Giant Atoms Unveil Dark Matter

Giant atoms could help unveil 'dark matter' and other cosmic secrets. [23]

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The Dark Energy Spectroscopic Instrument, called DESI, has an ambitious goal: to scan more than 35 million galaxies in the night sky to track the expansion of our universe and the growth of its large-scale structure over the last 10 billion years. [19]

If the axion exist and it is the main component of Dark Matter, the very relic axions that would be bombarding us continuously could be detected using microwave resonant (to the axion mass) cavities, immersed in powerful magnetic fields. [18]

In yet another attempt to nail down the elusive nature of dark matter, a European team of researchers has used a supercomputer to develop a profile of the yet-to-be-detected entity that appears to pervade the universe. [17]

MIT physicists are proposing a new experiment to detect a dark matter particle called the axion. If successful, the effort could crack one of the most perplexing unsolved mysteries in particle physics, as well as finally yield a glimpse of dark matter. [16]

Researches at Stockholm University are getting closer to light dark-matter particle models. Observations rule out some axion-like particles in the quest for the content of dark matter. The article is now published in the Physical Review Letters. [15]

Scientists have detected a mysterious X-ray signal that could be caused by dark matter streaming out of our Sun's core.

Hidden photons are predicted in some extensions of the Standard Model of particle physics, and unlike WIMPs they would interact electromagnetically with normal matter.

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

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.

Contents

Author: George Rajna

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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Giant atoms could help unveil 'dark matter' and other cosmic secrets

The universe is an astonishingly secretive place. Mysterious substances known as dark matter and dark energy account for some 95% of it. Despite huge effort to find out what they are, we simply don't know.

We know dark matter exists because of the gravitational pull of galaxy clusters – the matter we can see in a cluster just isn't enough to hold it together by gravity. So there must be some extra material there, made up by unknown particles that simply aren't visible to us. Several candidate particles have already been proposed.

Scientists are trying to work out what these unknown particles are by looking at how they affect the ordinary matter we see around us. But so far it has proven difficult, so we know it interacts only weakly with normal matter at best. Now my colleague Benjamin Varcoe and I have come up with a new way to probe dark matter that may just prove successful: by using atoms that have been stretched to be 4,000 times larger than usual.

Advantageous atoms

We have come a long way from the Greeks' vision of atoms as the indivisible components of all matter. The first evidence-based argument for the existence of atoms was presented in the early 1800s by John Dalton. But it wasn't until the beginning of the 20th century that JJ Thomson and Ernest Rutherford discovered that atoms consist of electrons and a nucleus. Soon after, Erwin Schrödinger described the atom mathematically using what is today called quantum theory.

Modern experiments have been able to trap and manipulate individual atoms with outstanding precision. This knowledge has been used to create new technologies, like lasers and atomic clocks, and future computers may use single atoms as their primary components.

Individual atoms are hard to study and control because they are very sensitive to external perturbations. This sensitivity is usually an inconvenience, but our study suggests that it makes some atoms ideal as probes for the detection of particles that don't interact strongly with regular matter – such as dark matter.

Our model is based on the fact that weakly interacting particles must bounce from the nucleus of the atom it collides with and exchange a small amount of energy with it – similar to the collision between two pool balls. The energy exchange will produce a sudden displacement of the nucleus that will eventually be felt by the electron. This means the entire energy of the atom changes, which can be analysed to obtain information about the properties of the colliding particle.

However the amount of transferred energy is very small, so a special kind of atom is necessary to make the interaction relevant. We worked out that the so-called "Rydberg atom" would do the trick. These are atoms with long distances between the electron and the nucleus, meaning they possess high potential energy. Potential energy is a form of stored energy. For example, a ball on a high shelf has potential energy because this could be converted to kinetic energy if it falls off the shelf.

In the lab, it is possible to trap atoms and prepare them in a Rydberg state – making them as big as 4,000 times their original size. This is done by illuminating the atoms with a laser with light at a very specific frequency.

This prepared atom is likely much heavier than the dark matter particles. So rather than a pool ball striking another, a more appropriate description will be a marble hitting a bowling ball. It seems strange that big atoms are more perturbed by collisions than small ones – one may expect the opposite (smaller things are usually more affected when a collision occurs).

The explanation is related to two features of Rydberg atoms: they are highly unstable because of their elevated energy, so minor perturbations would disturb them more. Also, due to their big area, the probability of the atoms interacting with particles is increased, so they will suffer more collisions.

Spotting the tiniest of particles

Current experiments typically look for dark matter particles by trying to detect their scattering off atomic nuclei or electrons on Earth. They do this by looking for light or free electrons in big tanks of liquid noble gases that are generated by energy transfer between the dark matter particle and the atoms of the liquid.

But, according to the laws of quantum mechanics, there needs to be a certain a minimum energy transfer for the light to be produced. An analogy would be a particle colliding with a guitar string: it will produce a note that we can hear, but if the particle is too small the string will not vibrate at all.

So the problem with these methods is that the dark matter particle has to be big enough if we are to detect it in this way. However, our calculations show that the Rydberg atoms will be disturbed in a significant way even by low-mass particles – meaning they can be applied to search for candidates of dark matter that other experiments miss. One of such particles is the Axion, a hypothetical particle which is a strong candidate for dark matter.

Experiments would require for the atoms to be treated with extreme care, but they will not require to be done in a deep underground facility like other experiments, as the Rydberg atoms are expected to be less susceptible to cosmic rays compared to dark matter.

We are working to further improve the sensitivity of the system, aiming to extend the range of particles that it may be able to perceive.

Beyond dark matter we are also aiming to one day apply it for the detection of gravitational waves, the ripples in the fabric of space predicted by Einstein long time ago. These perturbations of the space-time continuum have been recently discovered, but we believe that by using atoms we may be able to detect gravitational waves with a different frequency to the ones already observed. [23]

Will scientists ever prove the existence of dark matter?

Astronomers in the US are setting up an experiment which, if it fails – as others have – could mark the end of a 30-year-old theory.

