

Gravitational Waves and Dark Matter

A theoretical analysis examines the possibility that the black holes detected by LIGO serve as dark matter. [6]

In a landmark discovery for physics and astronomy, international scientists said Thursday they have glimpsed the first direct evidence of gravitational waves, or ripples in space-time, which Albert Einstein predicted a century ago. [5]

Scientists at the National Institute for Space Research in Brazil say an undiscovered type of matter could be found in neutron stars (illustration shown). Here matter is so dense that it could be 'squashed' into strange matter. This would create an entire 'strange star' - unlike anything we have seen. [4]

The changing acceleration of the electrons explains the created negative electric field of the magnetic induction, the electromagnetic inertia, the changing relativistic mass and the Gravitational Force, giving a Unified Theory of the physical forces. Taking into account the Planck Distribution Law of the electromagnetic oscillators also, we can explain the electron/proton mass rate and the Weak and Strong Interactions.

Contents

Preface.....	2
Synopsis: Gravitational Waves May Hold Dark Matter Secret.....	2
Scientists glimpse Einstein's gravitational waves	3
Wobbling like jelly.....	3
Underground detectors	4
'New era '.....	4
Probing Strange Stars with Advanced Gravitational Wave	5
WHAT IS A NEUTRON STAR?.....	5
Electromagnetic inertia and mass.....	6
Electromagnetic Induction	6
Relativistic change of mass.....	6
The frequency dependence of mass	6
Electron – Proton mass rate	7
The Gravitational force	7

The Graviton	8
The Higgs boson	8
Higgs mechanism	8
What is the Spin?	9
Conclusions	9
References	9

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Preface

Today the most popular enigma is the gravitational force after founding the Higgs boson experimentally. Although the graviton until now is a theoretical particle, its existence is a necessary basis of the Quantum Gravitation and the Theory of Everything.

The electromagnetic origin of mass gives an explanation of the inertia, the relativistic change of mass and also the gravitational force.

Synopsis: Gravitational Waves May Hold Dark Matter Secret

This past summer, the LIGO detectors observed the gravitational-wave signature of two 30-solar-mass black holes spiraling into each other. Such black holes could be abundant in the Universe, so abundant that they could be the missing dark matter. Simeon Bird and colleagues from Johns Hopkins University, Maryland, have explored this possibility by estimating the merger rate of 30-solar-mass black holes playing the role of dark matter. The results are consistent with the rate inferred from LIGO's observations, but more data will be needed to convincingly connect black holes and dark matter.

Dark matter is often considered to consist of microscopic particles, but certain theories of the early Universe predict the formation of black holes that could serve as dark matter constituents. The size of these primordial black holes (PBHs) is severely limited by gravitational lensing surveys that fail to observe these foreground objects, but there is a window for dark matter PBHs in the range from 20 to 100 solar masses.

Bird and colleagues imagined that the Universe is filled with 30-solar-mass PBHs at a density consistent with dark matter models. Making assumptions about the concentration and velocity of dark matter inside galaxies, they then calculated how often these PBHs fly close enough to each other to merge. The predicted merger rate agreed with the estimate by LIGO researchers that mergers of 30-solar-mass black holes should occur 2 to 53 times per year in a gigaparsec-cubed volume—the equivalent of about a billion Milky Way galaxies. However, there are large uncertainties in dark matter models, so more merger observations will be needed to find specific dark matter signals, such as a high fraction of events in small galaxies.

This research is published in Physical Review Letters. [6]

Scientists glimpse Einstein's gravitational waves

When two black holes collided some 1.3 billion years ago, the joining of those two great masses sent forth a wobble that hurtled through space and arrived at Earth on September 14, 2015, when it was picked up by sophisticated instruments, researchers announced.

"Like Galileo first pointing his telescope upward, this new view of the sky will deepen our understanding of the cosmos, and lead to unexpected discoveries," said France Cordova, director of the US National Science Foundation, which funded the work.

The phenomenon was observed by two US-based underground detectors, designed to spot tiny vibrations from passing gravitational waves, a project known as the Laser Interferometer Gravitational-wave Observatory, or LIGO.

It took scientists months to verify their data and put it through a process of peer-review before announcing it on Thursday, marking the culmination of decades of efforts by teams around the world.

"LIGO has ushered in the birth of an entirely new field of astrophysics," said Cordova.

