

Galaxy Quakes and Dark Matter

A trio of brightly pulsating stars at the outskirts of the Milky Way is racing away from the galaxy and may confirm a method for detecting dwarf galaxies dominated by dark matter and explain ripples in the outer disk of the galaxy. [16]

A recent uptick in the discovery of the smallest, oldest galaxies benefits studies of dark matter, galaxy formation and the evolution of the universe. [15]

Gamma-ray observations of dark matter spikes near supermassive black holes provide a test of fermionic dark matter models. [13]

If dark matter comes in both matter and antimatter varieties, it might accumulate inside dense stars to create black holes. [12]

For a long time, there were two main theories related to how our universe would end. These were the Big Freeze and the Big Crunch. In short, the Big Crunch claimed that the universe would eventually stop expanding and collapse in on itself. This collapse would result in...well...a big crunch (for lack of a better term). Think "the Big Bang", except just the opposite. That's essentially what the Big Crunch is. On the other hand, the Big Freeze claimed that the universe would continue expanding forever, until the cosmos becomes a frozen wasteland. This theory asserts that stars will get farther and farther apart, burn out, and (since there are no more stars bring born) the universe will grown entirely cold and eternally black. [11]

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

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

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

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Author: George Rajna

Galaxy quakes could improve hunt for dark matter

This new method to characterize dark matter marks the first real application of the field of galactoseismology. Just as seismologists analyze waves to infer properties about the Earth's interior, Sukanya Chakrabarti, assistant professor at Rochester Institute of Technology, uses waves in the galactic disk to map the interior structure and mass of galaxies. She presented her findings at a press conference hosted by the American Astronomical Society meeting in Kissimmee, Fla., on Jan. 7. Chakrabarti's findings have been submitted to *Astrophysical Journal Letters*.

Her team used spectroscopic observations to calculate the speed of the three Cepheid variables—stars used as yardsticks to measure distance in galaxies—in the Norma constellation. Chakrabarti's 2015 study used Cepheid variables to mark the location of a dark-matter dominated dwarf galaxy approximately 300,000 light years away. In contrast, the disk of the Milky Way terminates at 48,000 light years.

The current study tracks a cluster of Cepheids that are racing away at an average speed of 450,000 miles per hour; while the radial velocity of stars in the stellar disk of the Milky Way is about 13,000 miles per hour, Chakrabarti said. The method confirms her 2009 prediction.

"The radial velocity of the Cepheid variables is the last piece of evidence that we've been looking for," Chakrabarti said. "You can immediately conclude that they are not part of our Galaxy."

Invisible particles known as dark matter make up 85 percent of the mass of the universe. The mysterious matter represents a fundamental problem in astronomy because it is not understood, Chakrabarti said.

Her method for locating satellite galaxies dominated by dark-matter taps principles used in seismology to explore the interior of the galaxy.

"We have made significant progress into this new field of galactoseismology where by you can infer the dark matter content of dwarf galaxies, where they are, as well as properties of the interior of galaxies by looking at observable disturbances in the gas disk," Chakrabarti said.

She added: "The original prediction was based on observed waves in the outer gas disk of our galaxy which led to a specific prediction for how massive this dark matter dominated dwarf galaxy would have to be to produce these waves. It's very similar to seismology in a sense because we're trying to

infer things about the interior of galaxies and how much dark matter there is and how much there has to be to produce these disturbances."

The study further questions the standard paradigm that old stars populate the dark matter halo and young stars form in the gas-rich stellar disks.

"Given the evidence, these are very likely young Cepheid variables," Chakrabarti said. "It raises the question, shouldn't we also be exploring and looking for young Cepheid variables in the halo?"

There could be a population of yet undiscovered Cepheid variables that formed from a gas-rich dwarf galaxy falling into the halo, she said.

"We used to have a static picture of galaxy evolution but now we know that galaxies are constantly merging with other smaller galaxies and so within this more dynamical scenario, it's important to ask why wouldn't there be young Cepheid variables that are made in the halo due to fresh gas flowing in, or due to gas-rich dwarf galaxies merging with our own," Chakrabarti said.

Spectroscopic observations used in the study were made at the Gemini Observatory and on the Magellan telescopes, as well as on the WiFeS spectrograph. The international team includes Rodolfo Angeloni, Ken Freeman, Leo Blitz, among others, and RIT research scientist Benjamin Sargent and Andrew Lipnicky, a graduate student in the astrophysical sciences and technology program. [16]

The booming science of dwarf galaxies

Galaxies are commonly perceived as gigantic spirals full of billions to trillions of stars. Yet some galaxies, called dwarf galaxies, can harbor just a few hundred suns.

