Hot Dark Matter?

For decades, researchers have tried to detect this invisible dark matter. Several types of devices have been put up on Earth and in space to capture the particles that dark matter is supposed to consist of, and experiments have attempted to create a dark matter particle by colliding ordinary matter particles at very high temperatures. [13]

"Call it the sound of dark matter," says Asimina Arvanitaki, a theoretical particle physicist at Perimeter Institute. Despite making up the vast majority of stuff in our universe, dark matter remains invisible. But perhaps it's not inaudible. Dark matter is some of the most abundant, yet most elusive, stuff in the universe. Though scientists are confident it is out there (thanks to the gravitational effects it has on its surroundings), the search to identify it has thus far come up empty. [12]

An international team of scientists using a combination of radio and optical telescopes has for the first time managed to identify the location of a fast radio burst, allowing them to confirm the current cosmological model of the distribution of matter in the universe. [11]

Invisibility — like time travel, teleportation, flying, and super-speed — has been a fixture in science fiction ever since science fiction has existed. The most well-known examples range from the one used by the Romulans in Star Trek, Harry Potter's deathly hallows cloaking device, and the eleven cloak Frodo and Sam used to evade Sauron's army at the gates of Mordor. There are hundreds, if not thousands, of other mentions in books, movies and television. Over the years, many scientists have come up with inventive ways to hide objects from sight (one includes a 3D printer); only the process is certainly much more complex than science fiction makes it look. [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

Dark matter—hot or not?

For almost a century, astronomers and cosmologists have postulated that space is filled with an invisible mass known as "dark matter". Accounting for 27% of the mass and energy in the observable universe, the existence of this matter was intended to explain all the "missing" baryonic matter in cosmological models.

Unfortunately, the concept of dark matter has solved one cosmological problem, only to create another.

If this matter does exist, what is it made of? So far, theories have ranged from saying that it is made up of cold, warm or hot matter, with the most widely-accepted theory being the Lambda Cold Dark Matter (Lambda-CDM) model. However, a new study produced by a team of European astronomer suggests that the Warm Dark Matter (WDM) model may be able to explain the latest observations made of the early universe.

But first, some explanations are in order. The different theories on dark matter (cold, warm, hot) refer not to the temperatures of the matter itself, but the size of the particles themselves with respect to the size of a protogalaxy – an early universe formation, from which dwarf galaxies would later form.

The size of these particles determines how fast they can travel, which determines their thermodynamic properties, and indicates how far they could have traveled – aka. their "free streaming length" (FSL) – before being slowed by cosmic expansion. Whereas hot dark matter would be made up of very light particles with high FSLs, cold dark matter is believed to be made up of massive particles bigger that a protogalaxy (hence, a low FSL).

Cold dark matter has been speculated to take the form of Massive Compact Halo Objects (MACHOs) like black holes; Robust Associations of Massive Baryonic Objects (RAMBOs) like clusters of brown dwarfs; or a class of undiscovered heavy particles – i.e. Weakly-Interacting Massive Particles (WIMPs), and axions.

The widely-accepted Lambda-CDM model is based in part of the theory that dark matter is "cold". As cosmological explanations go, it is the most simple and can account for the formation of galaxies or galaxy cluster formations. However, there remains some holes in this theory, the biggest of which is that it predicts that there should be many more small, dwarf galaxies in the early universe than we can account for.

In short, the existence of dark matter as massive particles that have low FSL would result in small fluctuations in the density of matter in the early universe – which would lead to large amounts of low-mass galaxies to be found as satellites of galactic halos, and with large concentrations of dark matter in their centers.

Naturally, the absence of these galaxies might lead one to speculate that we simply haven't spotted these galaxies yet, and that IR surveys like the Two-Micron All Sky Survey (2MASS) and the Wide-field Infrared Survey Explorer (WISE) missions might find them in time.

But as the international research team – which includes astronomers from the Astronomical Observatory of Rome (INAF), the Italian Space Agency Science Data Center and the Paris Observatory

– another possibility is that dark matter is neither hot nor cold, but "warm" – i.e. consisting of middle-mass particles (also undiscovered) with FSLs that are roughly the same as objects big as galaxies.