Deep underground, in a defunct gold mine in South Dakota, scientists are assembling an array of odd devices: a chamber for holding tonnes of xenon gas; hundreds of light detectors, each capable of pinpointing a single photon; and a vast tank that will be filled with hundreds of gallons of ultra-pure water. The project, the LZ experiment, has a straightforward aim: it is designed to detect particles of an invisible form of matter – called dark matter – as they drift through space.

It is thought there is five times more dark matter than normal matter in the universe, although it has yet to be detected directly. Finding it would solve one of science’s most baffling mysteries and explain why galaxies are not ripped apart by stars flying off into deep space.

However, many scientists believe time is running out for the hunt, which has lasted 30 years, cost millions of pounds and produced no positive results. The LZ project – which is halfway through construction – should be science’s last throw of the dice, they say. “This generation of detectors should be the last,” said astronomer Stacy McGaugh at Case Western Reserve University in Cleveland, Ohio. “If we don’t find anything we should accept we are stuck and need to find a different explanation, perhaps by modifying our theories of gravity, to explain the phenomena we attribute to dark matter.”

Other researchers reject this view: “Theory indicates we have a really good chance of finding dark matter particles,” said Chamkaur Ghag, chair of the Dark Matter UK consortium. “This is certainly not the time to talk of giving up.”

The concept of dark matter stems from observations made in the 1970s. Astronomers expected to find that stars rotated more slowly around a galaxy the more distant they were from the galaxy’s centre, just as distant planets revolve slowly round the Sun. (Outermost Neptune moves round the Sun at a stately 12,000mph; innermost Mercury does so at 107,082mph.)

That prediction was spectacularly undone by observations, however. Stars at a galaxy's edge orbit almost as fast as those near its centre. According to theory, they should be hurled into space. So astronomers proposed that invisible dark matter must be providing the extra gravity needed to hold galaxies together. Proposed sources of dark matter include burnt-out stars; clouds of dust and gas; and subatomic particles called Wimps – weakly interacting massive particles. All have since been discounted, except Wimps. Many astronomers are now convinced they permeate space and form halos round galaxies to give them the gravitational "muscle" needed to hold fast-flying stars in place.

Getting close to Wimps has not been easy. Scientists have built increasingly sensitive detectors deeper and deeper underground to protect them from subatomic particles that bombard Earth's surface and which would trigger spurious signals. These devices resemble huge Russian dolls: a vast metal tank containing water – to provide added protection against incoming stray particles – is erected and, within this, a giant sphere of an inert gas such as xenon is suspended. Wimps making it through to the final tank should occasionally strike a xenon nucleus, producing a flash of light that can be pinpointed by electronic detectors.

Despite three decades of effort, this approach has had no success, a failure that is starting to worry some researchers. "We are now building detectors containing more and more xenon and which are a million times more sensitive than those we used to hunt Wimps 30 years ago," said astrophysicist Professor David Merritt, of the Rochester Institute of Technology, New York. "And still we have found nothing."

Last July, scientists reported that after running their Large Underground Xenon (Lux) experiment for 20 months they had still failed to spot a Wimp. Now an upgraded version of Lux is being built – the LZ detector, a US-UK collaboration – while other devices in Canada and Italy are set to run searches.

The problem facing Wimp hunters is that as their detectors get ever more sensitive, they will start picking up signals from other weakly interacting particles called neutrinos. Tiny, almost massless, these constantly whizz through our planet and our bodies. Neutrinos are not nearly heavy enough to account for the gravitational abnormalities associated with dark matter but are still likely to play havoc with the next generation of Wimp detectors.

"I believe the Wimp hypothesis will be truly dead when we reach that point," said McGaugh. "It already has serious problems but if we get to the point where we are picking up all this background interaction, the game is up. You will not be able to spot a thing."

This point is rejected by Ghag. "Yes, occasionally a neutrino will kick a xenon nucleus and produce a result that resembles a Wimp interaction. We will, initially, be in trouble. But as we characterise the collisions we should find ways to differentiate them and concentrate only on those produced by Wimps."

But there is no guarantee that Wimps – if they exist – will ever interact with atoms of normal matter. "You can imagine a scenario where dark matter particles turn out to be so incredibly weak at interacting with normal matter that our detectors will never see anything," said cosmologist Andrew Pontzen, of University College London. [22]

Physicists measure the loss of dark matter since the birth of the universe

Russian scientists have discovered that the proportion of unstable particles in the composition of dark matter in the days immediately following the Big Bang was no more than 2 percent to 5 percent. Their study has been published in Physical Review D.

"The discrepancy between the cosmological parameters in the modern universe and the universe shortly after the Big Bang can be explained by the fact that the proportion of dark matter has decreased. We have now, for the first time, been able to calculate how much dark matter could have been lost, and what the corresponding size of the unstable component would be," says co-author Igor Tkachev of the Department of Experimental Physics at INR.

Astronomers first suspected that there was a large proportion of hidden mass in the universe back in the 1930s, when Fritz Zwicky discovered "peculiarities" in a cluster of galaxies in the constellation Coma Berenices—the galaxies moved as if they were under the effect of gravity from an unseen source. This hidden mass, which is only deduced from its gravitational effect, was given the name dark matter. According to data from the Planck space telescope, the proportion of dark matter in the universe is 26.8 percent; the rest is "ordinary" matter (4.9 percent) and dark energy (68.3 percent).

The nature of dark matter remains unknown. However, its properties could potentially help scientists to solve a problem that arose after studying observations from the Planck telescope. This device accurately measured the fluctuations in the temperature of the cosmic microwave background radiation—the "echo" of the Big Bang. By measuring these fluctuations, the researchers were able to calculate key cosmological parameters using observations of the universe in the recombination era—approximately 300,000 years after the Big Bang.

However, when researchers directly measured the speed of the expansion of galaxies in the modern universe, it turned out that some of these parameters varied significantly—namely the Hubble parameter, which describes the rate of expansion of the universe, and also the parameter associated with the number of galaxies in clusters. "This variance was significantly more than margins of error and systematic errors known to us. Therefore, we are either dealing with some kind of unknown error, or the composition of the ancient universe is considerably different to the modern universe," says Tkachev.