The recent discovery of 20 new potential dwarf galaxies fueled a boom in the science of these faint objects, which are valuable tools to study dark matter, galaxy formation and cosmic history.

Ten years ago, only about a dozen dwarf galaxies were known. This number quickly doubled after the Sloan Digital Sky Survey began its second phase of operation in 2005. SDSS-II took better than ever images of the sky, and researchers started using computer programs to identify dwarf galaxies in them.

The number of potential dwarf galaxies has spiked of late, largely due to results from the first two years of the new Dark Energy Survey, which can see objects 10 times as faint. The total number of known dwarf galaxy candidates orbiting our Milky Way—not all of them have been confirmed as galaxies yet—has now reached about 50.

"The precise number is being updated on almost a weekly basis during recent months," says Keith Bechtol of the University of Wisconsin, Madison, one of the lead authors of two DES papers, published in March and August, announcing the discoveries of potential satellite galaxies. "These are truly exciting times for this type of research."

Dim lights for dark matter research

In general, the term “dwarf galaxy” refers to a galaxy that is smaller than a tenth of the size of our Milky Way, which is made of 100 billion stars. So not all dwarf galaxies are truly dwarfish. In fact, two of these objects in the southern night sky, called the Magellanic Clouds, are so large that they are visible to the naked eye.

However, researchers are particularly interested in the faintest dwarf galaxies. They make excellent laboratories in which to study dark matter—the invisible form of matter that is five times more prevalent than its visible counterpart but whose nature remains a mystery.

Scientists’ best guess is that it’s made of fundamental particles, with hypothetical weakly interacting massive particles, or WIMPs, as the top contenders. Researchers think WIMPs could produce gamma rays as they decay or annihilate each other in space. They’re searching for this radiation with sensitive gamma-ray telescopes.

Ultra-faint dwarf galaxies orbiting the Milky Way are ideal targets for this search for two reasons. First, because they have high ratios of dark matter to regular matter and are relatively close to us, they could produce detectable dark matter signals.

“The motions of stars in ultra-faint galaxies are so fast that they are best explained if there is 100 to 1000 times more dark matter than the masses of all the stars taken together,” Bechtol says.

Second, these galaxies are the oldest known galaxies. Their busiest days are in the past; most formed their stars more than 10 billion years ago. This, together with the fact that they have few stars and little gas, makes them very “clean” objects for the dark matter search.

By contrast, in the also dark-matter-rich center of the much younger Milky Way, stars are still forming and many other astrophysical processes are producing gamma-ray signals that could obscure signs of dark matter.

“If we ever saw gamma rays coming from these ultra-faint galaxies, it would be a smoking gun for dark matter,” says researcher Andrea Albert of the Kavli Institute for Particle Astrophysics and Cosmology, a joint institute of Stanford University and the SLAC National Accelerator Laboratory. She is involved in the dark matter analysis of the recently discovered DES dwarf galaxy candidates with the Fermi Gamma-ray Space Telescope.

No convincing sign of WIMPs has yet been found coming from dwarf galaxies, including the most recent DES candidate dwarf galaxies, as preliminary results presented at the 2015 Topics in Astroparticle and Underground Physics conference in Torino, Italy, suggest.

But even the absence of a signal is progress because it sets limits on what dark matter can and cannot be.

Excavation tools for astrophysical archeology

Researchers also study dwarf galaxies because they hope to learn about the history of our cosmic neighborhood and the formation of galaxies like our own.

Current models suggest that galaxies don't start out as enormous objects with a gazillion of stars, but rather as small structures that merge with others into larger ones. Dwarf galaxies are at the bottom of this hierarchy and are believed to be the building blocks of larger galaxies.

"The way we see the Milky Way and its satellites today is only a snapshot in time," says astronomer Marla Geha of Yale University. "Our own galaxy is a merger of smaller galaxies, and it's still merging."

In other words, the Milky Way itself may have started out as a dwarf galaxy with only a few hundred to thousand stars. Today, it is a large galaxy, and simulations suggest that in 4 to 5 billion years the Milky Way will merge with the Andromeda Galaxy, the nearest major galaxy in our cosmic neighborhood.

But dwarf galaxies can give us insight into more than just our local neighborhood. By better understanding dwarf galaxies, researchers can also study the evolution of the whole universe.

Since dark matter is abundant and interacts gravitationally with itself and regular matter, it has influenced the cosmos and its structures ever since the big bang. In fact, we know today that galaxies are embedded in clumps, or halos, of dark matter that have formed in the expanding universe. These halos, in turn, are surrounded by smaller halos that harbor dwarf satellite galaxies.

