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MONOGRAPH

DARK MATTER AND DARK ENERGY AND ITS IMPACT IN THE MILKY WAY

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GRATITUDE

First of all I want to thank God for all opportunities he has given me during my whole life, because he is the one who has made everything possible.

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SUMMARY

Since humans appeared on Earth, they have always tried to understand things that surround them, and the vision of the universe is not an exception, that is the reason of the importance for studying the cosmos, we need to understand the space, which is where we live and where we will stay forever. In this monograph work I am going to talk about dark matter and dark energy and how they work, their influences in the Milky Way. It is important to understand these concepts to understand the dynamic of the universe.

As it has been known by years, matter is everything that occupies a place in space, but when we try to put those facts into the space some things change. Matter and energy exists in the Universe but they can also be manifested in different ways. For example, the mysterious dark matter, a matter you know is there but you cannot see. Some scientists have proved its existence by many projects and observation through telescopes, others by making calculations or with statistics comparing the speed of a body or its gravitational

force. Dark matter is a fact but is still unknown for astrophysics and scientists their components or how it works specifically nor it purpose in the universe.

Energy is a very common concept, actually it is used in people everyday life, because is used to do movements or actions. It is known universe is in expansion, and a new discovery says the speed of that expansion is becoming faster every time. When it is analyzed those concepts together in a cosmological way, is found the universe has energy too, but dark energy, as an idea to explain the acceleration of the universe expansion, because is not the normal energy uses in Earth.

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INTRODUCTION

The following monograph work is an investigation about dark matter and dark energy, nowadays a central topic of research in cosmology, is recommendable to learn about these concerns because dark matter and dark energy are important factors and essential components of the universe.

Nowadays is still unknown their origin, consequently the specific study of dark matter and dark energy has a huge significance therefore the aim of these monograph is to acquire a better vision of the dynamic of the universe.

Several has been the authors that have been interested in those affairs such as Eusebio Sánchez in his book "*Los ingredientes secretos Materia oscura, energía oscura y las nuevas ideas sobre el universo"*, Tonatiuh Matos in his book *"¿Dé Qué Está Hecho el Universo? Materia oscura y energía oscura*", the astronomers Miguel Pato, Fabo Iocoo and Gianfranco Bertone, the Nature Physics magazine.

The importance of cosmology started hundreds of millions of years ago when the firsts human beings used to look at the stars and though they were gods and goddesses, then when time were passing by stars started to caught their attention in a deeper way as a result they started to watch them carefully and realized annotations trying to understand how they worked.

This monograph is divided in four chapters: the first one is about dark matter, its definition, proofs of its existence and the most important astronomers that helped with its discovery; the second one, dark energy, its definition, proofs of existence and the most

important theories that helped with its discovery; the third one, the Milky Way, its definition, structure and composition, the Solar system, the Earth, their place in the milky way galaxy and dark matter and dark energy in the milky way galaxy; the fourth one, is a description about an interview with an expert who gave his opinion about the topic addressed and some specific details of the topics he gave.

CHAPTER I

DARK MATTER

1.1 Definition

Nowadays as a society, we have progressed a lot because we have been developed in too many aspects. One of those aspects is science, because of the instruments that we have today to watch and study the space now are more precise than they were in the past and detail us better how is the universe formed. One of the most important or mysterious discoveries, because we don't know exactly how it works, it is Dark Matter.

In the past people used to think that the universe's structure and matter were formed in the same way or with the same elements or atoms that we can find right here on Earth, such as oxygen, nitrogen, carbon, hydrogen, iron, helium, etcetera; now we know that in the past we were wrong, and the rest of the universe is not formed in the same way as the stars, our solar system or ourselves.

According to Tonatiuh Matos in his book: "What the universe is made of: Dark Matter and Dark Energy" all matter we can see just occupies approximately 4% in all the universe. Exists 96% of components that we can not see and we unknown, 74% of it is Dark Energy, and 22% is what we call Dark Matter.