Russian physicists measure the loss of dark matter since the birth of the universe

The concentration of the unstable component of dark matter F against the speed of expansion of non-gravitationally bound objects (proportional to the age of the Universe) when examining various combinations of Planck data for several different cosmological phenomena. Credit: MIPT

The discrepancy can be explained by the decaying dark matter (DDM) hypothesis, which states that in the early universe, there was more dark matter, but then part of it decayed.

"Let us imagine that dark matter consists of several components, as in ordinary matter (protons, electrons, neutrons, neutrinos, photons). And one component consists of unstable particles with a rather long lifespan. In the era of the formation of hydrogen, hundreds of thousands of years after the Big Bang, they are still in the universe, but by now (billions of years later), they have disappeared, having decayed into neutrinos or hypothetical relativistic particles. In that case, the amount of dark matter in the era of hydrogen formation and today will be different," says lead author Dmitry Gorbunov, a professor at MIPT and staff member at INR.

The authors of the study analyzed Planck data and compared them with the DDM model and the standard ?CDM (Lambda-cold dark matter) model with stable dark matter. The comparison showed that the DDM model is more consistent with the observational data. However, the researchers found that the effect of gravitational lensing (the distortion of cosmic microwave background radiation by a gravitational field) greatly limits the proportion of decaying dark matter in the DDM model.

Using data from observations of various cosmological effects, the researchers were able to give an estimate of the relative concentration of the decaying components of dark matter in the region of 2 percent to 5 percent.

"This means that in today's universe, there is 5 percent less dark matter than in the recombination era. We are not currently able to say how quickly this unstable part decayed; dark matter may still be disintegrating even now, although that would be a different and considerably more complex model," says Tkachev. [21]

No trace of dark matter in gamma-ray background

Researchers from the University of Amsterdam's (UvA) GRAPPA Center of Excellence have just published the most precise analysis of the fluctuations in the gamma-ray background to date. By making use of more than six years of data gathered by the Fermi Large Area Telescope, the researchers found two different source classes contributing to the gamma-ray background. No traces of a contribution of dark matter particles were found in the analysis. The collaborative study was performed by an international group of researchers and is published in the latest edition of the journal Physical Review D.

Gamma rays are particles of light, or photons, with the highest energy in the universe and are invisible to the human eye. The most common emitters of gamma rays are blazars: supermassive black holes at the centers of galaxies. In smaller numbers, gammy rays are also produced by a certain kind of stars called pulsars and in huge stellar explosions such as supernovae.

In 2008 NASA launched the Fermi satellite to map the gamma-ray universe with extreme accuracy. The Large Area Telescope, mounted on the Fermi satellite, has been taking data ever since. It continuously scans the entire sky every three hours. The majority of the detected gamma rays is produced in our own Galaxy (the Milky Way), but the Fermi telescope also managed to detect more than 3000 extragalactic sources (according to the latest count performed in January 2016). However, these individual sources are not enough to explain the total amount of gamma-ray photons coming from outside our Galaxy. In fact, about 75% of them are unaccounted for.

Isotropic gamma-ray background

As far back as the late 1960s, orbiting observatories found a diffuse background of gamma rays streaming from all directions in the universe. If you had gamma-ray vision, and looked at the sky, there would be no place that would be dark.

The source of this so-called isotropic gamma-ray background has hitherto remained unknown. This radiation could be produced by unresolved blazars, or other sources too faint to be detected with the Fermi telescope. Parts of the gamma-ray background might also hold the fingerprint of the illustrious dark matter particle, a so-far undetected particle held responsible for the missing 80% of the matter in our universe. If two dark matter particles collide, they can annihilate and produce a signature of gamma-ray photons.

Fluctuations

Together with colleagues, Dr Mattia Fornasa, an astroparticle physicist at the UvA and lead author of the paper, performed an extensive analysis of the gamma-ray background by using 81 months of data gathered by the Fermi Large Area Telescope – much more data and with a larger energy range than in previous studies. By studying the fluctuations in the intensity of the gamma-ray background, the researchers were able to distinguish two different contributions to the gamma-ray background. One class of gamma-ray sources is needed to explain the fluctuations at low energies (below 1 GeV) and another type to generate the fluctuations at higher energy – the signatures of these two contributions is markedly different.

In their paper the researchers suggest that the gamma rays in the high-energy ranges – from a few GeV up – are likely originating from unresolved blazars. Further investigation into these potential sources is currently being carried out by Fornasa, fellow UvA researcher Shin'ichiro Ando and colleagues from the University of Torino, Italy. However, it seems much harder to pinpoint a source for the fluctuations with energies below 1 GeV. None of the known gamma-ray emitters have a behaviour that is consistent with the new data.

Constraints on dark matter

To date, the Fermi telescope has not detected any conclusive indication of gamma-ray emission originating from dark-matter particles. Also, this latest study showed no indication of a signal associated with dark matter. Using their data, Fornasa and colleagues were even able to rule out some models of dark matter that would have produced a detectable signal.

'Our measurement complements other search campaigns that used gamma rays to look for dark matter and it confirms that there is little room left for dark matter induced gamma-ray emission in the isotropic gamma-ray background', says Fornasa. [20]

Ultraprecise measurements in XXL

The Dark Energy Spectroscopic Instrument, called DESI, has an ambitious goal: to scan more than 35 million galaxies in the night sky to track the expansion of our universe and the growth of its large-scale structure over the last 10 billion years. Using DESI—a project led by Lawrence Berkeley National Laboratory—scientists hope to create a 3-D map of a third of the night sky that is more accurate and precise than any other.

A precise map requires that DESI itself be built and assembled with micrometer precision. Fermilab, a Department of Energy national laboratory, is contributing a key piece of the instrument: a large, barrel-shaped device that will hold optical lenses to collect the light from millions of distant galaxies. The smallest deviation in lens alignment could lead to the instrument being permanently out-of-focus. Every piece of the barrel must be perfectly placed, so the Fermilab team is currently taking every measure to ensure its precise assembly.

The process involves a special machine, meticulous handling and a healthy dose of patience.

Precision assembly

The lens-holding device is a roughly 8-foot-long and 4-foot-wide segmented cylinder—about the size of a small elevator. Once the hulking steel barrel is complete, it will be installed at the Mayall four-meter telescope at the Kitt Peak National Observatory, southwest of Tucson, Arizona.