"The discovery of an increasing number of dwarf galaxies is exciting because our cosmological theories predict that the Milky Way has a few hundred of them," Geha says. "If we don't find enough satellites, we will need to adjust our models. However, considering that we haven't surveyed the entire sky yet and haven't been looking deeply enough, we're mostly on track for our predictions."

Some of the dwarf galaxy candidates discovered by DES earlier this year could potentially orbit the Magellanic Clouds, the largest satellites of the Milky Way. If confirmed, the result would be quite fascinating, says KIPAC researcher Risa Wechsler.

"Satellites of satellites are predicted by our models of dark matter," she says. "Either we're seeing these types of systems for the first time, or there is something we don't understand about how these satellite galaxies are distributed in the sky."

A better and better view

So far, studies of dwarf galaxies have largely been restricted to satellites of our Milky Way, and researchers believe that much could be learned from studying more distant ones.

"One question we would like to answer is why the faintest dwarf galaxies are so extreme in size, age and dark matter content," Geha says. "Is this because the ones we can observe are affected by their proximity to the Milky Way, or are these properties common to all dwarf galaxies in the universe?"

For the ultimate test, researchers want to be able to detect even fainter objects and look farther into space than they can with DES. They'll be able to do so once the Large Synoptic Survey Telescope will come online in 2022. The telescope's 3.2-gigapixel camera will produce the deepest views of the night sky ever observed.

And if that's not enough, NASA is planning a space mission called the Wide-Field Infrared Survey Telescope, which could spot ultra-faint dwarf galaxies that evade even LSST's watchful eye. [15]

Russian Scientists to Develop Dark Matter Detection Model in 1-2 Years

Russian scientists plan to develop a dark matter detection prototype within one to two years, the Siberian Branch of Russian Academy of Science's senior nuclear physics research official said Sunday. "We know that [dark matter] leaves almost no traces and our main task is to dramatically lower the detection threshold to a minimum, which is physically possible in principle. There is quite substantial progress and we hope that a prototype of this detector can be created in the next year or two," said Yuri Tikhonov, Budker Institute of Nuclear Physics deputy director in charge of research.

Tikhonov noted that the detector would search for the elusive space material with the help of condensed inert gases, including argon. He said scientists have identified argon as the gas most suitable for ensuring the detection threshold to register dark matter's nuclei recoils.

"These results will serve as the basis for creating a dark matter detector. You need low-background underground laboratories, such as the Gran Sasso in Italy. We have been invited to cooperate there with a big experiment," he said.

The work is being carried out with funding from the Russian Science Foundation, Tikhonov added.

"The scale of preparation for such an experiment is five to seven years. It is an enormous installation of tens of tonnes of liquid argon. I think that the construction will be close to completion this decade. But the worldwide goal is to find dark matter by 2023-25," he said.

Dark matter does not emit electromagnetic radiation, and remains immune to direct observation. Astrophysicists have so far only observed gravitational effects of dark matter on cosmic objects, such as galaxies and galaxy clusters.

Indirect observations include searching for excess gamma ray emissions, which may be the product of weakly interacting massive particle (WIMP) decay. The theoretical WIMPs are thought to be the main component of dark matter. [14]

Synopsis: Black Hole Tests of Fermionic Dark Matter

One of the principal strategies to indirectly detect dark matter is to search for the photons produced when it annihilates. Such searches look for gamma rays or x rays in regions of the sky where dark matter is known to be abundant. Researchers at the University of Illinois at Urbana-Champaign have proposed to look inside dark matter spikes induced by the gravitational pull of supermassive black holes. Such measurements could test so called p-wave dark matter models.

Most astrophysical dark matter searches rely on the assumption that the annihilation cross section does not depend on particle velocity. However, there are models in which dark matter annihilates via p-wave interactions—that is, the pair of annihilating particles has initial angular momentum one—leading to a cross section proportional to the velocity squared. This happens, for instance, in models where fermionic dark matter annihilates to pairs of spinless bosons. Since the dark matter

temperature, and hence its velocity, is believed to be low, p-wave signatures were largely inaccessible by current searches.

However, near a supermassive black hole like the Milky Way's Sagittarius A*, dark matter is expected to cluster into a density spike. Within such a spike, the density and velocities of dark matter particles could be sufficient for thermal p-wave annihilation to produce a detectable gamma-ray signal. Using two prototypical p-wave models and gamma-ray data from NASA's Fermi Large Area Telescope, the researchers found no evidence for p-wave dark matter and constrained its annihilation cross section for the first time. Their analysis suggests that a dedicated search for sharp gamma-ray lines near Sagittarius A* can improve these constraints.