Gravitational waves are a measure of strain in space, an effect of the motion of large masses that stretches the fabric of space-time—a way of viewing space and time as a single, interweaved continuum.

They travel at the speed of light and cannot be stopped or blocked by anything.

Einstein said space-time could be compared to a net, bowing under the weight of an object. Gravitational waves would be like ripples that emanate from a pebble thrown in a pond.

While scientists have previously been able to calculate gravitational waves, they had never before seen one directly.

Wobbling like jelly

According to the Massachusetts Institute of Technology's (MIT) David Shoemaker, the leader of the LIGO team, it looked just like physicists thought it would.

"The waveform that we can calculate based on Einstein's theory of 1916 matches exactly what we observed in 2015," David Shoemaker, the leader of the LIGO team, told AFP.

"It looked like a chirp, it looked at something that started at low frequencies—for us low frequencies means 20 or 30 hertz, that's like the lowest note on a bass guitar, sweeping very rapidly up over just a fraction of a second... up to 150 hertz or so, sort of near middle C on a piano."

The chirp "corresponded to the orbit of these two black holes getting smaller and smaller, and the speed of the two objects going faster and faster until the two became a single object," he explained.

"And then right at the end of this waveform, we see the wobbling of the final black hole as if it were made of jelly as it settled into a static state."

Underground detectors

The L-shaped LIGO detectors—each about 1.5 kilometers (four kilometers) long—were conceived and built by researchers at MIT and Caltech.

One is located in Hanford, Washington, and the other is in Livingston, Louisiana.

A third detector, called VIRGO, is scheduled to open in Italy later this year.

Tuck Stebbins, head of the gravitational astrophysics laboratory at NASA's Goddard Spaceflight Center, described the detectors as the "most complex machines humans have ever built."

Both LIGO and VIRGO have undergone major upgrades in recent years.

Physicist Benoit Mours of France's National Center for Scientific Research (CNRS), which is leading the VIRGO team along with Italian colleagues, described the discovery as "historic" because it "allows us to directly verify one of the predictions of the theory of general relativity."

Physicists said the gravitational wave detected at 1651 GMT on September 14 originated in the last fraction of a second before the fusion of two black holes somewhere in the southern sky, though they can't say precisely where.

Einstein had predicted such a phenomenon would occur when two black holes collided, but it had never before been observed.

An analysis by the MIT and Caltech found that the two black holes joined about 1.3 billion years ago, and their mass was 29-36 times greater than the Sun.

The wave arrived first at the Louisiana detector, then at the Washington instrument 7.1 milliseconds later.

The two instruments are 1,800 miles (3,000 kilometers) apart, and since both made the same reading, scientists consider their discovery confirmed.

'New era'

"Black holes are interesting because they do not give off any light and that is why these particular objects had never been seen before—because all of the astrophysical instruments to date use light," said Shoemaker.

"So this is one of the ways in which this tool is special and unique in the astronomical toolkit."

He said the new data "can really help to explain the formation of galaxies and overall large scale structures of the material in the universe."

Details of the discovery are being published in the journal Physical Review Letters.

Indirect proof of gravitational waves was found in 1974 through the study of a pulsar and a neutron star. Scientists Russell Hulse and Joseph Taylor won the Nobel Prize for physics for that work in 1993.

"Humanity has now another tool for exploring the universe," Stebbins told AFP.

"This is like the perfect outcome. The door is open to new discoveries," he added.

"This is a new era in astrophysics." [5]

Probing Strange Stars with Advanced Gravitational Wave

The only known way to find strange matter at the moment would be to confirm its existence within neutron stars. On Earth, it is currently impossible to directly observe strange matter, even in places like the Large Hadron Collider at Cern in Switzerland. Pictured is the Large Hadron Collider Beauty experiment (LHCb).

'As its name says, a neutron star is a star made up of neutrons - which are made up of two down and one up quarks,' Dr Moraes continued.

'It is a star of very high density and rapid rotation rate. Most of them have masses close to 1.3-1.4 solar masses.'

Most matter we see comes in two 'flavours', made up of just two types of fundamental particles - up and down quarks.

WHAT IS A NEUTRON STAR?

When the core of a massive star undergoes gravitational collapse at the end of its life, protons and electrons are literally scrunched together, leaving behind one of nature's most wondrous creations: a neutron star.

Neutron stars cram roughly 1.3 to 2.5 solar masses into a city-sized sphere perhaps 12 miles (20 kilometers) across.