The lenses will collect the light reflected from the telescope's mirror and focus it into 5,000 optical fibers, through which the light is transported to special detectors, called spectrographs. With the help of 10 such spectrographs, scientists can measure the distance of the galaxies.

In May, a team of specialists at Fermilab began assembling the barrel's five segments carefully, checking that each nut and bolt was perfectly situated. But a nuts-and-bolts-level fit isn't enough. To achieve the precision scientists are aiming for, the DESI barrel and its inner structure must be assembled accurately to within an incredibly tight 20 micrometers. That's one 10th of the thickness of a sheet of paper.

To achieve the required fit, the team has been making small, critical adjustments to the assembled barrel.

Accurate alignment

The barrel adjustments take place in a vacant area the size of a small bedroom. Four tall pillars – nearly seven feet high – stand at the corners of the space.

Above their heads, a rail, similar to train tracks, connects the tops of the two pillars on one side. A second rail connects the other two. A moveable carriage track spans the gap – like a high bridge spans a river – connecting the two rails. The carriage itself glides along the track.

The team guides the carriage so that it stops just above the barrel. The carriage carries a mechanical arm that points towards the floor. It can rotate in all directions in the space within the pillars. At the end of the arm is a highly sensitive and precise sensor, fixed to an articulating motorized probe.

The arm with the sensor comes to life: It reaches down to the barrel and starts feeling for its surfaces. It searches for specific points on the barrel – a corner, an edge, another significant surface marker. When it finds them, it measures the coordinates in the designated space. Very carefully and with tiny movements, it moves over the whole surface of the barrel, measuring up, down and around the surface. As it does, it records the measurement data and saves it for further analysis. Jorge Montes, one of the team members, strategically places markers on the barrel's surface to assist their alignment efforts.

After making the measurement, the scientists return the barrel to an outside area. There they disassemble it, realign all the parts, relying on the previously placed markers. They then reassemble it. With great care they bring the once more fully assembled barrel into the empty space and measure anew the precision of their assembly.

Comparing their performance with their previous assembly, they learn which pieces, if any, are misaligned—even slightly—and where they improved the alignment.

Ultraprecise Measurements in XXL

The barrel will hold the lenses and optics for DESI, which will map one-third of the night sky. To create an accurate map, the barrel's pieces must be accurately assembled to within 20 micrometers. Dial Machine of Rockford, Illinois, …more

A magic machine

The precise, slow-moving measuring machine that points out the misalignments is called a coordinate measuring machine, or CMM. The group making these point-by-point measurements, led by Fermilab engineering physicist Michael Roman, uses it to ensure the DESI barrel's perfect assembly.

With the help of the CMM, they repeat the whole procedure of assembly, measurement and disassembly again and again, always comparing their performance against previous tries. When they reach their alignment within 10 micrometers—about a 10th the width of a human hair—in a certain number of tries, they are satisfied.

"From early on we knew that the barrel needed high-precision measurements for the assembly and that it would be too large for any of the CMMs at Fermilab to perform such measurements," Roman said.

"In strong support of DESI, Fermilab bought a machine for the dedicated measurements on the barrel," said scientist Gaston Gutierrez, who is one of the DESI project leads at Fermilab.

Steady and stable

To ensure that the CMM's measurements are as precise as they need to be, the CMM is set up in an air-conditioned room, where scientists monitor and control the temperature 24 hours a day. Materials expand when they get warm, affecting the accuracy of CMM's measurements.

So scientists worked out the right control settings for the environmental control system to ensure that the temperature never varied more than one degree from 20 degrees Celsius.

Even the eventual effect of heavy weights on the DESI barrel, including the lenses, can be measured with the new CMM. Scientists place the DESI barrel in the machine and measure it, then add test weights on its sides and remeasure the barrel. The team can see how the barrel shrinks or bends, if at all, and determine whether the lenses will hold steady when the telescope is in motion.

The Fermilab team expects to finish all CMM measurements by early 2017. Then they will disassemble the DESI barrel and send it to the University College London. In London, their colleagues will install the lenses in the support structures. Once the lenses are installed, the barrel will start its journey to its future home in Arizona.

Measuring the expansion of the universe

Scientists have discovered that our universe is growing bigger and bigger—without any end in sight. Like raisins in a rising loaf of bread, the universe's galaxies are being pushed apart from each other.

From previous measurements, scientists have a kind of cosmic ruler, a standard length that goes back to the universe's early beginning. Using this ruler together with the high-precision DESI map, scientists will be able to tell how far galaxies have moved apart and how much our universe has grown throughout its history.

"With the DESI experiment, we want to follow the growing steps of our universe," Gutierrez said. "We start from today and go backwards in time to measure how much the universe has expanded since its early days.

The fabrication, assembly and operation of DESI are small but highly important steps toward precisely understanding the universe. [19]

What is the axion? and why it is being searched for by particle physicists? what is its relation with the Dark Matter of the Universe?

A physical law has CP (charge-parity) symmetry (link is external) if it is equally valid after interchanging each particle by its antiparticle (charge conjugation or C symmetry (link is external)) and -at the same time- inverting the spatial coordinates (parity, “mirror” or P symmetry (link is external)). It is known since some time now that the electroweak interactions do not respect CP symmetry, that is, physicists have observed phenomena that, although only slighly, violate this symmetry.

However, this does not seem to be the case with the strong interactions (link is external) (those responsible for holding toghether protons and neutrons in the nuclei). The non observation of CP-violating phenomena here impose severe restrictions to input parameters (i.e. parameters not predicted) of the Standard Model, so that they need to be fine-tunned for theory and observation to agree. When this happens in a physical theory usually means that there is something we do not understand and our theory is not complete. This is the strong CP problem.

The Peccei-Quinn mechanism was proposed to solve this problem in a natural way, without required parameter fine-tunning. As a collateral effect, however, a new particle appears, the axion, which may have important observable consequences. In the first place, the axion is a neutral and very light (but not massless) particle, and it does not interact (or does it very weakly) with conventional matter. In some way one can see the axion as a “strange photon”. In fact, theory predicts that the axion, if it exists, could transform into a photon (and viceversa) in the presence of electromagnetic fields. This property of the axion is crucial for most of the experimental strategies of axion detection.