It is called Dark Matter because it does not emit any type of electromagnetic radiation, for instance, the light, so that we can not see it, but we know that it is there because of its gravitational pull force, it has to interact in a very faint way or maybe does not even interact with it so we can understand why we cannot see it nowadays.

> Generally, astronomers and astrophysics separate Dark Matter in two: cold Dark Matter and hot Dark Matter. It is called cold Dark Matter when it stops to interact with the rest of the matter, its kinetic energy is not high and the speed of vibration of its particles are not close to the light speed anymore so its kinetic contribution to the mass is not important at all. On the other hand, it is called hot dark matte when it stops to interact with the rest of the matter, the kinetic movement of its particles is comparable to the light speed, what it means that the contribution of its kinetic movement is comparable to

> its mass in repose. Other scientists defend the idea of the existence of warm Dark Matter which is an intermediate between cold Dark Matter and hot Dark Matter. (Tonatiuh, 2004, p.270-272).

The composition of Dark Matter is still unknown, but many experiments that were executed in Super-Kamio-Kande Japanese laboratory defend that tauon neutrino is the best candidate to be part of its composition, even its particles are too small to be part of all the missing matter, is known is a lot and its particles has to be bigger, they consider neutrinos as part of Dark Matter but in lower percentage.

Dark Matter is an important factor in modern cosmology although it seems unnecessary or worthless in our terrestrial life because its existence would solve some unknowns related to the Big Bang theory, as we know the universe is in an expansion, and without Dark Matter, it will still expanding forever (Big Rip). If the actual hypothesis of Dark Matter is true, depending on how many of it is in the universe the expansion of the universe can stop or maybe turn back causing the Big Crunch.

1.2 Proofs of the existence of Dark Matter

For astronomers and scientists is important and necessary to find something different to the common matter that can form the structure of the universe. To prove the existence of that 'different' component, that we call Dark Matter the first thing that scientists have tried to find are observational evidences, besides wondering if anyone has ever seen anything similar to this kind of matter; and the answer that they have obtained all of them is yes, this evidence was detected a long time ago in galaxy clusters and then in galaxies, but at that time no attention was paid. It is known that in galaxies two forces act, the gravitational force that is caused by all the mass of the stars in the galaxy, and the centrifugal force "force that displace the body by inertia out of the place that it is because gravity and its weigh permit this to happen", caused by rotation of the stars around the galaxies; to make this happens there should be in the galaxy a specific quantity of stars and mass related to the size and gravitational force of it, but many scientists were surprised when they discovered that there was apparently in our galaxy less matter than it should be focused on that theory, because of that they deduce that there should be matter that we can not see but is there to complete or forge the structure of our galaxy, this matter is called Dark Matter.

At the beginning of universe and during the formation of the primordial elements, a bit of deuterium (isotope of hydrogen that has a proton and a neutron in the nucleus) was formed, this isotope cannot be reduced in any way in nature, so all the deuterium that exists between galaxies and stars were formed after the Big Bang. The more deuterium there are, the fewer protons there must be so that it is not mixed with deuterium, but strangely more deuterium than expected was found. The presence of the observed matter and deuterium

cannot be explained unless the existence of any kind of matter that does not interpose in the destruction of deuterium but that can contribute in a gravitational way to the formation of structures.

The rest of ideas about the existence of Dark Matter are based on the following concept: Every single galaxy is enveloped in a spherical halo of matter that extends further than the visible limits of the galactic disk "It is the area of the galaxy where the more quantity of stars, rocks, and planets are accumulated and because of its intense gravity makes the galaxy turn on itself", it was proposed that these halos were made of baryons but after some scientific studies they realized that massive halos were not made of baryonic matter. Even though this theory has been investigated by many international projects in search of baryonic matter, based in a gravitational lens method called microlending. As is known nowadays the light that we normally perceive can be diverted by massive objects when it is passing near them and microlending consists to watch these events, in other words, identify at any luminous point in the space and wait for massive object to pass in that direction, so what we were seeing would be an alteration of light because light would bend as a result of the interference of the massive body, even though that object that was seen was dark, we can detect it because of its gravitational force. Even many massive objects of non-luminous baryonic matter have been detected they are not enough to be considered part of the main components of Dark Matter.