Matter is packed so tightly that a sugar-cube-sized amount of material would weigh more than 1 billion tons, about the same as Mount Everest.

But in these extreme conditions a rare type of three-flavour matter, made of up, down and strange quarks, could be being created.

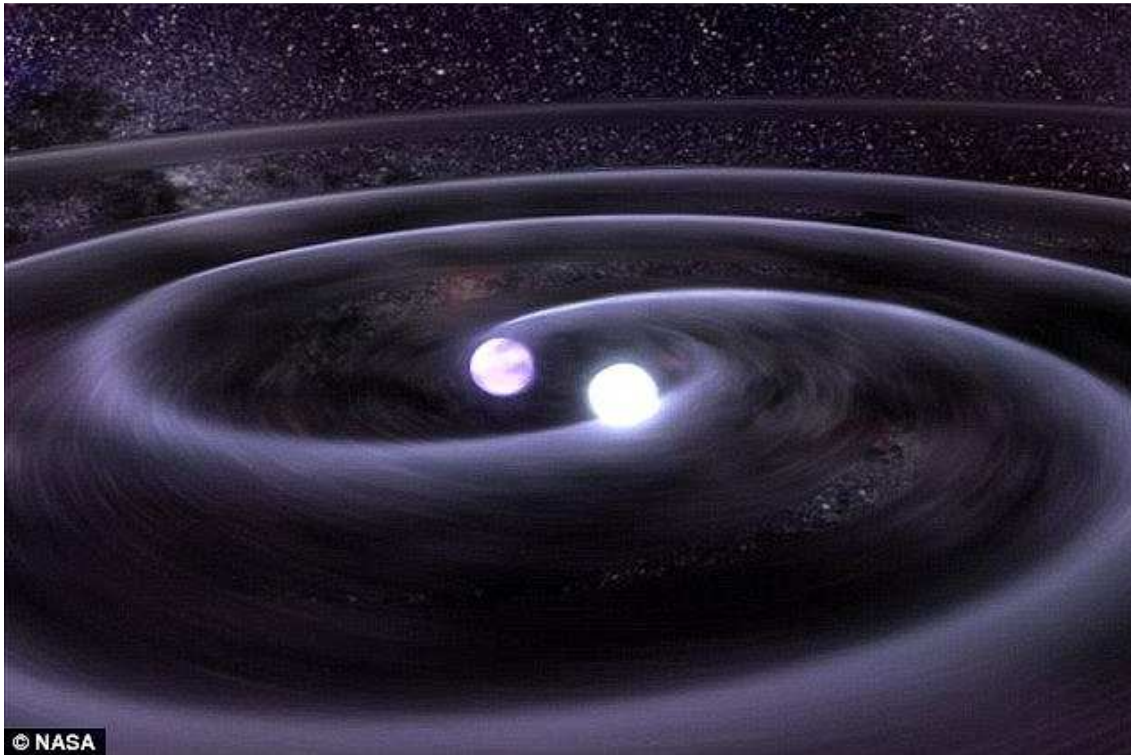
This is what strange matter would be. And Dr Moraes says, if the neutron star is massive enough and rotating at a fast enough speed, the entire star could be made of this matter.

The star would be much smaller and lighter than a neutron star. For example, a neutron star with a mass 0.2 times that of the sun would have a radius greater than nine miles (15km), but a strange star of the same mass would be less than a third the size.

One of the implications of the theory, if true, would be that there might be more types of matter in the universe than we know of.

Dr Moraes says, as we cannot observe individual fundamental particles like quarks on Earth, the only way to prove strange matter's existence would be to spot it in a neutron star.

Interestingly, though, proving that strange stars exist could also provide a detection for one of the 'holy grails' of astronomy - gravitational waves.



Dr Moraes says the interaction of a neutron star and a strange star (illustration shown) could create ripples in space-times, resulting in gravitational waves. These are one of the 'holy grails' of astronomy that have been impossible to detect in other experiments so far. [4]

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

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 frequency dependence of mass

Since $E = h\nu$ and $E = mc^2$, $m = h\nu / c^2$ that is the m depends only on the ν frequency. It means that the mass of the proton and electron are electromagnetic and the result of the electromagnetic induction, caused by the changing acceleration of the spinning and moving charge! It could be that the m_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, their 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.