As Dr. Nicola Menci – a researcher with the INAF and the lead author of the study – told universe Today via email:

"The Cold Dark Matter particles are characterized by low root mean square velocities, due to their large masses (usually assumed of the order of >~ 100 GeV, a hundred times the mass of a proton). Such low thermal velocities allow for the clumping of CDM even on very small scales. Conversely, lighter dark matter particles with masses of the order of keV (around 1/500 the mass of the electron) would be characterized by larger thermal velocities, inhibiting the clumping of DM on mass scales of dwarf galaxies. This would suppress the abundance of dwarf galaxies (and of satellite galaxies) and produce shallow inner density profiles in such objects, naturally matching the observations without the need for a strong feedback from stellar populations."

In other words, they found that the WDM could better account for the early universe as we are seeing it today. Whereas the Lambda-CDM model would result in perturbations in densities in the early universe, the longer FSL of warm dark matter particles would smooth these perturbations out, thus resembling what we see when we look deep into the cosmos to see the universe during the epoch of galaxy formation.

For the sake of their study, which appeared recently in the July 1st issue of The Astrophysical Journal Letters, the research team relied on data obtained from the Hubble Frontier Fields (HFF) program. Taking advantage of improvements made in recent years, they were able to examine the magnitude of particularly faint and distant galaxies.

As Menci explained, this is a relatively new ability which the Hubble Space Telescope would not have been able to do a few years ago:

"Since galaxy formation is deeply affected by the nature of DM on the scale of dwarf galaxies, a powerful tool to constraint DM models is to measure the abundance of low-mass galaxies at early cosmic times (high redshifts z=6-8), the epoch of their formation. This is a challenging task since it implies finding extremely faint objects (absolute magnitudes M_UV=-12 to -13) at very large distances (12-13 billion of light years) even for the Hubble Space Telescope.

"However, the Hubble Frontier Field programme exploits the gravitational lensing produced by foreground galaxy clusters to amplify the light from distant galaxies.

Since the formation of dwarf galaxies is suppressed in WDM models – and the strength of the suppression is larger for lighter DM particles – the high measured abundance of high-redshift dwarf galaxies (~ 3 galaxies per cube Mpc) can provide a lower limit for the WDM particle mass, which is completely independent of the stellar properties of galaxies."

The results they obtained provided strict constraints on dark matter and early galaxy formation, and were thus consistent with what HFF has been seeing. These results could indicate that our failure to detect dark matter so far may have been the result of looking for the wrong kind of particles. But of course, these results are just one step in a larger effort, and will require further testing and confirmation.

Looking ahead, Menci and his colleagues hope to obtain further information from the HFF program, and hopes that future missions will allow them to see if their findings hold up. As already noted, these include infrared astronomy missions, which are expected to "see" more of the early universe by looking beyond the visible spectrum.

"Our results are based on the abundance of high-redshift dwarfs measured in only two fields," he said. "However, the HFF program aims at measuring such abundances in six independent fields. The operation of the James Webb Space Telescope in the near future – with a lensing program analogous to the HFF – will allow us to pin down the possible mechanisms for the production of WDM particles, or to rule out WDM models as alternatives to CDM," he said. "

For almost a century, dark matter has been a pervasive and ellusive mystery, always receding away the moment think we are about to figure it out. But the deeper we look into the known universe (and the farther back in time) the more we are able to learn about the its evolution, and thus see if they accord with our theories. [14]

Researchers present a new model for what dark matter might be

For decades, researchers have tried to detect this invisible dark matter. Several types of devices have been put up on Earth and in space to capture the particles that dark matter is supposed to consist of, and experiments have attempted to create a dark matter particle by colliding ordinary matter particles at very high temperatures.

If such a collision should one day succeed, we would however not be able to directly see the produced dark matter particle. It would immediately pass on and fly away from the detectors - but it will take some energy with it, and this energy loss will be recorded and indicate that a dark particle had been produced.