1.3 Most important astronomers that help with its discovery

Between the most important astronomers that help with this discovery we have Jan H. Oort who was a Holland astronomer that in 1932 analyzed the movement of some stars with a certain distance to the disc of Milky Way galaxy and studied how it influenced in stars to determine its mass, for it surprise the mass that he had obtained was twofold bigger than the quantity of visible matter in nebulas, stars, among others, becoming this in the first evidence of the presence of Dark Matter in the galaxies.

Moreover, another important astronomer was Fritz Zwicky, who was Swiss and a physicist too, when he analyzed the speed of some galaxies in the Coma Cluster he realized that a lot of this galaxies were moving too fast, because of this the cluster should disintegrate and as a consequence all the galaxies should go out as a result of its centrifugal force. It was known at that time that the cluster had stable configurations, for this reason, this astronomer concluded that exerts a bigger gravitational force that balance the centrifugal force of the movement of the galaxies around the cluster, consequently the cluster should contain non-luminous matter detected that keep them in balanced.

CHAPTER II

DARK ENERGY

2.1 Definition

We all know that energy is the capacity that a body has to do something, and we can experiment with it every day, for example when we run, dance, jump, walk, etcetera. Scientists have tried over the years to put that knowledge into space, and try to understand the movement of the planets, galaxies, comets, asteroids, among others. Now is known that that kind of force is gravity, but there is something else in all of this, something that today is considered a mystery. It has always been known that the universe started with the Big Bang ''A huge explosion that threw all matter away into the space and during the years formed the galaxies, the planets and different kind of systems'', it is known since thirty years ago that the universe is in expansion, astronomers do not why, but something that is even rarer and unimaginable is that the speed of its expansion is becoming faster every time. Trying to understand this concept, experts have created Dark Energy as an idea we can use to explain that unknown force and energy that makes the speed of the universe's expansion become faster every time.

We have to know that stars live for the fusion between some elements, the most important are hydrogens, that creates helium. The transformation from hydrogen to helium is the reason for the brightness of a star. Helium is a very heavy element and for this reason, when is created it goes and concentrates in the center of the star. They live for the fusion of those elements forming carbon, oxygen, magnesium, silicon, iron, until there is a point they don't have hydrogen anymore and its nucleus is made just by helium, what means that is solid, and because of this, the stars become colder but brilliant and then it dies.

When a star dies, its life ends with a huge explosion that we call supernova, then the mass of the star is reduced; the luminosity in that explosion can be different according to many things, such as its mass, the conditions around the star and their luminosity that let us now the next thing that is going to happen to that dead star.

''If the mass of a star is bigger than a specific limit, it can not become a white dwarf, and as a result of this, it collapses. Is that mass what is called Chandrasekhar limit'' (González, 2011, Visión electrónica, 1(1)). In other words, the star becomes a white dwarf ''stable cold star, maintained by the repulsion due to the principle of exclusion between electrons'' (Stephen, 1998, p.109), if the final mass of it is not bigger than the Chandrasekhar limit. But if the final nucleus mass is bigger than de Chandrasekhar limit it collapses becoming in any of these possibilities a pulsing star, a neutron star or even a black hole.