Electron – Proton mass rate

The Planck distribution law explains the different frequencies of the proton and electron, giving equal intensity to different λ wavelengths! Also since the particles are diffraction patterns they have some closeness to each other – can be seen as a gravitational force. [2]

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

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

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

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

The Big Bang caused acceleration created radial currents of the matter, and since the matter is composed of negative and positive charges, these currents are creating magnetic field and attracting forces between the parallel moving electric currents. This is the gravitational force experienced by the matter, and also the mass is result of the electromagnetic forces between the charged particles. The positive and negative charged currents attract 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 be 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 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. [3]

The Higgs boson

By March 2013, the particle had been proven to behave, interact and decay in many of the expected ways predicted by the Standard Model, and was also tentatively confirmed to have + parity and zero spin, two fundamental criteria of a Higgs boson, making it also the first known scalar particle to be discovered in nature, although a number of other properties were not fully proven and some partial results do not yet precisely match those expected; in some cases data is also still awaited or being analyzed.

In my opinion, the best explanation of the Higgs mechanism for a lay audience is the one invented by David Miller. You can find it here: <http://www.strings.ph.qmul.ac.uk/~jmc/epp/higgs3.html> .

The field must come first. The boson is an excitation of the field. So no field, no excitation. On the other hand in quantum field theory it is difficult to separate the field and the excitations.

The Higgs field is what gives particles their mass.

There is a video that gives an idea as to the Higgs field and the boson. It is here:

<http://www.youtube.com/watch?v=RIg1Vh7uPyw> . Note that this analogy isn't as good as the Miller one, but as is usually the case, if you look at all the analogies you'll get the best understanding of the situation.

Since the Higgs boson is necessary to the W and Z bosons, the dipole change of the Weak interaction and the change in the magnetic effect caused gravitation must be conducted. The Wien law is also important to explain the Weak interaction, since it describes the T_{\max} change and the diffraction patterns change. [2]

Higgs mechanism

The magnetic induction creates a negative electric field, causing an electromagnetic inertia. Probably it is the mysterious Higgs field giving mass to the charged particles? We can think about the photon as an electron-positron pair, they have mass. The neutral particles are built from negative and positive charges, for example the neutron, decaying to proton and electron. The wave – particle duality makes sure that the particles are oscillating and creating magnetic induction as an inertial mass, explaining also the relativistic mass change. Higher frequency creates stronger magnetic induction, smaller frequency results lesser magnetic induction. It seems to me that the magnetic induction is the secret of the Higgs field.

In particle physics, the Higgs mechanism is a kind of mass generation mechanism, a process that gives mass to elementary particles. According to this theory, particles gain mass by interacting with the Higgs field that permeates all space. More precisely, the Higgs mechanism endows gauge bosons in a gauge theory with mass through absorption of Nambu–Goldstone bosons arising in spontaneous symmetry breaking.

The simplest implementation of the mechanism adds an extra Higgs field to the gauge theory. The spontaneous symmetry breaking of the underlying local symmetry triggers conversion of components of this Higgs field to Goldstone bosons which interact with (at least some of) the other fields in the theory, so as to produce mass terms for (at least some of) the gauge bosons. This mechanism may also leave behind elementary scalar (spin-0) particles, known as Higgs bosons.

In the Standard Model, the phrase "Higgs mechanism" refers specifically to the generation of masses for the W^\pm , and Z weak gauge bosons through electroweak symmetry breaking. The Large Hadron Collider at CERN announced results consistent with the Higgs particle on July 4, 2012 but stressed that further testing is needed to confirm the Standard Model.

What is the Spin?

So we know already that the new particle has spin zero or spin two and we could tell which one if we could detect the polarizations of the photons produced. Unfortunately this is difficult and neither ATLAS nor CMS are able to measure polarizations. The only direct and sure way to confirm that the particle is indeed a scalar is to plot the angular distribution of the photons in the rest frame of the centre of mass. A spin zero particles like the Higgs carries no directional information away from the original collision so the distribution will be even in all directions. This test will be possible when a much larger number of events have been observed. In the mean time we can settle for less certain indirect indicators.

Conclusions

The latest theory was proposed by Dr Pedro Moraes and Dr Oswaldo Miranda, both of the National Institute for Space Research in Brazil. They say that some types of neutron stars might be made of a new type of matter called strange matter. What the properties of this matter would be, though, are unknown - but it would likely be a 'liquid' of several types of sub-atomic particles. [4]

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