This research is published in Physical Review Letters. [13]

Dark Matter Black Holes Could Be Destroying Stars at the Milky Way's Center

If dark matter comes in both matter and antimatter varieties, it might accumulate inside dense stars to create black holes. Dark matter may have turned spinning stars into black holes near the center of our galaxy, researchers say. There, scientists expected to see plenty of the dense, rotating stars called pulsars, which are fairly common throughout the Milky Way. Despite numerous searches, however, only one has been found, giving rise to the so-called "missing pulsar problem." A possible explanation, according to a new study, is that dark matter has built up inside these stars, causing the pulsars to collapse into black holes. (These black holes would be smaller than the supermassive black hole that is thought to lurk at the very heart of the galaxy.)

The universe appears to be teeming with invisible dark matter, which can neither be seen nor touched, but nonetheless exerts a gravitational pull on regular matter.

Scientists have several ideas for what dark matter might be made of, but none have been proved. A leading option suggests that dark matter is composed of particles called weakly interacting massive particles (WIMPs), which are traditionally thought to be both matter and antimatter in one. The nature of antimatter is important for the story. When matter and antimatter meet they destroy one another in powerful explosions—so when two regular WIMPs collide, they would annihilate one another.

But it is also possible that dark matter comes in two varieties—matter and antimatter versions, just like regular matter. If this idea—called asymmetric dark matter—is true, then two dark matter particles would not destroy one another nor would two dark antimatter particles, but if one of each type met, the two would explode. In this scenario both types of dark matter should have been created in abundance during the big bang (just as both regular matter and regular antimatter are thought to have been created) but most of these particles would have destroyed one another, and those that remain now would be just the small excess of one type that managed to avoid being annihilated.

If dark matter is asymmetric, it would behave differently from the vanilla version of WIMPs. For example, the dense centers of stars should gravitationally attract nearby dark matter. If dark matter is made of regular WIMPs, when two WIMPs meet at the center of a star they would destroy one another, because they are their own antimatter counterparts. But in the asymmetric dark matter

picture, all the existing dark matter left today is made of just one of its two types—either matter or antimatter. If two of these like particles met, they would not annihilate, so dark matter would simply build up over time inside the star. Eventually, the star's core would become too heavy to support itself, thereby collapsing into a black hole. This is what may have happened to the pulsars at the Milky Way's center, according to a study published November 3 in *Physical Review Letters*.

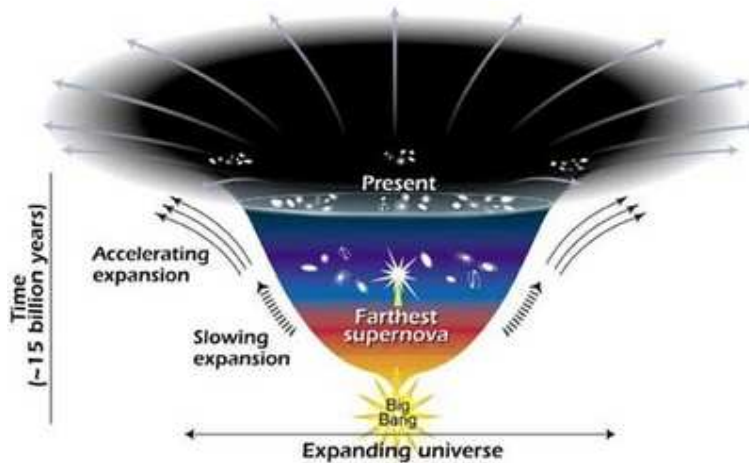
The scenario is plausible, says Raymond Volkas, a physicist at the University of Melbourne who was not involved in the study, but the missing pulsar problem might easily turn out to have a mundane explanation through known stellar effects. "It would, of course, be exciting to have dramatic direct astrophysical evidence for asymmetric dark matter," Volkas says. "Before believing an asymmetric dark matter explanation, I would want to be convinced that no standard explanation is actually viable."

The authors of the study, Joseph Bramante of the University of Notre Dame and Tim Linden of the Kavli Institute for Cosmological Physics at the University of Chicago, agree that it is too early to jump to a dark matter conclusion. For example, Linden says, maybe radio observations of the galactic center are not as thorough as scientists have assumed and the missing pulsars will show up with better searches. It is also possible some quirk of star formation has limited the number of pulsars that formed at the galactic center.