Two groups of astronomers were studying the light of a supernova in space because they knew that the light of it does not change during many days, after their investigation they knew perfectly the light of that supernova and as a result of this, the distance of it from earth and the speed at which it is moving away from our galaxy. These two groups found independently that the further the galaxies were the less speed of expansion they had, and they realized they were wrong at thinking that the universe expansion was stopping because now we know that the universe expansion is becoming faster. Moreover is that kind of strange force, that accelerates the universe expansion what they called Dark Energy, but astronomers don't know if this expansion is going to spot at some point, because they think that Dark Energy besides as a type of a particular energy, could be another kind of rare matter, because the total mass of the universe has critical density "the matter density of a spatially flat universe" which means there is a lot of different kinds of matter, and as it was mentioned in the previous chapter Dark Energy occupies approximately 74% of the universe total components. It means that if Dark Energy contributes to the total mass of the universe, it can not allow its expansion because contributes to the universe to brake slowly its expansion just for being matter. In other words, Dark Energy is the force that makes the speed of the universe's expansion become faster and maybe in the future slower.

2.2 Proof of the existence of Dark Energy

As it was mentioned before scientists found that more distant supernovae were, less brilliant than they should be, therefore they realized they were further than they thought, which meant the universe was in expansion. Now we know they were right because of all the observational experiments astronomers and astrophysicists have made.

> This mysterious energy has to have a particular and strange property, an opposite force of gravity to counter its effects into the cosmos expansion in large distances and with more capacity of intensity, which causes an accelerated expansion. For this reason, Dark Energy must be very different from any other kind of matter and energy, this includes even Dark Matter. In the first place it does not emit or absorb any kind of electromagnetic radiation, that is why it is called dark. In the second place Dark Matter is something really strange that because of its own naturality exerts a negative pressure, this pressure causes a repulsive gravitational force and with it, the accelerated expansion of the universe. For our biggest surprise, its

> distribution in the universe is equitable and Dark Energy just interacts with matter through the gravity force and in a weak way, that is why its impact can be only appreciated when cosmological distances are studied, in smaller distances, there isn't enough Dark Energy accumulated to be perceived. (Sánchez, 2015, p.345-349)

All these characteristics transform Dark Energy in an exotic, strange and mysterious entity. It is easy to know that it has to be there because of things mentioned in this chapter before, but it is more difficult to take that cosmological concept from space to be done here in labs because its scale of energy would be very little and impossible to recreate, Dark Energy can just be studied observing universe in its entirety.

2.3 Most important theories that help with its discovery.

Dark Energy since its detection has caught the attention of many astronomers that have presented different ideas trying to understand this concept. According to E. Sánchez (2015), every single idea can be classified in any of these four groups: The Cosmological Constant, Quintessence, Modified Gravity Theories and The Rupture of the Cosmological Principle.

It was Albert Einstein who proposed first The Cosmological Constant in 1918 even when Dark Energy had not even appeared yet. His general theory of gravity predicted that the universe is supposed to expand, to regulate the theory with the ideology of that age, he came up with the theory of the cosmological constant as the repulsive force that was the opposite of gravity and that for this reason, the universe stayed static. Years later Edwin Hubble discovered the universe expansion, and Einstein realized he had lost the opportunity to show the world the most brilliant prediction of theories he had never made, the cosmos expansion. The cosmological constant is not an artificial idea after all because nowadays there are two types of forces that scientists use for their experiments, the one that is well-known for all, the gravity, and the second one, the cosmological constant. This last coincide with all of the Dark Energy properties that were mentioned before. Dark Energy according to this theory is a circumstantial property of empty space, and its density is a remarkable characteristic because of being an intrinsic property of space, as it expands more Dark Energy is created.

Unfortunately, the standard model of elementary particles, predicts the quantity of that energy associated with empty space, and when the expected amount of energy is compared with the amount of standard model, we realize that this prediction is wrong, because the equation fails, with the difference of 10120 between both quantities, which means that there is something that is not being considered. This is why it is just a theory because there is

something big that is still unknown and that is not understood, maybe in elementary particles theory or in cosmology.