This Feynman diagram represents the process of conversion of an axion (dashed line on the left) into a photon (wavy line on the right) in the presence of an electromagnetic field (the wavy line going downwards)

But doubtless one of the most suggestive properties of axions is that, in a natural way, they could be produced in huge numbers soon after the Big Bang. This population of axions would still be present today and could compose the Dark Matter of the Universe. The existence of Dark Matter is widely accepted in the scientific community, but its nature is still a mystery. Together with WIMPs, the axions are among the most searched candidates in the context of the nature of Dark Matter.

Detection of axions

Thanks to the property of conversion into photons in electromagnetic fields, axions could be produced and detected in the laboratory by using very intense magnets. This type of experiments are being carried out (e.g. ALPS (link is external) in DESY, or OSQAR at CERN), although their sensitivity is still far from “seeing” the axions predicted by the Peccei-Quinn mechanism.

If the axion exist and it is the main component of Dark Matter, the very relic axions that would be bombarding us continuously could be detected using microwave resonant (to the axion mass) cavities, immersed in powerful magnetic fields. This scheme is followed, e.g., by the ADMX (link is external)experiment in the University of Washington. ADMX could detect the axion, if its mass (which is unknown) lies in the sensitivity range of the experiment (around the few microelectronvolts) and if the Dark Matter is mainly composed by axions.

Another promising detection technique, this one independent of the axion being the Dark Matter, is that of the axion helioscope, aiming to detect axions produced at the solar interior. These could be detected, once again, using a powerful magnet, but this time equipped with low background x-ray detectors. The most powerful axion helioscope to-date is the CERN Axion Solar Telescope or CAST, datking data since about a decade at CERN. Although so far there is no sign of the axion, CAST has been the first axion helioscope with enough sensitivity to surpass previous very stringent astrophysical limits on the axion properties, and enter so far unexplored area. In particular, CAST is sensitive to Peccei-Quinn axions with masses in the 0.1-1 eV range approximately.

The International Axion Observatory is a new generation axion helioscope. Its layaout is an ambitious extension of CAST’s philosophy, using a superconducting magnet of larger dimensions and specifically designed to search for axions, and equipped with x-ray optics and low background detectors. IAXO would have sensitivity to detect axions in the much larger mass range than CAST and thus would explore an important area of parametric space which is also inaccessible by other techniques. In addition, IAXO’s magnet could also host other kind of axion experiments, so IAXO could become a sort of a generic infrastructure for axion research. If the axion exists IAXO will have a real opportunity to discover it. [18]

Across the universe: simulated distribution of dark matter

In yet another attempt to nail down the elusive nature of dark matter, a European team of researchers has used a supercomputer to develop a profile of the yet-to-be-detected entity that appears to pervade the universe. Physicists led by Zoltan Fodor of the University of Wuppertal have predicted the masses of dark-matter candidates called axions using the JUQUEEN (Blue Gene/Q) supercomputer at the Forschungszentrum Jülich research institute in Germany. These hypothetical particles are promising dark-matter candidates that are not described by the Standard Model of particle physics but are predicted by an extension to quantum chromodynamics (QCD). Axions are thought to have exceedingly small masses and could, in theory, be detected directly. "However, to find this kind of evidence it would be extremely helpful to know what kind of mass we are looking for," says team-member Andreas Ringwald at DESY in Hamburg. "Otherwise the search could take decades, because one would have to scan far too large a range." The team's simulations showed that if axions exist, they should have a mass of 50–1500 meV, making them up to 10 billion times lighter than electrons. This would require every cubic centimetre of the universe to contain on average 10 million such ultra-lightweight particles. "The results we are presenting will probably lead to a race to discover these particles," says Fodor. The team says that within the next few years, it should be possible to either confirm or rule out the existence of axions experimentally. The simulations are described in Nature. [17]

Team simulates a magnetar to seek dark matter particle

MIT physicists are proposing a new experiment to detect a dark matter particle called the axion. If successful, the effort could crack one of the most perplexing unsolved mysteries in particle physics, as well as finally yield a glimpse of dark matter.

Axions are hypothetical elementary particles that are thought to be among the lightest particles in the universe—about one-quintillionth the size of a proton. These ultralight particles are virtually invisible, yet if they exist, axions and other yet-unobserved particles may make up 80 percent of the material in the universe, in the form of dark matter.

In a paper published online in Physical Review Letters, the MIT team proposes an experiment to detect axions by simulating an extreme astrophysical phenomenon known as a magnetar—a type of neutron star that generates an immensely powerful magnetic field. The physicists reasoned that in the presence of an axion such a huge magnetic field should waver ever so slightly, producing a second, vastly smaller magnetic field as a signature of the axion itself.

The team consists of MIT associate professor of physics Jesse Thaler, MIT Pappalardo Fellow Benjamin Safdi, and Yonatan Kahn PhD '15, now a postdoc at Princeton University. Together, they designed an experiment to recreate the physics of a magnetar in a controlled laboratory environment, using technology borrowed from magnetic resonance imaging (MRI).

The core of the experiment, which they've named ABRACADABRA (A Broadband/Resonant Approach to Cosmic Axion Detection with an Amplifying B-field Ring Apparatus), consists of a series of magnetic coils, wound in the shape of a toroid, or donut, which is then encased in a layer of superconducting metal and kept in a refrigerator at temperatures just above absolute zero, to minimize external noise. The scientists plan to use a highly sensitive magnetometer, placed inside the donut hole, to detect any signs of axions' influence.

"Axions are very strange, counterintuitive particles," Thaler says. "They're extremely light, with feeble interactions, and yet this particle may dominate the matter budget of the universe and be five times more abundant by mass than ordinary matter. So we really had to think hard on whether these particles are in principle detectable using current technology. It's extremely daunting."

A "tantalizing" particle

If they are detected, axions may also explain an outstanding dilemma in particle physics, known as the Strong CP (charge parity) problem: Since the 1970s, scientists have grown increasingly puzzled over what Safdi describes as "the indifference of neutrons to electric fields." Neutrons are elementary particles that are found in the nucleus of almost every atom in matter, and they do not carry a net charge.