Despite all these initiatives no dark particle has yet been detected.

"Maybe it's because we have looked after dark particles in a way that will never be able to reveal them. Maybe dark matter is of a different character and needs to be looked for in a different way," says Martin Sloth, associate professor at The Centre for Cosmology and Particle Physics Phenomenology (CP3-Origins), University of Southern Denmark.

Together with his postdoc McCullen Sandora from CP3-Origins and postdoc Mathias Garny from CERN, he now presents a new model for what dark matter might be in the journal Physical Review Letters.

For decades, physicists have been working on the theory that dark matter is light and therefore interacts weakly with ordinary matter. This means that the particles are capable of being produced in colliders. This theory's dark particles are called weakly-interacting massive particles (WIMPs), and they are theorized to have been created in an inconceivably large number shortly after the birth of the universe 13.7 billion years ago.

"But since no experiments have ever seen even a trace of a WIMP, it could be that we should look for a heavier dark particle that interacts only by gravity and thus would be impossible to detect directly," says Martin Sloth.

Sloth and his colleagues call their version of such a heavy particle a PIDM particle (Planckian Interacting Dark Matter).

In their new model, they calculated how the required number of PIDM particles could have been created in the early universe.

"It was possible, if it was extremely hot. To be more precise the temperatures in the early universe must have been the highest possible in the Big Bang theory," says Sloth.

Whether this was the case or not can be tested. He explains further:

"If the universe indeed was as hot as calculated in our model, several gravitational waves from the very early childhood of the universe would have been created. We might be able to find out in the near future."

With this Sloth refers to a number of planned experiments around the world that will be able to detect signals from very early gravitational waves.

"If these experiments do not detect such signals, then our model will be falsified. Thus gravitational waves can be used to test our model," he says.

More than 10 different experiments are planned. They aim to measure the polarization of the cosmic background radiation, either from the ground or with instruments sent up in a balloon or satellite to avoid atmospheric disturbances.

Dark matter and dark energy

27% of the universe is believed to consist of dark matter. Dark matter is thought to be the gravitational "glue" that binds the galaxies together. No one knows what dark matter actually is.

5% the universe consists of known material such as atoms and subatomic particles.

The rest of the universe is believed to consist of dark energy. Dark energy is believed to be responsible for the current rate of the expansion of the universe. [13]

"The Dark-Matter Frequency"--Can the Mysterious Phenomena Be Detected as Sound Waves?

“Call it the sound of dark matter,” says Asimina Arvanitaki, a theoretical particle physicist at Perimeter Institute. Despite making up the vast majority of stuff in our universe, dark matter remains invisible. But perhaps it’s not inaudible. Dark matter is some of the most abundant, yet most elusive, stuff in the universe. Though scientists are confident it is out there (thanks to the gravitational effects it has on its surroundings), the search to identify it has thus far come up empty.

As its name implies, dark matter neither emits nor absorbs light – nor any other electromagnetic radiation that present-day telescopes can detect. But perhaps looking for dark matter isn't the only way to find it. Perhaps we can, in a sense, listen.

Research by Arvanitaki and collaborators, published recently in Physical Review Letters, explores whether dark matter could be a type of wave that resonates, like a guitar string, at a frequency within the range of human hearing.

"It would be a very boring, monotonous tone," Arvanitaki explains. She demonstrates with a baritone "Oooooo."

Arvanitaki is not suggesting we could merely hear the hidden matter of the universe humming away on an otherwise quiet night. Rather, she and her collaborators have explored the possibility that dark matter might take the form of a wave that resonates in the kilohertz range – the frequency audible to us.

It's also possible that the wave could resonate at higher or lower frequencies, such as those audible to dogs or elephants, or not audible to any known ears.

The idea behind the "sound" of dark matter is one that can be tested with existing experimental apparatus at low cost, and could yield illuminating insights into one of the universe's most profound puzzles.

To explore this idea requires reimagining dark matter not as a particle – the most common conception of it – but as a wave. Or a bit of both.