There is an alternative theory of the cosmological constant, Quintessence, which understands Dark Energy in a completely different manner, as an area extended in the whole universe, and which its properties can be changing with time, this explains why it wasn't detected until 20 years ago, because it was absent at the beginning of all, but gradually became a dominant component of the universe allowing people to study it. Above all, this is just a theory because there is no proof of it, but what this theory defends, differently from The Cosmological Theory is that in the following billion years, the expansion of the universe will become even faster than now and this process will continue forever, which means that galaxies, stars, solar systems, nebulas are going to be separated one from each other, and as a result they couldn't be observed by any modern telescope because they were too far to be watched, consequently the repulsive force would increase to destroy galaxies themselves, making stars wander in cosmos, causing the known Big Rip.

There is another theory that tries to understand the concept of the accelerated universe expansion, this theory is called Modified Gravity Theories, it considers that Albert Einstein's general theory of relativity is right with the gravity force and its aim is to expand this theory without the strange concept of Dark Energy. It is very difficult to understand how the dynamic of the universe works ignoring the idea of the existence of Dark Energy, but what this theory holds to counter it, according to E. Sánchez (2015) ''is that maybe huge distances that cosmology studies have a different intensity to what general relativity predicts with gravity, therefore, distant objects feel a distinct gravity, and the accelerated expansion didn't work because of the repulsive force exerted for an agent such as Dark Energy, but because the gravity force interacts different in objects that are relatively near than the ones that are located too far''.

The last theory that tries to explain the increase of speed in the acceleration expansion is The Rupture of the Cosmological Principle, first of all, scientists have described through the years the Big Bang theory in three strong principles, the first one, the cosmic inflation, which talks about the beginning of the universe when the explosion occurred. Therefore, matter had been thrown. The second one, the theory of general relativity, which explains the movement of planets by the force of gravity, and the third one and the most important for the theory of Dark Matter, the cosmological principle, according to Eusebio Sánchez in his book ''Los ingredientes secretos'', the cosmological principle affirms that universe is homogeneous and isotropic which means that universe properties are the same apart from the point we observe them, in other words, universe properties are the same in any direction in space we watch. In other words, those characteristics together means that we are not in an especial place in the universe, and that there are not even special places. What this theory presents is that maybe what we interpret as an acceleration is really a rupture of the cosmological principle, if the distribution of matter in the universe were not homogeneous nor isotropic, gravity would be manifested in different ways, depending on the matter that each section of the universe has, because the more matter there are, the more gravity force there'll be. However, for this to happen as it was mentioned we would have to be located in a special place in the universe, such as a place apart from the nucleus of the cosmos or in a

lonely place, which is something very imaginative and fictional. Nowadays with all the technology, we have scientists are sure that humanity is not in an empty place in universe, actually we are in an area full of matter, for this reason this theory has not been validated because more proofs are required. There are still many astronomers that believe in this theory and for this reason it has not been discarded, but with analysis and exploration about space in the following years we will be able to know more about this theory.

CHAPTER III

THE MILKY WAY

3.1 Definition

A galaxy is a huge system formed by millions, billions and trillions of stars, planets, rocks, Dark Energy, Dark Matter, molecular clouds, nebulas, cosmic dust and other celestial objects that remain together as a result of the gravitational interactions. All of them located

in the space in isolation. Every single person has watched at some time in their lives the little tiny brilliant points in the night sky, each of them are very far from Earth but they still look incredible even they seem to be small, all of them are part of a band, because the majority of them are in the same zone with a disk form, an example of what we called a spiral galaxy. If a person goes to the countryside, the beach, the woods or a place where there is no light pollution and see the night sky, it can be appreciated hundred million of stars twinkle, but who watches carefully can realize there is a white stain in there, it is the Milky Way, an spiral galaxy the humans are part of.

3.2 Structure and composition

According to Diego Valencia and Ivanio Puerari in their article ‘‘Estudio de Estructuras Espirales en Modelos de Discos Galácticos’’ the elements of the Milky Way galaxy such as the ones already mentioned at the beginning of the chapter are organized into 3 components: a bulge located in the center of the galaxy, a galactic disk with spiral arms, and a galactic stellar halo which surrounds the galactic disk and the stellar bulge.