"We don't expect neutrons to accelerate in the presence of an electric field because they don't carry electric charge, but you might expect them to rotate," Safdi says. "That's because we expect them to have an electric dipole moment, where you can think of a neutron having a plus charge on one side and a minus charge on the other. But from our current understanding, this rotation effect does not exist, whereas theory says it should."

Scientists have hypothesized that this bizarre effect may be explained by the axion, which would somehow remove a neutron's electric dipole moment. If so, the axion would modify electric and magnetic phenomena in a way that could be detectable experimentally.

"It's very tantalizing to say there might be a particle that serves this deep purpose, and even more so if we were to detect the presence of these particles in the form of dark matter," Thaler says.

The hunt is on

Currently, Thaler says most axion hunting has been carried out by researchers at the University of Washington who are running the Axion Dark Matter Experiment, or ADMX. The experiment uses a resonant microwave cavity, set within a large superconducting magnet, to detect very weak conversions of axions to microwave photons. The experiment is tuned to look for axions within a specific range of around one quadrillionth the mass of a proton.

Thaler and his team realized that they could extend this range, and look for much smaller, lighter particles, on the order of one quintillionth the mass of a proton, by recreating the physics of magnetars, in the lab.

"The Strong CP problem is associated with whether a neutron's spin responds to electric effects, and you can kind of think of a magnetar as one gigantic spin with big magnetic fields," Thaler explains. "If axions are coming in and changing the properties of nuclear matter to resolve the Strong CP problem, maybe axions can interact with this magnetar and allow you to see it in a new way. So the subtle effects of axions should be amplified."

The team's prototype design is surprisingly small—"about the palm of your hand," Safdi says. The researchers, who are theoretical physicists by training, are now working with experimentalists at MIT to build the prototype, which is designed to generate a baseline magnetic field of about 1 tesla, comparable to current MRI machines. If axions are present, that field should waver slightly, producing a very tiny oscillation at a frequency that is directly related to the axion's mass. Using a high-precision magnetometer, Thaler hopes to pick up that frequency and ultimately use it to identify the axion's size.

"Only recently have there been many good ideas to search for [low-frequency axions]," says Gray Rybka, an assistant professor of physics at the University of Washington and an ADMX researcher, who was not involved in the research. "The experiment proposed here builds on previous ideas and, if the authors are correct, may be the most practical experimental configuration that can explore some of the plausible lower-frequency axion regimes."

"We have an instrument that's sensitive to many wavelengths, and we can tickle it with an axion of one particular wavelength, and ABRACADABRA will resonate," Thaler says. "And we will be going into uncharted territory, where we could possibly see dark matter from this prototype. That would be amazing." [16]

Dark matter does not contain certain axion-like particles

Physicists are still struggling with the conundrum of identifying more than 80 percent of the matter in the universe. One possibility is that it is made up of extremely light particles that weigh less than a billionth of the mass of an electron. These particles are often called axion-like particles (ALPs). Since ALPs are hard to find, the researchers have not yet been able to test different types of ALPs that could be a constituent of dark matter.

For the first time, the researchers used data from NASA's gamma-ray telescope on the Fermi satellite to study light from the central galaxy of the Perseus galaxy cluster in the hunt for ALPs. The researchers found no traces of ALPs and for the first time, the observations were sensitive enough to exclude certain types of ALPs (ALPs can only constitute dark matter if they have certain characteristics).

ALPs cannot be detected directly, but there is a small chance that they transform into ordinary light and vice versa when traveling through a magnetic field. A research team at Stockholm University used a very bright light source, the central galaxy of the Perseus galaxy cluster, to look for these transformations. The gamma radiation from this galaxy could change its nature to ALPs while traveling through the magnetic field that fills the gas between the galaxies in the cluster.

"The ALPs we have been able to exclude could explain a certain amount of dark matter. What is particularly interesting is that with our analysis we are reaching a sensitivity that we thought could only be obtained with dedicated future experiments on Earth", says Manuel Meyer, post-doc at the Department of Physics, Stockholm University.

Searches for ALPs with the Fermi telescope will continue. More than 80 percent of the matter in the universe is unidentified. Dark matter shows itself only through its gravity, neither absorbing nor radiating any form of light. [15]

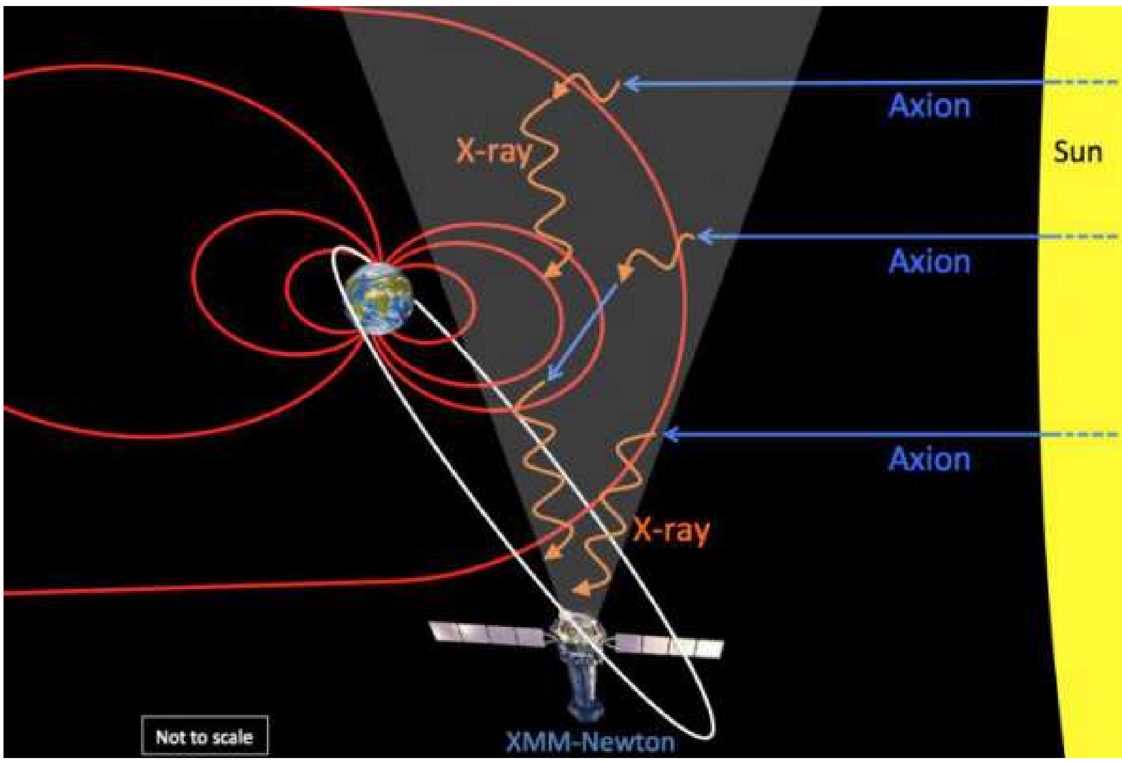
Astronomers may have detected the first direct evidence of dark matter

