPs include the search for products of WIMP annihilation, including gamma rays, neutrinos and cosmic rays in nearby galaxies and galaxy clusters; direct detection experiments designed to measure the collision of WIMPs with nuclei in the laboratory, as well as attempts to directly produce WIMPs in colliders such as the LHC. [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 Ia supernovae around $z=0.6$, 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

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

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 : $\Lambda = 8\pi\rho_{\text{vac}}$, 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

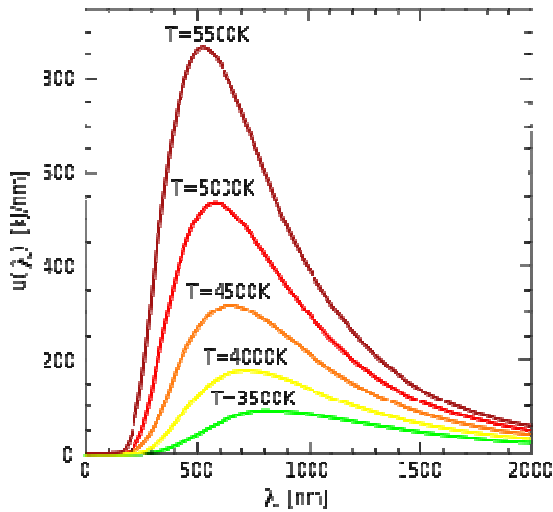
Dark matter is a type of matter hypothesized in astronomy and cosmology to account for a large part of the mass that appears to be missing from the universe. Dark matter cannot be seen directly with telescopes; evidently it neither emits nor absorbs light or other electromagnetic radiation at any significant 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 \underline{A} vector potential experienced by the electrons moving by \underline{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 \underline{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_0 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

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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 Big 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 ratio $M_p=1840 M_e$. In order to move one of these diffraction maximum (electron or proton) we need to intervene into the diffraction pattern with a force appropriate to the intensity of this diffraction maximum, means its intensity or mass.

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

In the light of today's mature detection methods, dark matter hunters should be able to find WIMPs in the next five to 10 years, Shutt, Tait and Wechsler say. Time will tell if scientists have the right idea about the nature of dark matter. [12]

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