> The bulge is assumed to be an oblate, isotropic rotator with a constant M/L ratio. A disk with the same M/L ratio is also included, as is a central black hole. Once the M/L ratio and black hole mass are specified the model makes explicit predictions for the stellar velocity dispersion and gas rotation curve everywhere in the bulge. (Kent, S. M;1992).

The second component is the galactic disk, a flat section in a galaxy that surrounds the bulge in a spiral galaxy, it contains gas and young stars, it can also contains old stars in spiral arms, most of its stars undergoing nearly circular orbits about the galactic center. It can be thin or thick depending on the galaxy but specifically in the Milky Way there is a thick galactic disc with a lot of matter.

The third luminous component of the Galaxy is the stellar halo, comprised of globular clusters and field stars which have high space velocities that can take them far out of the galactic disk. (Belokurov, V; Cambridge U). In other words a stellar halo is an spherical group of stars and globular clusters that surrounds the majority of disk galaxies. According to Swinburne University in its article Stellar Halo, Cosmos just 1% of the mass of a galaxy is concentrated in its halo, and as a consequence of its low luminance halos are difficult to

be watched. Normally the halo has no net rotation and is sustain almost entirely by the velocity dispersion opposing to the thin and thick disk of disk galaxies.

3.3 Solar system, Earth and their place in the Milky Way

Milky Way, as it was mentioned, is composed by several arms, which names are "the Sagittarius arm, the Orion arm, and the Perseus arm" (Vallée, J. P; 1988). According to William McCrea in his article "Ice ages and the Galaxy" the solar system is located near the inner edge of the Orion Arm, in other words it is located in the Milky Way galaxy. The Solar system is a conjunction formed by the sun and celestial objects that orbit around it as a result of its gravity, those planets are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune, with their satellites, asteroids, comets, dust and interstellar gas.

> "Data from spacecraft combined with ground-based observations have revealed a solar system that is more than a collection of planets, satellites, asteroids, comets and dust distributed in some arbitrary fashion: It has an intricate dynamical structure, which can be largely understood by the application of a simple inverse square law of force of its constituent bodies."
>
> (Murray, C. D., & Dermott, S. F;1999)

In other words, to understand the dynamical construction and transformation of the solar system, the qualitative and quantitative effects of the law of universal gravitation must be understood.

On one hand Johannes Kepler, who was an astronomer defined the movement of planets for the action of gravity, his first law says that the orbits that are followed by the planets around the sun are actually ellipsis where the sun occupies one of its focus, the second one says that the movement of planets are not uniform which means that they move faster than normally when they are close to the sun, and the third one says that "the squares of the translation periods (T) of the planets are directly proportional to the cubes of the major semi-axes (a) of the orbits" (Kepler, J; 1609) which means that in an equation $T^2 = a^3$.

On the other hand, "Newton's law of universal gravitation establishes that two masses m1 and m2 are attracted with a force F and are directly proportional to the product of these masses and inversely proportional to the square of the distance d that separates their

centers" (Keesing, R.G., 1998). That is the force that is eject reciprocally between the sun and planets corresponding to what is called weight. If one of those masses is bigger than the other one it can experiment an slightly acceleration that can be depreciated at the first approach describing an elliptical orbit around it. This law predicts rigorously the movement of planets around the sun and their satellites, as is the case of the moon. Newton realized the force that makes an apple to fall as a result of the terrestrial attraction is the same that holds the moon in its orbit around the Earth. The most important fact is that the moon has the appropriate speed v and is moving in the right direction surrounding the planet to be permanently falling.

3.4 Dark Matter and Dark Energy in the Milky Way Galaxy

At this moment Dark Matter and Dark Energy, their possible effects, their origin, and their own existence is a central theme in modern cosmology.