Scientists have detected a mysterious X-ray signal that could be caused by dark matter streaming out of our Sun's core.
Now scientists at the University of Leicester have identified a signal on the X-ray spectrum which appears to be a signature of 'axions' - a hypothetical dark matter particle that's never been detected before.
While we can't get too excited just yet - it will take years to confirm whether this signal really is dark matter - the discovery would completely change our understanding of how the Universe works. After all, dark matter is the force that holds our galaxies together, so learning more about it is pretty important.
The researchers first detected the signal while searching through 15 years of measurements taking by the European Space Agency's orbiting XMM-Newton space observatory.

Unexpectedly, they noticed that the intensity of X-rays recorded by the spacecraft rose by about 10% whenever XMM-Newton was at the boundary of Earth's magnetic field facing the Sun - even once they removed all the bright X-ray sources from the sky. Usually, that X-ray background is stable. "The X-ray background - the sky, after the bright X-ray sources are removed - appears to be unchanged whenever you look at it," said Andy Read, from the University of Leicester, one of the lead authors on the paper, in a press release. "However, we have discovered a seasonal signal in this X-ray background, which has no conventional explanation, but is consistent with the discovery of axions."

Researchers predict that axions, if they exist, would be produced invisibly by the Sun, but would convert to X-rays as they hit Earth's magnetic field. This X-ray signal should in theory be strongest when looking through the sunward side of the magnetic field, as this is where the Earth's magnetic field is strongest.

The next step is for the researchers to get a larger dataset from XMM-Newton and confirm the pattern they've seen in X-rays. Once they've done that, they can begin the long process of proving that they have, in fact, detecting dark matter streaming out of our Sun's core.



A sketch (not to scale) shows axions (blue) streaming out of the Sun and then converting into X-rays (orange) in the Earth's magnetic field (red). The X-rays are then detected by the XMM-Newton observatory. [13]

The axion is a hypothetical elementary particle postulated by the Peccei–Quinn theory in 1977 to resolve the strong CP problem in quantum chromodynamics (QCD). If axions exist and have low mass within a specific range, they are of interest as a possible component of cold dark matter. [14]

Hidden photons

Hidden photons are predicted in some extensions of the Standard Model of particle physics, and unlike WIMPs they would interact electromagnetically with normal matter. Hidden photons also have a very small mass, and are expected to oscillate into normal photons in a process similar to neutrino oscillation. Observing such oscillations relies on detectors that are sensitive to extremely small electromagnetic signals, and a number of these extremely difficult experiments have been built or proposed.

A spherical mirror is ideal for detecting such light because the emitted photons would be concentrated at the sphere's centre, whereas any background light bouncing off the mirror would pass through a focus midway between the sphere's surface and centre. A receiver placed at the centre could then pick up the dark-matter-generated photons, if tuned to their frequency – which is related to the mass of the incoming hidden photons – with mirror and receiver shielded as much as possible from stray electromagnetic waves.

Ideal mirror at hand

Fortunately for the team, an ideal mirror is at hand: a 13 m2 aluminium mirror used in tests during the construction of the Pierre Auger Observatory and located at the Karlsruhe Institute of Technology. Döbrich and co-workers have got together with several researchers from Karlsruhe, and the collaboration is now readying the mirror by adjusting the position of each of its 36 segments to minimize the spot size of the focused waves. They are also measuring background radiation within the shielded room that will house the experiment. As for receivers, the most likely initial option is a set of low-noise photomultiplier tubes for measurements of visible light, which corresponds to hidden-photon masses of about 1 eV/C^2. Another obvious choice is a receiver for gigahertz radiation, which corresponds to masses less than 0.001 eV/C^2; however, this latter set-up would require more shielding.

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]