The reason nearby pulsars would not be as affected by asymmetric dark matter is that dark matter, of any kind, should be densest at the cores of galaxies, where it should congregate under the force of its own gravity. And even there it should take dark matter a very long time to accumulate enough to destroy a pulsar because most dark particles pass right through stars without interacting. Only on the rare occasions when one flies extremely close to a regular particle can it collide, and then it will be caught there. In normal stars the regular particles at the cores are not dense enough to catch many dark matter ones. But in superdense pulsars they might accumulate enough to do damage. "Dark matter can't collect as densely or as quickly at the center of regular stars," Bramante says, "but in pulsars the dark matter would collect into about a two-meter ball. Then that ball collapses into a black hole and it sucks up the pulsar."

If this scenario is right, one consequence would be that pulsars should live longer the farther away they are from the dark matter–dense galactic center. At the far reaches of the Milky Way, for example, pulsars might live to ripe old ages; near the core, however, pulsars would be created and then quickly destroyed before they could age. "Nothing astrophysical predicts a very strong relation between the age of a pulsar and its distance from the center of a galaxy," Linden says. "You would really see a stunning effect if this scenario held." It is also possible, although perhaps not probable, that astronomers could observe a pulsar collapse into a black hole, verifying the theory. But once the black hole is created, it would be near impossible to detect: As dark matter and black holes are each unobservable, black holes made of dark matter would be doubly invisible. [12]

Everything You Need to Know About Dark Energy



For a long time, there were two main theories related to how our universe would end. These were the Big Freeze and the Big Crunch. In short, the Big Crunch claimed that the universe would eventually stop expanding and collapse in on itself. This collapse would result in...well...a big crunch (for lack of a better term). Think “the Big Bang”, except just the opposite. That’s essentially what the Big Crunch is. On the other hand, the Big Freeze claimed that the universe would continue expanding forever, until the cosmos becomes a frozen wasteland. This theory asserts that stars will get farther and farther apart, burn out, and (since there are no more stars being born) the universe will grow entirely cold and eternally black.

Now, we know that the expansion of the universe is not slowing. In fact, expansion is increasing. Edwin Hubble discovered that the farther an object was away from us the faster it was receding from us. In simplest terms, this means that the universe is indeed expanding, and this (in turn) means that the universe will likely end as a frozen, static wasteland. However, this can all change there is a reversal of dark energy’s current expansion effect. Sound confusing? To clear things up, let’s take a closer look at what dark energy is.

How We Discovered That The Universe Is Expanding:

The accelerating expansion of the universe was discovered when astronomers were doing research on type 1a supernova events. These stellar explosions play a pivotal role in discerning the distance between two celestial objects because all type 1a supernova explosions are remarkably similar in brightness. So if we know how bright a star should be, we can compare the apparent luminosity with the intrinsic luminosity, and we get a reliable figure for how far any given object is from us. To get a better idea of how these work, think about headlights. For the most part, car headlights all have the same luminosity. So if one car’s headlights are only 1/4 as bright as another car’s, then one car is twice as far away as the other.

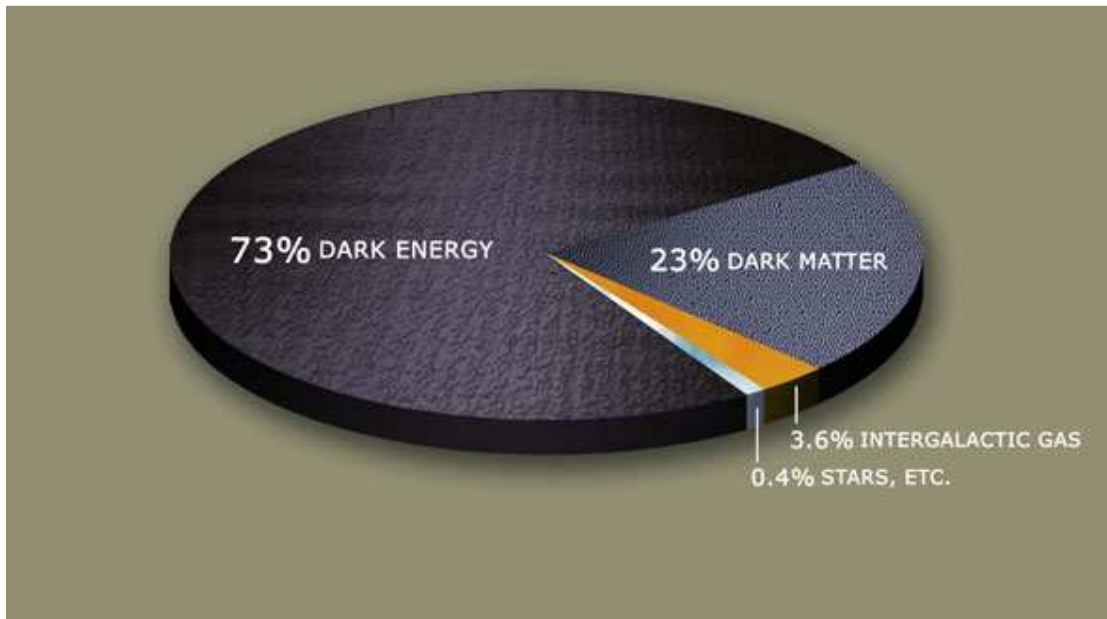
Incidentally, along with helping us make these key determinations about the locations of objects in the universe, these supernova explosions also gave us a sneak preview of one of the strangest observations ever made about the universe. To measure the approximate distance of an object, like a star, and how that distance has changed, astronomers analyze the spectrum of light emitted. Scientists were able to tell that the universe is increasing in expansion because, as the light waves make the incredibly long journey to Earth—billions of light-years away—the universe continues to