If you pack enough particles – bosons, to be exact – into a given space, they will overlap one another and begin to behave like a classical wave. If you posit a dark matter wave, its amplitude (the distance between its peaks and troughs) is set by the dark matter's density, and its frequency (the number of peaks over a given time) is set by its mass.

The question then becomes how to detect it. Waves come in a huge variety of sizes, from low-frequency radio waves the length of a football field to gamma rays with frequencies the width of atoms. Dark matter waves could conceivably have a frequency anywhere along this enormous spectrum, since we don't know its mass.

There's also the possibility that dark matter is not detectable at all, since the only interaction dark matter is known to have is gravitational; it is under no obligation to interact with us in other ways we can measure.

But in most current models of physics, matter rarely interacts with its environment in just one way. It seems likely the dark matter mingles with its surroundings in at least one way other than gravitationally.

Conveniently, Arvanitaki says, experiments around the world are making measurements that could bear telltale signs of dark matter interactions (even if such experiments were not specifically designed for the dark matter search).

“That’s the cool thing about this,” she says. “We don’t need to prove any new technology. Most of the technologies are there already, and it’s taking advantage of the tools developed for another purpose.”

For example, the team obtained data recorded by AURIGA, a resonant bar gravitational wave detector in Italy, and looked for evidence of dark matter waves within the kilohertz range.

Though the AURIGA experiment was not designed to seek dark matter, the data it collected could, like snippets of a movie lying on the cutting-room floor, reveal a previously hidden narrative.

Perhaps, Arvanitaki and collaborators suggested, the tiny oscillations measured by the experiment can be affected by dark matter waves. In theory, the frequency of those oscillations would be amplified if they were in sync with the frequency of dark matter. Similar effects can happen at everyday scales, such as when London's Millennium Bridge opened in June 2000. It began to sway from side to side "as many pedestrians fell spontaneously into step with the bridge's vibrations, inadvertently amplifying them," according to a paper in Nature.

Arvanitaki and collaborators also explored whether the frequency of oscillations in atomic clocks – the world’s most precise timekeepers – could similarly be used to detect gravitational waves. In this scenario, the oscillation of the dark matter wave would cause a measurable oscillation in the energy levels in the atomic clock.

In their initial investigations, the team saw no evidence in the data. They have only scratched the surface, however, in using these tools to search for dark matter. Experimentalists are currently looking at the AURIGA data for telltale patterns, and atomic clocks can be tuned to cover wider swaths of the parameter space where dark matter may reside (into the 1 Hz range and below).

So while dark matter remains, for now at least, both invisible and silent, Arvanitaki says this new method of hunting for it has just begun. The research so far has made an important step in the process of elimination – another suspect removed from the lineup of dark matter candidates – with more investigation to be done.

The likelihood of finding evidence of dark matter in a very narrow kilohertz range was low – like trying to catch one specific fish in an ocean teeming with life. The big catch is still out there, though, with a vast sea of wave frequencies yet to explore.

“This is the story of experiment,” says Arvanitaki. “You just have to look. Even if you don’t find anything, that doesn’t mean you stop. If you don’t look, you don’t know.” [12]

New fast radio burst discovery finds 'missing matter' in the universe

An international team of scientists using a combination of radio and optical telescopes has for the first time managed to identify the location of a fast radio burst, allowing them to confirm the current cosmological model of the distribution of matter in the universe.

On April 18, 2015, a fast radio burst (FRB) was detected by the Commonwealth Scientific and Industrial Research Organisation (CSIRO)'s 64-m Parkes radio telescope in Australia. An international alert was triggered to follow it up with other telescopes and within a few hours, a number of telescopes around the world were looking for the signal, including CSIRO's Australian Telescope Compact Array (ATCA).

FRBs are mysterious bright radio flashes generally lasting only a few milliseconds. Their origin is still unknown, with a long list of potential phenomena associated with them. FRBs are very difficult to detect; before this discovery only 16 had been detected.