As it was mentioned before, Dark Matter has been detected through the universe in galaxy clusters, dwarfs and spiral galaxies and in cosmological scales.

"It has been historically difficult to pin down the Dark Matter contribution to the total mass density in the Milky Way, particularly in the innermost regions of the Galaxy and in the solar neighborhood" (Iocco, F., Pato, M., & Bertone, G; 2015). In other words, this mysterious matter inhabited in the Milky Way and is well-known that is present in the outer galaxy but until knowing has been difficult to define its existence in the Solar System and in the internal sections of the Milky Way.

A recent international study leading by astrophysics Miguel Pato, Fabo Iocco and Gianfranco Bertone demonstrates the presence of Dark Matter in the Milky Way. This research has been published in Nature Physic and was guided by Fabio Iocco from the CSIC (Consejo Superior de Investigaciones Científicas) and the Autonomous University of Madrid.

Their research holds that current studies of the Dark Matter density in the inner galaxy can be separated in two groups "Mass modelling, which says that the distribution of Dark Matter is pretended to pursue a model of density inspired by numerical simulations with two or more free parameters whose best-fit values are determined after the dynamic restrictions and local measurements" (Iocco, F., Pato, M., & Bertone, G; 2015)

> "The statistical error on the Dark Matter density in the inner Galaxy and in particular in the solar neighborhood, is in this case very small, of the order of 10%, but this reflects only the strong assumptions made about the distribution of Dark Matter. The Dark Matter density profile is in fact observationally unknown, and the aforementioned classes of profiles are

> inspired by simulations without baryons, whose role is not negligible in the inner Galaxy" (Iocco, F., Pato, M., & Bertone, G., 2015)

Local measurements are based in the analysis and exploration of Dark Matter that can be watched in the solar system and nearby places.

> "These methods can be used to assess the evidence for Dark Matter locally through an estimate of the gravitational potential from the kinematics of stars. However, the value found for the local Dark Matter density is usually compatible with zero, unless one makes strong assumptions about the dynamics of the tracer populations". (Iocco, F., Pato, M., & Bertone, G., 2015)

They showed a report about a correlation between the curve of rotation observed in the galaxy and the curve estimated just with the visible matter. "This fact provides an alternative form to restrict additional contributions of matter to the rotation curve, thus to assume about the existence and abundance of Dark Matter" (Iocco, F., Pato, M., & Bertone, G; 2015). This method was among the first to detect Dark Matter outside the Milky Way and it was thought for long time that it implemented weak restrictions in the inner sections of the Milky Way, combination of a rotation deficient curve data an extensive ambiguity related to the distribution of baryons. They expose that "the latter progress in both fronts allow scientists to get a reliable proof about the existence of Dark Matter inside the inner Milky Way and the solar neighborhood"(Iocco, F., Pato, M., & Bertone, G; 2015).

"The following astronomical observations to measure the exact distribution of Dark Matter in our galaxy with exactitude, this can redefine the comprehension of the evolution and structure of our galaxy and will introduce stronger predictions for the experiments that look for Dark Matter particles. As a result the investigation constitutes a fundamental step forward in the research of Dark Matter"(Pato, M.,2015).

On the other hand astronomers has investigated the consequences of Dark Energy as a "phantom energy" (Caldwell, R. R., Kamionkowski, M., & Weinberg, N. N;2003), in which the total of its pressure and density is contrary.

> "The positive phantom-energy density becomes infinite in finite time, overcoming all other forms of matter, such that the gravitational repulsion rapidly brings our brief epoch of cosmic structure to a close. The phantom

> energy rips apart the Milky Way, solar system, Earth, and ultimately the molecules, atoms, nuclei, and nucleons of which we are composed, before the death of the Universe in a big rip.".(Caldwell, R. R., Kamionkowski, M., & Weinberg, N. N;2003).

Therefore, this is just a theory not a fact than can be proved nowadays. For this to happen millions of years has to pass through, this means that all human beings that live in this age and the following won't be able to appreciate this catastrophe.