expand. And as it expands, it stretches the light waves through a process called “redshifting” (the “red” is because the longest wavelength for light is in the red portion of the electromagnetic spectrum). The more redshifted this light is, the faster the expansion is going. Many years of painstaking observations (made by many different astronomers) have confirmed that this expansion is still ongoing and increasing because (as previously mentioned) the farther away an object is, the more redshifted it is, and (thus) the faster it is moving away from us.

How Do We Know That Dark Energy Is Real?

The existence of dark energy is required, in some form or another, to reconcile the measured geometry of space with the total amount of matter in the universe. This is because of the largely successful Planck satellite and Wilkinson Microwave Anisotropy Probe (WMAP) observations. The satellite’s observations of the cosmic microwave background radiation (CMB) indicate that the universe is geometrically flat, or pretty close to it.

All of the matter that we believe exists (based on scientific data and inferences) combines to make up just about 30% of the total critical density of the observed universe. If it were geometrically flat, like the distribution suggests from the CMB, critical density of energy and matter should equal 100%. WMAP’s seven year sky survey, and the more sophisticated Planck Satellite 2 year survey, both are very strong evidence of a flat universe. Current measurements from Planck put baryonic matter (atoms) at about 4%, dark matter at 23%, and dark energy making up the remainder at 73%.



What’s more, an experiment called Wiggle Z galaxy sky survey in 2011 further supported the dark energy hypothesis by its observations of large scale structures of the universe (such as galaxies, quasars, galaxy clusters, etc). After observing more than 200,000 galaxies (by looking at their redshift and measuring the baryonic acoustic oscillations), the survey quantitatively put the age of when the universe started increasing its acceleration at a timeline of 7 billion years. After this time in the universe, the expansion started to speed up.

How Does Dark Energy Work?

According to Occam's razor (which proposes that the hypothesis with the fewest amount of assumptions is the correct one), the scientific community has favored Einstein's cosmological constant. Or in other words, the vacuum energy density of empty space, imbued with the same negative pressure value everywhere, eventually adds up with itself to speed up and suffuse the universe with more empty space, accelerating the entire process. This would kind of be similar to the energy pressure when talking about the "Casimir effect," which is caused by virtual particles in so-called "empty space", which is actually full of virtual particles coming in and out of existence.

The Problem With Dark Energy:

Called "the worst prediction in all of physics," cosmologists predict that this value for the cosmological constant should be 10^{-120} Planck units. According to dark energy equation, the parameter value for w (for pressure and density) must equal -1 . But according to the latest findings from Pan-STARRS (short for Panoramic Survey Telescope and Rapid Response System), this value is in fact -1.186 . Pan-STARRS derived this value from combining the data it obtained with the observational data from Planck satellite (which measured these very specific type 1a supernovas, 150 of them between 2009 and 2011, to be exact).

"If w has this value, it means that the simplest model to explain dark energy is not true," says Armin Rest of the Space Telescope Science Institute (STScI) in Baltimore. Armin Rest is the lead author of the Pan-STARRS team reporting these results to the astrophysics Web site arXiv (actual link to the paper) on October 22, 2013.

The Significance:

What exactly does the discrepancy in the value in the cosmological constant mean for our understanding of dark energy? At first glance, the community can dismiss these results as experimental uncertainty errors. It is a well accepted idea that telescope calibration, supernova physics, and galactic properties are large sources of uncertainties. This can throw off the cosmological constant value. Several astronomers have immediately spoken up, denying the validity of the results. Julien Guy of University Pierre and Marie Curie in Paris say the Pan-STARRS researchers may have underestimated their systematic error by ignoring a source of uncertainty from supernova light-curve models. They have been in contact with the team, who are looking into that very issue, and others are combing over the meticulous work on the Pan-STARRS team to see if they can find any holes in the study.