"In the past FRBs have been found by sifting through data months or even years later. By that time it is too late to do follow up observations." says Dr Evan Keane, Project Scientist at the Square Kilometre Array Organisation and the lead scientist behind the study. To remedy this, the team developed their own observing system to detect FRBs within seconds, and to immediately alert other telescopes, when there is still time to search for more evidence in the aftermath of the initial flash.

Thanks to the ATCA's six 22-m dishes and their combined resolution, the team was able to pinpoint the location of the signal with much greater accuracy than has been possible in the past and detected a radio afterglow that lasted for around 6 days before fading away. This afterglow enabled them to pinpoint the location of the FRB about 1000 times more precisely than for previous events.

"The key to this project was the rapid localisation of the FRB and identifying the host galaxy" said Benjamin Stappers, Professor of Astrophysics at The University of Manchester. "Discovering more FRBs will allow us to do even more detailed studies of the missing matter and perhaps even study dark energy. To do this, we are starting projects with arrays of telescopes like eMerlin and MeerKAT, which will allow us to have a localisation directly from the burst itself."

The team then used the National Astronomical Observatory of Japan (NAOJ)'s 8.2-m Subaru optical telescope in Hawaii to look at where the signal came from, and identified an elliptical galaxy some 6 billion light years away. "It's the first time we've been able to identify the host galaxy of an FRB" added Dr Keane. The optical observation also gave them the redshift measurement (the speed at which the galaxy is moving away from us due to the accelerated expansion of the universe), the first time a distance has been determined for an FRB.

FRBs show a frequency-dependent dispersion, a delay in the radio signal caused by how much material it has gone through. "Until now, the dispersion measure is all we had. By also having a distance we can now measure how dense the material is between the point of origin and Earth, and compare that with the current model of the distribution of matter in the universe" explains Dr Simon Johnston, co-author of the study, from CSIRO's Astronomy and Space Science division.
"Essentially this lets us weigh the universe, or at least the normal matter it contains."

In the current model, the universe is believed to be made of 70% dark energy, 25% dark matter and 5% 'ordinary' matter, the matter that makes everything we see.
However, through observations of stars, galaxies and hydrogen, astronomers have only been able to account for about half of the ordinary matter, the rest could not be seen directly and so has been referred to as 'missing'.

"The good news is our observations and the model match, we have found the missing matter" explained Dr Keane. "It's the first time a fast radio burst has been used to conduct a cosmological measurement."

Looking forward, the Square Kilometre Array, with its extreme sensitivity, resolution and wide field of view is expected to be able to detect hundreds of FRBs and to pinpoint their host galaxies. A much larger sample will enable precision measurements of cosmological parameters such as the distribution of matter in the universe, and provide a refined understanding of dark energy. [11]

Scientists Have Found a Way to Interfere With Light to Make Objects Invisible

Before we can get into what a scientific cloak of invisibility is, we must first understand the relationship between light and physical objects. Believe it or not, this relationship is rather simple. For starters, when we look at anything — are it an apple or the car of a passing motorist — what we see boils down to the wavelength of light the object reflects and absorbs.

With, say, the Sun, its white color stems from the fact that it absorbs all wavelengths of light. However, right off the bat, most people would say that the Sun is actually yellow in color (that, however, is a whole other beast). Given this, it’s not silly to ask whether it's possible to take measures that will either obscure an object’s true color, or perhaps make it invisible altogether.

