Maybe dark matter is not made up of heavy particles after all?

Scientists have conducted a simulation that explains the collision between two clusters of galaxies. Clusters of galaxies are the biggest objects that exist in the universe. They are collections of hundreds of thousands of galaxies pulled together by gravity. Rare, extreme examples of clusters caught in the act of colliding seem to be challenging the accepted view that dark matter is made up of heavy particles. [13]

Dark matter may not be made of tiny particles as most scientists believe, but instead may consist of large chunks of strange matter anywhere from the size of an apple to an asteroid, researchers said. [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.

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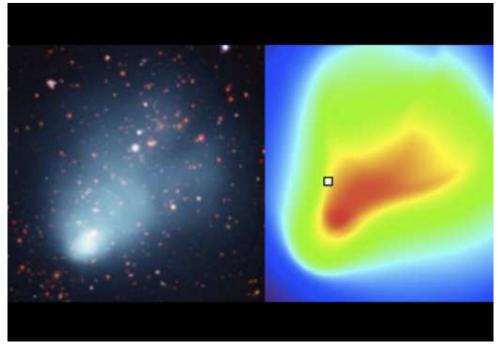
The Big Bang

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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Maybe dark matter is not made up of heavy particles after all

An image comparing the data showing the many galaxies and the X-ray emission from the hot gas (left) with the model of the hot gas (right). The "comet" shape of the X-ray data is well reproduced by the model.

Credit: Image courtesy of University of the Basque Country

Tom Broadhurst, the Ikerbasque researcher in the Department of Theoretical Physics of the UPV/EHU, together with Sandor Molnar of the National Taiwan University and visiting Ikerbasque researcher at the UPV/EHU in 2013, have conducted a simulation that explains the collision between two clusters of galaxies. Clusters of galaxies are the biggest objects that exist in the universe. They are collections of hundreds of thousands of galaxies pulled together by gravity.

In general, galaxy clusters grow in size by merging with each other to become increasingly larger. Gravitational forces cause them to slowly come together over time despite the expansion of the universe. The system known as "El Gordo," the biggest known cluster of galaxies, is in turn the result of the collision between two large clusters. It was found that the collision process compresses the gas within each cluster to very high temperatures so that it is shining in the Xray region of the spectrum. In the Xray spectrum this gas cloud is comet shaped with two long tails stretching between the dense cores of the two clusters of galaxies. This distinctive configuration has allowed the researchers to establish the relative speed of the collision, which is extreme (~2200km/second), as it puts it at the limit of what is allowed by current theory for dark matter.

These rare, extreme examples of clusters caught in the act of colliding seem to be challenging the accepted view that dark matter is made up of heavy particles, since no such particles have actually been detected yet, despite the efforts being made to find them by means of the LHC (Large Hadron Particle Collider) accelerator in Geneva and the LUX (Large Underground Xenon Experiment), an underground dark matter detector in the United States. In Tom Broadhurst's opinion, "it's all the

more important to find a new model that will enable the mysterious dark matter to be understood better." Broadhurst is one of the authors of a wave-dark-matter model published in Nature Physics last year.

This new piece of research has entailed interpreting the gas observed and the dark matter of El Gordo "hydrodynamically" through the development of an in-house computational model that includes the dark matter, which comprises most of the mass, and which can be observed in the Xray region of the visible spectrum because of its extremely high temperature (100 million kelvin). Dr Broadhurst and Dr Molnar have managed to obtain a unique computational solution for this collision because of the comet-like shape of the hot gas, and the locations and the masses of the two dark matter cores that have passed through each other at an oblique angle at a relative speed of about 2200 km/s. This means that the total energy release is bigger than that of any other known phenomenon, with the exception of the Big Bang. [13]

Not Particles, But Chunks: Dark Matter Gets Stranger

The Hubble Space Telescope captured this image of galaxy cluster ZwCl0024+1652, revealing a ghostly ring of dark matter floating within the cluster. Astronomers said the ring, which measures 2.6 million light-years across, may have been produced by a collision between two gigantic clusters. This image is considered one of the strongest pieces of evidence for the existence of dark matter.

Currently one of the greatest mysteries in science, the invisible substance called dark matter is thought to make up five-sixths of all matter in the universe. Yet no one knows what pieces of dark matter look like.

In a new study, researchers outlined their idea that dark matter is made of particles they called "Macros." The scientists theorized that if these particles were as dense as atomic nuclei, they could not be smaller than 0.12 pounds (55 grams). If they were, existing particle detectors would have already seen them. At the same time, Macros could not be larger than 2.2 billion trillion pounds (1 billion trillion kilograms), because then their gravitational field would be strong enough to warp starlight, a phenomenon that astronomers have not seen, either.

As for how these particles may have formed in the early universe, the researchers said. Back then, the cosmos was still extraordinarily hot, reaching temperatures of more than 6.3 trillion degrees

Fahrenheit (3.5 trillion degrees Celsius), comparable to the temperature in the center of a massive supernova. Under these conditions, Macros could have assembled from particles called quarks, the more-basic particles that make up protons and neutrons.