Despite this, these results were very thorough and made by an experienced team, and work is already on its way to rule out any uncertainties. Not only that, but this is third sky survey to now produce experimental results that have dependencies for the pressure and density value of w being equal to -1 , and it is starting to draw attention from cosmologists everywhere. In the next year or two, this result will be definitive, or it will be ruled out and disappear, with the cosmological constant continue being supported.

Well, if the cosmological constant model is wrong, we have to look at alternatives. That is the beauty of science, it does not care what we wish to be true: if something disagrees with observations, it's wrong. Plain and simple. [11]

The Big Bang

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

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

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

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

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

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

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

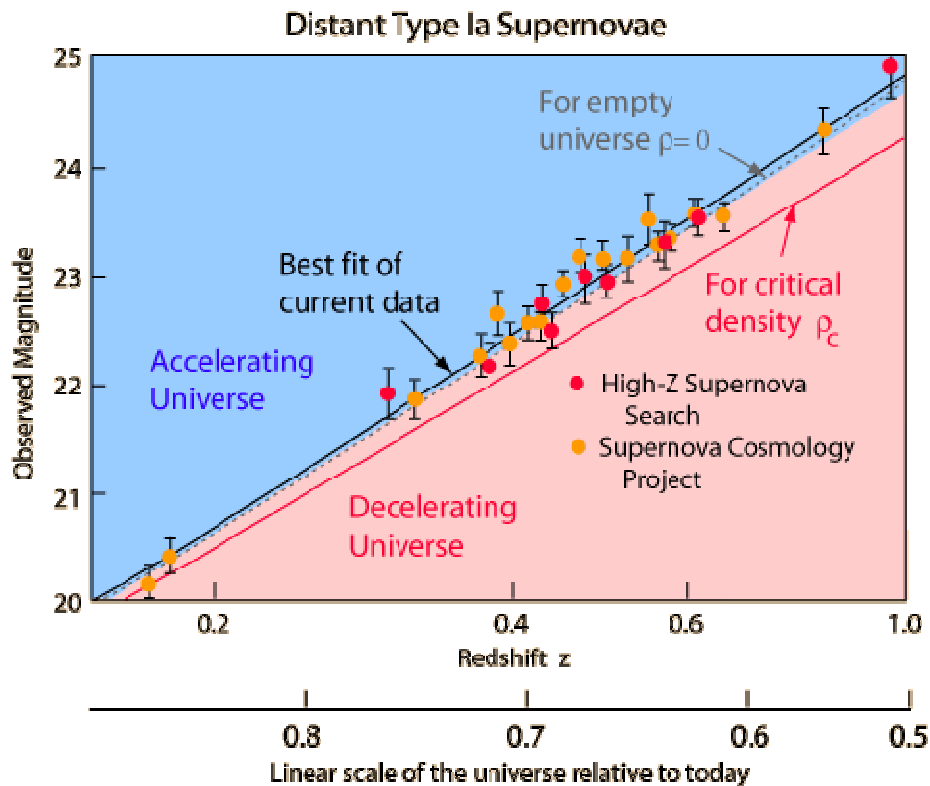
Cosmology underwent a paradigm shift in 1998 when researchers announced that the rate at which the Universe was expanding was accelerating. The idea of a constant dark energy throughout space-time (the “cosmological constant”) became the standard model of cosmology, but now the Portsmouth and Rome researchers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

Evidence for an accelerating universe

One of the observational foundations for the big bang model of cosmology was the observed expansion of the universe. [9] Measurement of the expansion rate is a critical part of the study, and it has been found that the expansion rate is very nearly "flat". That is, the universe is very close to the critical density, above which it would slow down and collapse inward toward a future "big

crunch". One of the great challenges of astronomy and astrophysics is distance measurement over the vast distances of the universe. Since the 1990s it has become apparent that type Ia supernovae offer a unique opportunity for the consistent measurement of distance out to perhaps 1000 Mpc. Measurement at these great distances provided the first data to suggest that the expansion rate of the universe is actually accelerating. That acceleration implies an energy density that acts in opposition to gravity which would cause the expansion to accelerate. This is an energy density which we have not directly detected observationally and it has been given the name "dark energy".

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



The data summarized in the illustration above involve the measurement of the redshifts of the distant supernovae. The observed magnitudes are plotted against the redshift parameter z . Note that there are a number of Type Ia supernovae around $z=0.6$, which with a Hubble constant of 71 km/s/mpc is a distance of about 5 billion light years.