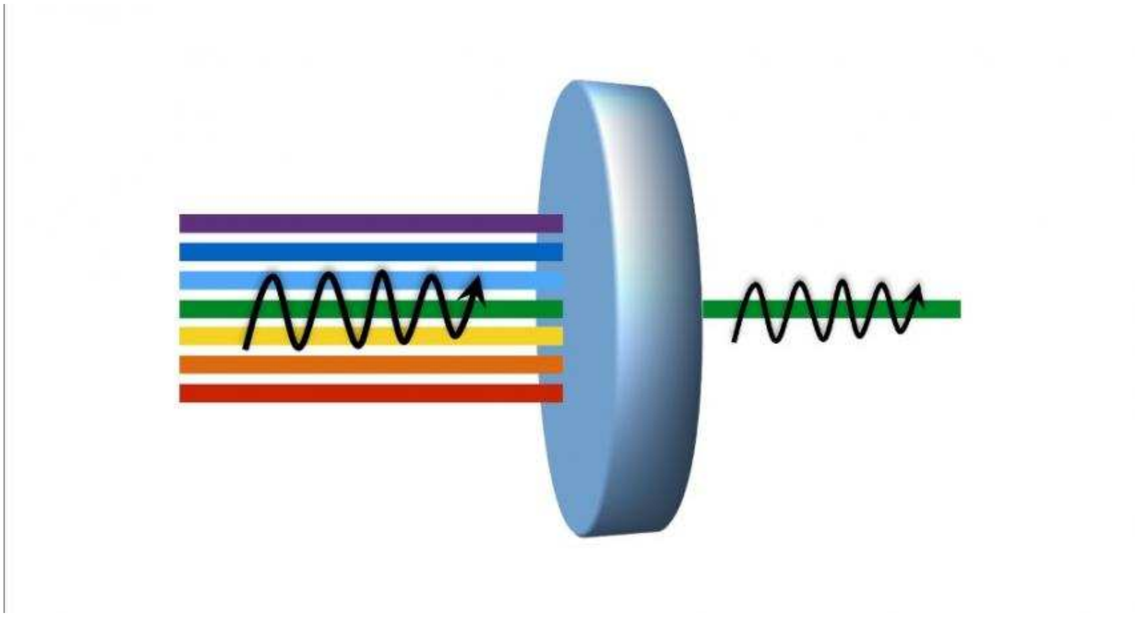
This scenario isn’t nearly as crazy as you might think. In fact, French scientists recently announced they’ve found a way to manipulate light in such a way that a tiny, opaque object looks entirely transparent to the human eye. While it sounds relatively simple on the surface, things are not entirely what they seem.

How Does It Work?

The technique the researchers used stems from quantum effects. As things like Raleigh scattering have taught us, particles of light live a turbulent life, always smashing into this and that on their journey through spacetime. When they do come in contact with molecules and other particles of matter, their constituent parts, called photons, are sent barreling off in another direction at odd angles. More complications arise when we add additional interacting atoms or molecules into the equation. Singles in such an environment are referred to as quantum emitters, and they are hugely important in the budding field of quantum technologies.

Now, when one source of light comes in contact with one emitter, it bounces and incites a change in its electromagnetic field, leading to the scattering photons generating even more complex wave patterns. Then, one must take dipoles — or quantum emitters with a positive and a negative side — into account. This feature, which is the result of the emitter having an uneven distribution of electrons, can have a rather large influence on the electromagnetic field. And the electromagnetic field of all emitters in question is important (as phys.org notes, the electromagnetic field experienced by an emitter depends not only on the light beam striking its surface, but also on all of the electromagnetic fields radiated by all of its neighbors, which in turn are affected by the emitter in question).

Ultimately, this often breeds something called dipole-dipole interactions; a combination of things known to scatter light more intensely, and, as these researchers have demonstrated, the effect can also be used to manipulate the way in which light reflects from a surface.



A quantum emitter (represented as the blue disk) interacts with an electromagnetic field. Physicists have learned that dipole-dipole interactions in said quantum emitters can be manipulated to make opaque objects look transparent (Image Credit: Puthumpally-Joseph, et al, American Physical Society)

More specifically, the researchers use a new technique called DIET (dipole-induced electromagnetic transparency) to prevent light from bouncing off a surface, and reflecting back the given wavelength, which essentially make the object transparent at visible wavelengths.

“The significance of our work is in the discovery of a very neat phenomenon (dipole-induced electromagnetic transparency [DIET]), which may be used to control light propagation in optically active media,” coauthor Eric Charron, Professor at the University of Paris-Sud in Orsay, France, told Phys.org in October. “We showed how light scattering by a nanometric size system, collectively responding through strongly coupled two-level atoms/molecules, can be manipulated by altering the material parameters: an otherwise opaque medium can be rendered transparent at any given frequency, by adequately adjusting the relative densities of the atoms/molecules composing it.”