There are six types of quarks — up, down, top, bottom, charm and strange. Protons and neutrons are each made of up and down quarks — protons are made of two up quarks and one down quark, whereas neutrons are made of two down quarks and one up quark. The researchers said that both these ordinary quarks as well as strange quarks could have combined to form dark matter Macros.

Strange quarks ordinarily have extremely short lives, and so far scientists have only seen them within particle accelerators. However, neutrons are also highly unstable by themselves, but are stable when they are bound with protons in atoms, said Glenn Starkman, a co-author of the new report and a theoretical physicist at Case Western Reserve University in Cleveland. So, it could be that strange quarks created soon after the birth of the universe became bound to other particles to produce stable strange matter. And this might constitute dark matter.

Macros that were made when the universe began would be cold and dark now, the researchers said. [The 9 Biggest Unsolved Mysteries in Physics]

This new idea comes at a time when researchers are looking again at the possibility that dark matter is made of particles that scientists have already created and detected, as opposed to an exotic new particle.

The consensus among scientists right now is that dark matter particles interact very weakly, if at all, with the known forces within the universe. As such, dark matter is theorized to be invisible and nearly completely intangible, mostly only detectable via the gravitational pull it exerts.

Several decades ago, scientists proposed two possibilities about the nature of exotic dark matter particles. One was that dark matter was made of axions, which were thought to be weakly interacting, low-mass particles. The other was that dark matter was made of much larger particles called WIMPS, or weakly interacting massive particles.

However, for the past three decades, physicists have failed to find evidence for either proposition.

Scientists were especially intrigued by WIMPS, because the existence of such particles might confirm an idea known as supersymmetry theory, which in turn could help lead to a "theory of everything" that can explain all of the universe's known forces.

But while these suggestions were being looked at, the idea that dark matter was somewhere between ordinary and exotic "hasn't been completely neglected," said Starkman. "But it has been mostly relegated to the backwaters of the field, because people were so hopeful about supersymmetry and the prospects of it giving a WIMP dark matter candidate."

Now, researchers are investigating ideas about dark matter that may not require new physics to explain the existence of the mysterious substance. Macros are one such idea. The ideas fit within the Standard Model of particle physics, which is the best current description of the subatomic world.

"There is a big, wide window open for dark matter to emerge from the Standard Model," Starkman said.

The study on Macros also ruled out certain large masses for the objects. The scientists calculated that Macros could not weigh between 220 trillion and 220 quadrillion pounds (100 trillion and 100 quadrillion kg). If they were this size, Macros' gravitational fields would have distorted gamma rays from gamma ray bursts, the most powerful explosions in the universe, in ways that have not been seen.

In addition, if Macros are extremely high mass, they would only hit Earth about once every billion years, explaining why scientists have not yet detected the objects. If Macros are relatively low mass, although they might strike Earth more frequently, they might not leave any recognizable evidence, the researchers said.

It remains uncertain how researchers might detect Macros, if these objects exist. One way is to look for distortions in starlight and gamma rays that high-mass Macros might cause. Another is to look for tracks that relatively low-mass Macros could leave in rock, Starkman said.

Starkman and co-authors David Jacobs and Bryan Lynn submitted their findings to the journal Monthly Notices of the Royal Astronomical Society. [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 supersymetric 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 differes 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 superparticules 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]

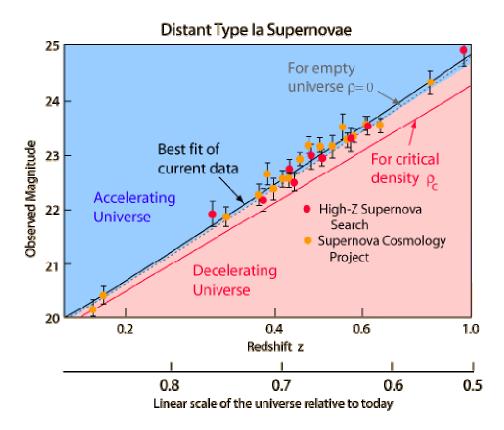## Weakly interacting massive particles

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.

Distant Type Ia Supernovae

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: Λ = $8\pi\rho_{vac}$, 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.
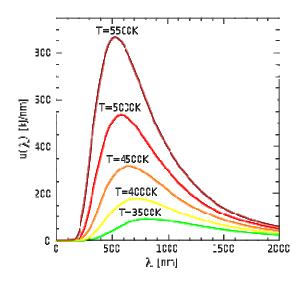
Dark Matter and Energy

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

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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 Bing Bang caused parallel moving of the matter gives this magnetic force, experienced as gravitational force.

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

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

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

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

Scientists have conducted a simulation that explains the collision between two clusters of galaxies. Clusters of galaxies are the biggest objects that exist in the universe. They are collections of hundreds of thousands of galaxies pulled together by gravity. Rare, extreme examples of clusters caught in the act of colliding seem to be challenging the accepted view that dark matter is made up of heavy particles. [13]

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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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