Equation

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

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

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

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

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

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

Explanatory models

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

Dark Matter and Energy

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

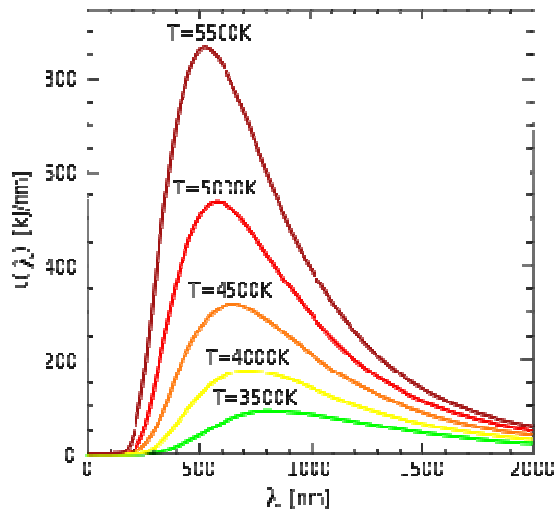
Cosmic microwave background

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

Thermal radiation

Thermal radiation is electromagnetic radiation generated by the thermal motion of charged particles in matter. All matter with a temperature greater than absolute zero emits thermal radiation. When the temperature of the body is greater than absolute zero, interatomic collisions

cause the kinetic energy of the atoms or molecules to change. This results in charge-acceleration and/or dipole oscillation which produces electromagnetic radiation, and the wide spectrum of radiation reflects the wide spectrum of energies and accelerations that occur even at a single temperature. [8]



Electromagnetic Field and Quantum Theory

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

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

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

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

Lorentz transformation of the Special Relativity

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

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

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

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

The Classical Relativistic effect

The moving charges are self maintain the electromagnetic field locally, causing their movement and this is the result of their acceleration under the force of this field.

In the classical physics the charges will distributed along the electric current so that the electric potential lowering along the current, by linearly increasing the way they take every next time period because this accelerated motion.

Electromagnetic inertia and Gravitational attraction

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

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

Since $E = h\nu$ and $E = mc^2$, $m = h\nu / c^2$ that is the m depends only on the ν frequency. It means that the mass of the proton and electron are electromagnetic and the result of the electromagnetic induction, caused by the changing acceleration of the spinning and moving charge! It could be that the m_0 inertial mass is the result of the spin, since this is the only accelerating motion of the electric charge. Since the accelerating motion has different frequency for the electron in the atom and the

proton, they masses are different, also as the wavelengths on both sides of the diffraction pattern, giving equal intensity of radiation.

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

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

Electromagnetic inertia and mass

Electromagnetic Induction

Since the magnetic induction creates a negative electric field as a result of the changing acceleration, it works as an electromagnetic inertia, causing an electromagnetic mass. [1]

Relativistic change of mass

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The frequency dependence of mass

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Electron – Proton mass rate

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

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

Gravity from the point of view of quantum physics

The Gravitational force

The gravitational attractive force is basically a magnetic force.

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

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

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

The mass as seen before a result of the diffraction, for example the proton – electron mass ratio $M_p = 1840$. 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

If dark matter comes in both matter and antimatter varieties, it might accumulate inside dense stars to create black holes. It is also possible, although perhaps not probable, that astronomers could observe a pulsar collapse into a black hole, verifying the theory. But once the black hole is created, it would be near impossible to detect: As dark matter and black holes are each unobservable, black holes made of dark matter would be doubly invisible. [12]

For a long time, there were two main theories related to how our universe would end. These were the Big Freeze and the Big Crunch. In short, the Big Crunch claimed that the universe would eventually stop expanding and collapse in on itself. This collapse would result in...well...a big crunch (for lack of a better term). Think “the Big Bang”, except just the opposite. That’s essentially what the Big Crunch is. On the other hand, the Big Freeze claimed that the universe would continue expanding forever, until the cosmos becomes a frozen wasteland. This theory asserts that stars will get farther and farther apart, burn out, and (since there are no more stars bring born) the universe will grown entirely cold and eternally black. [11]

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

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

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

There is an asymmetry between the mass of the electric charges, for example proton and electron, can understood by the asymmetrical Planck Distribution Law. This temperature dependent energy distribution is asymmetric around the maximum intensity, where the annihilation of matter and antimatter is a high probability event. The asymmetric sides are creating different frequencies of electromagnetic radiations being in the same intensity level and compensating each other. One of these compensating ratios is the electron – proton mass ratio. The lower energy side has no compensating intensity level, it is the dark energy and the corresponding matter is the dark matter. The electric currents causing self maintaining electric potential is the source of the special and general relativistic effects. The Higgs Field is the result of the electromagnetic induction. The Graviton is two photons together. [3]

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