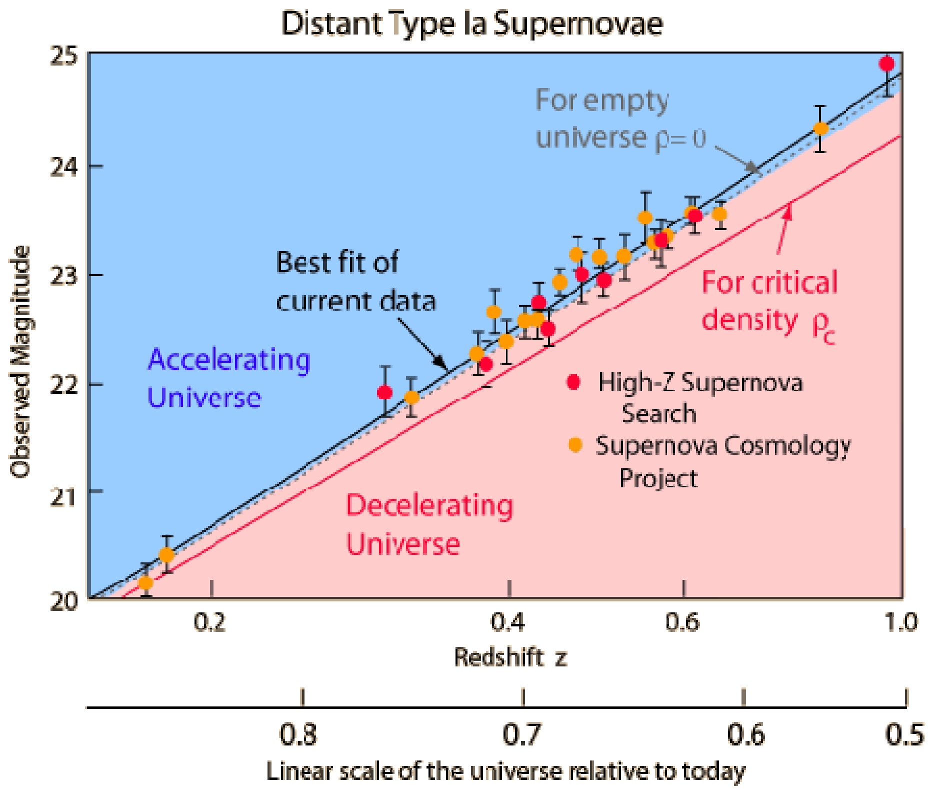
Weakly interacting massive particles

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.



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

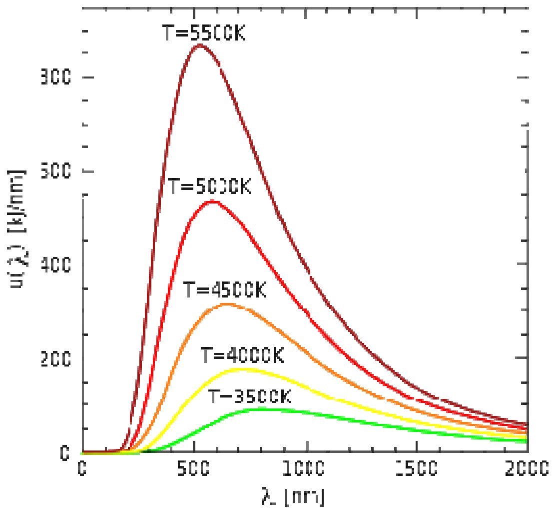
Dark matter is a type of matter hypothesized in astronomy and cosmology to account for a large part of the mass that appears to be missing from the universe. Dark matter cannot be seen directly with telescopes; evidently it neither emits nor absorbs light or other electromagnetic radiation at any significant 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

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The frequency dependence of mass

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.

Electron – Proton mass rate

The Planck distribution law explains the different frequencies of the proton and electron, giving equal intensity to different lambda wavelengths! Also since the particles are diffraction patterns they have some closeness to each other – can be seen as a gravitational force. [1]

There is an asymmetry between the mass of the electric charges, for example proton and electron, can understood by the asymmetrical Planck Distribution Law. This temperature dependent energy distribution is asymmetric around the maximum intensity, where the annihilation of matter and antimatter is a high probability event. The asymmetric sides are creating different frequencies of electromagnetic radiations being in the same intensity level and compensating each other. One of these compensating ratios is the electron – proton mass ratio. The lower energy side has no compensating intensity level, it is the dark energy and the corresponding matter is the dark matter.

Gravity from the point of view of quantum physics

The Gravitational force

The gravitational attractive force is basically a magnetic force.

The same electric charges can attract one another by the magnetic force if they are moving parallel in the same direction. Since the electrically neutral matter is composed of negative and positive charges they need 2 photons to mediate this attractive force, one per charges. The Bing Bang caused parallel moving of the matter gives this magnetic force, experienced as gravitational force.

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

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

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

The Big Bang caused acceleration created radial currents of the matter, and since the matter is composed of negative and positive charges, these currents are creating magnetic field and attracting forces between the parallel moving electric currents. This is the gravitational force experienced by the matter, and also the mass is result of the electromagnetic forces between the charged particles. The positive and negative charged currents attracts each other or by the magnetic forces or by the much stronger electrostatic forces!?

The Graviton

In physics, the graviton is a hypothetical elementary particle that mediates the force of gravitation in the framework of quantum field theory. If it exists, the graviton is expected to be massless (because the gravitational force appears to have unlimited range) and must be a spin-2 boson. The spin follows from the fact that the source of gravitation is the stress-energy tensor, a second-rank tensor (compared to electromagnetism's spin-1 photon, the source of which is the four-current, a first-rank tensor). Additionally, it can be shown that any massless spin-2 field would give rise to a force indistinguishable from gravitation, because a massless spin-2 field must couple to (interact with) the stress-energy tensor in the same way that the gravitational field does. This result suggests that, if a massless spin-2 particle is discovered, it must be the graviton, so that the only experimental verification needed for the graviton may simply be the discovery of a massless spin-2 particle. [2]

Conclusions

Researchers predict that axions, if they exist, would be produced invisibly by the Sun, but would convert to X-rays as they hit Earth's magnetic field. This X-ray signal should in theory be strongest when looking through the sunward side of the magnetic field, as this is where the Earth's magnetic field is strongest. The high frequency of the X-ray and the uncompensated Planck distribution makes the axion a good candidate to be dark matter.
Hidden photons are predicted in some extensions of the Standard Model of particle physics, and unlike WIMPs they would interact electromagnetically with normal matter.
In particle physics and astrophysics, weakly interacting massive particles, or WIMPs, are among the leading hypothetical particle physics candidates for dark matter.
The gravitational force attracting the matter, causing concentration of the matter in a small space and leaving much space with low matter concentration: dark matter and energy.
There is an asymmetry between the mass of the electric charges, for example proton and electron, can understood by the asymmetrical Planck Distribution Law. This temperature dependent energy distribution is asymmetric around the maximum intensity, where the annihilation of matter and antimatter is a high probability event. The asymmetric sides are creating different frequencies of electromagnetic radiations being in the same intensity level and compensating each other. One of these compensating ratios is the electron – proton mass ratio. The lower energy side has no compensating intensity level, it is the dark energy and the corresponding matter is the dark matter.

The electric currents causing self maintaining electric potential is the source of the special and general relativistic effects. The Higgs Field is the result of the electromagnetic induction. The Graviton is two photons together. [3]

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