CHAPTER IV

INTERVIEW

4.1 Interview applied to an Ecuadorian Astrophysic

This interview was applied to Carlos Briones who is a famous Ecuadorian astronomer to obtain wide responses to extend knowledge about the biggest mysteries in space so in that way acquire a better vision about how the dynamic of universe works.

What is Dark Matter?

Dark Matter is the matter that doesn't emit electromagnetic radiation nor interact with any electromagnetic radiation "It is transparent throughout the electromagnetic spectrum" (Briones, C., 2018).

What is Dark Matter made of?

It is still unknown but it is supposed to be composed by neutrinos "A very small particles such as electrons that are moving close to the speed light and that slightly interact with universe" (Briones, C., 2018).

What does Dark Matter exist for?

Its function in the universe is still unknown (Briones, C., 2018). Its means that astronomers doesn't know exactly the purpose of Dark Matter even though they know it exists.

What causes the Universe expansion?

"The most common hypothesis for the accelerated expansion of the universe is to assume the existence of an exotic type energy called Dark Energy" (Briones, C., 2018). Dark Energy has to exist such as a way to explain the acceleration of the universe expansion.

How can you define Dark Energy?

Dark Energy is a form of energy, present in all space "Produce a pressure that tends to accelerate the expansion of the universe, as a result of a repulsive gravitational force. (Briones, C., 2018).

Do you think this could be found in the whole universe, even in our Milky Way?

"Of course because the universe is homogeneous" (Briones, C., 2018). It means that the same particles and components are located in each part of the universe even if we look closer of further.

In what form are Dark Matter and Dark Energy manifested in our Milky Way?

In the redshift spectrum "electromagnetic radiation, normally visible light, which is emitted or reflected from an object, is shifted towards red at the end of the electromagnetic spectrum" (Briones, C., 2018). This means that astronomers have their techniques to be sure that Dark Matter and Dark Energy are real in our Milky Way.

CONCLUSIONS

At the end of this monographic work is concluded that:

- Dark matter is matter that does not emit any type of electromagnetic radiation, for instance, the light, so that we cannot see it, but we know that it is there because of its gravitational pull force which means there are a lot of unknown matter waiting there to be discovered. Therefore there are many things astronomers need to figure out about this topic such as its components.
- Dark energy is a concept experts use to explain the force that makes the speed of the universe expansion becoming faster every time, therefore it can be proved that nor Solar System nor Earth are statics in the Universe, we are all moving even faster every day, this could mean the Big Bang Theory is true, and that speed of expansion is the explosion we are still living, or could mean we are going to be expanding

forever or maybe it will stop at some point and we are going to move in reverse causing the Big Rip, for astronomers these is still unknown.

- There are many proofs of the interactions of dark matter and dark energy in the innermost regions of the milky way and in the solar neighborhood. A recent international study leading by astrophysics Miguel Pato, Fabo Iocco and Gianfranco Bertone demonstrates the presence of dark matter in the Milky Way. This research was published in Nature Physic and was guided by Fabio Iocco from the CSIC (Consejo Superior de Investigaciones Científicas) and the Autonomous University of Madrid. This means dark matter or dark energy are not an idea to explain some unusual behaviors of matter in the universe, there are facts.

RECOMMENDATIONS

At the end of this work it is recommended:

- For astronomic investigations, the use of books instead of the internet due to the reliability of books compared to online articles because of their huge, specific and deep content can be found in book, also the readings about these topics should be careful and concentrated as a result of the difficult level of comprehension of its texts.
- The observations through telescopes to dark matter and dark energy should increase thus more scientists would analyze those objects and establish their own concept making easier the understanding of those facts to the society.
- Every single person should know a little bit about astronomy; schools, or high schools should teach it, because maybe there are students that would be good at it,

or do not know that astronomy is something they like, as a result that they have never had the opportunity to hear or study about this topic.

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