What the Future Holds

The catch is that they’ve yet to replicate their results on an object larger than two atoms across (which is unfathomably small compared to the macro size-scale we are familiar with). However, they believe they are not only well on their way toward making larger molecules essentially invisible, but toward tricking our eyes into believing an object is another color altogether.

Their work also sheds more (proverbial) light on ways we can slow light down drastically, or keep it frozen in place (however, it’s worth mentioning that science has already done both successfully). The former is done by altering the path photons take by manipulating the way in which the particles interact with their medium.

The benefits of this breakthrough are far too numerous to state, but clearly, there is more work to do.

“Currently our goal is to hunt for the observation of DIET in multilevel atomic or molecular systems,” said Charron. “Each emitter will behave as a series of oscillating dipoles, and this is expected to yield a series of transparency windows, thus opening the way for more elaborate and flexible manipulation strategies. We will publish new results on this topic in Arxiv in the next few weeks. Moreover, DIET offers yet another way to slow the light due to strong anomalous dispersion. We thus plan to develop the study of slow light with DIET in the near future, with potential applications for information processing.” [10]

The Big Bang

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

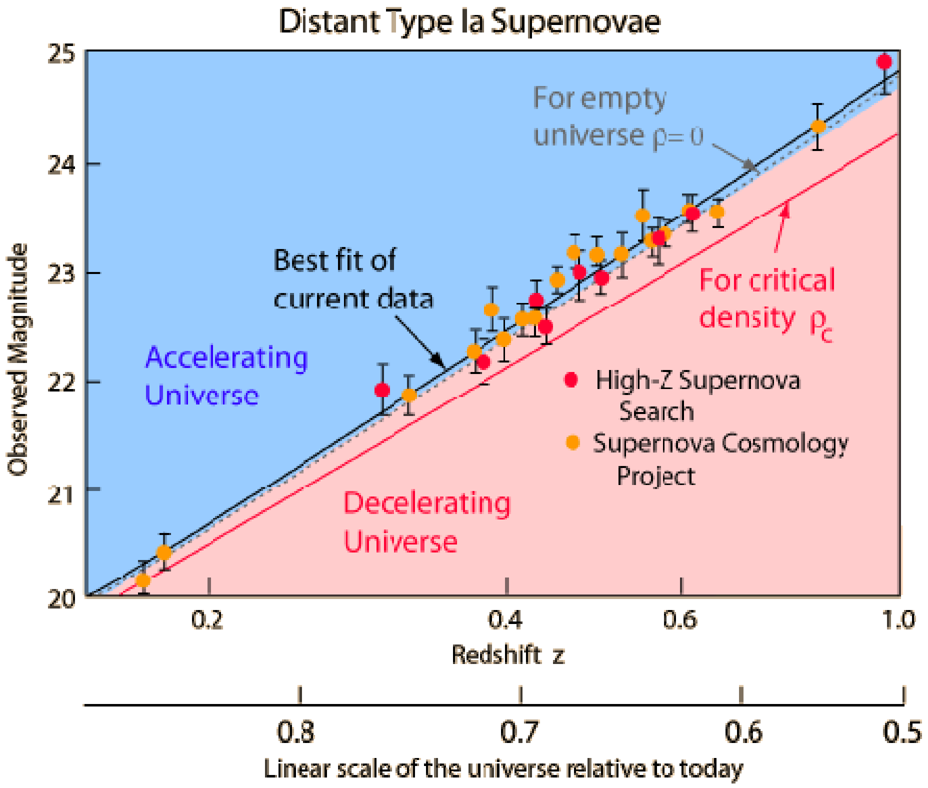
The gravitational force attracting the matter, causing concentration of the matter in a small space and leaving much space with low matter concentration: dark matter and energy.

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

Evidence for an accelerating universe

One of the observational foundations for the big bang model of cosmology was the observed expansion of the universe. [9] Measurement of the expansion rate is a critical part of the study, and it has been found that the expansion rate is very nearly "flat". That is, the universe is very close to the critical density, above which it would slow down and collapse inward toward a future "big crunch". One of the great challenges of astronomy and astrophysics is distance measurement over the vast distances of the universe. Since the 1990s it has become apparent that type Ia supernovae offer a unique opportunity for the consistent measurement of distance out to perhaps 1000 Mpc. Measurement at these great distances provided the first data to suggest that the expansion rate of the universe is actually accelerating. That acceleration implies an energy density that acts in opposition to gravity which would cause the expansion to accelerate. This is an energy density which we have not directly detected observationally and it has been given the name "dark energy".

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



The data summarized in the illustration above involve the measurement of the redshifts of the distant supernovae. The observed magnitudes are plotted against the redshift parameter z. Note that there are a number of Type 1a supernovae around z=.6, which with a Hubble constant of 71 km/s/mpc is a distance of about 5 billion light years.

Equation

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

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

where *R* and *g* describe the structure of spacetime, *T* pertains to matter and energy affecting that structure, and *G* and *c* are conversion factors that arise from using traditional units of measurement. When Λ is zero, this reduces to the original field equation of general relativity. When *T* is zero, the field equation describes empty space (the vacuum).

The cosmological constant has the same effect as an intrinsic energy density of the vacuum, ρ_{vac} (and an associated pressure). In this context it is commonly moved onto the right-hand side of the equation, and defined with a proportionality factor of 8π: $\Lambda = 8\pi\rho_{\text{vac}}$, 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

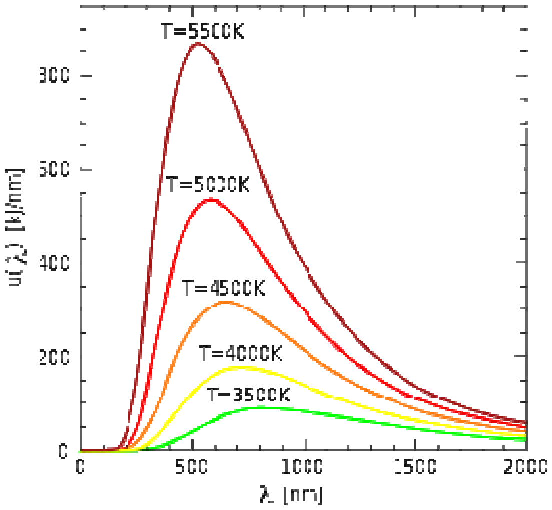
Dark matter is a type of matter hypothesized in astronomy and cosmology to account for a large part of the mass that appears to be missing from the universe. Dark matter cannot be seen directly with telescopes; evidently it neither emits nor absorbs light or other electromagnetic radiation at any significant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

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Electron – Proton mass rate

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

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

Gravity from the point of view of quantum physics

The Gravitational force

The gravitational attractive force is basically a magnetic force.

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

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

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

The mass as seen before a result of the diffraction, for example the proton – electron mass rate 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

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]

References

[1] 3 Dimensional String Theory

Author: George Rajna

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

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

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

[3] Higgs Field and Quantum Gravity

Author: George Rajna

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

[4] The Magnetic field of the Electric current

Author: George Rajna

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

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

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

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

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

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

[10] http://www.fromquarkstoquasars.com/scientists-have-found-a-way-to-interfere-with-light-to-make-objects-invisible/

[11] New fast radio burst discovery finds 'missing matter' in the universe
http://phys.org/news/2016-02-fast-radio-discovery-universe.html

[12] "The Dark-Matter Frequency"--Can the Mysterious Phenomena Be Detected as Sound Waves?
http://www.dailygalaxy.com/my_weblog/2016/03/the-dark-matter-frequency-can-the-elusive-phenomena-be-detected-as-sound-waves.html

[13] Researchers present a new model for what dark matter might be
http://phys.org/news/2016-03-dark.html

[14] Dark matter—hot or not?
http://phys.org/news/2016-08-dark-matterhot.html