On Maxwell’s Reversed Laws as Root of Magnetic Monopoles in Dark Matter

Russell Bagdoo
rbagdoo@gmail.com
rbagdoo@yahoo.ca

Abstract

According to the Standard Model of cosmology, dark matter is an entity to explain the dynamics of galaxies and structures on a larger scale. Ubiquitous, it represents about 80% of the matter in the universe. Evanescent to the extreme, it resists any attempt at detection, whether by astronomers or particle physicists. We do not know what it consists of and could be very different from what we think. We offer another track to apprehend this deep something that escapes us. The idea is this. To explain dark matter, we conjectured that it is composed of very light or very heavy particles, such as neutrinos and antineutrinos associated with a magnetic charge and that these neutrinos essentially originate from primordial black holes and classical black holes. We therefore assumed that when baryonic matter crosses the event horizon and there is a blackout, Maxwell's laws are reversed, the electric charge turns into a magnetic charge and it is the magnetic current that induces electric current. In the peripheral internal regions of the black hole, the density and temperature of baryonic matter are very high. The particles would undergo a phase transition and behave like magnetic particles. Standard neutrinos become sterile magnetic neutrinos, true magnetic monopoles. Neutrinos cross the horizon (in several ways) outward to form this all-pervading darkness. They would be essential to the formation of galaxies and clusters of galaxies. The model we are sketching indicates that sterile neutrinos associated with a magnetic charge would interact with the weak force via the magnetic fields that shape the cosmos. These neutrinos form the halos that surround galaxies. They receive the energy of magnetic fields from stars of outer galaxies or pulsars and would be related to the distribution of visible and invisible matter. The magnetic energy, converted into kinetic energy, which they receive from magnetic fields could cause gamma-ray glows in the dark.

Keywords: dark matter, event horizon, magnetic monopole, inverted Maxwell’s equations, magneto-electricity, Dirac equation, sterile magnetic neutrino, intermediate black hole, magnetic field, halo, gamma-rays glows.

l Introduction

Dark matter would represent more than 80% of the matter in the universe [1] to constitute about 27% of the total energy density of the observable universe [2], according to cosmological models. It was imagined to explain the cohesion of galaxies and galactic clusters. Because it seems that galaxies are rotating too fast to be gravitationally maintained by the sheer mass of visible matter we observe in these galaxies [3]. Dark matter provides the additional attraction preventing rotating galaxies from ejecting gas and stars from their most external regions.

Swiss astronomer Fritz Zwicky is credited with its discovery in the early 1930s. He spoke about the problem of the missing mass at that time, but astrophysicists did not take this idea seriously. The question came up again in the late 1970s with the advent of radio astronomy and the work of Albert Bosma, in the Netherlands, and Vera Rubin, in the United States. At that time, it was believed that the missing mass was ordinary matter, known as "baryonic", hidden, made mainly of hydrogen, therefore essentially of protons and neutrons [4]. Since all this time, astronomers have come to convince themselves that the luminous continents that we distinguish are distributed in a flattened disk. This flattened distribution of visible baryonic matter would only be the emerged part of a spherical cocoon five times larger made of dark matter that exerts a gravitational influence on ordinary matter, but that does not interact electromagnetically.

The problem is that nothing is known about its nature. This dark matter appears to be a new form of matter never made or detected in the laboratory or in particle accelerators [5]. In fact, to reconcile theory and observation, cosmologists must either change the material content of the universe with dark matter, or change the laws of gravity itself. These two options seem *a priori* equally admissible. However, the hypothesis of an unknown form of matter remains by far the simplest and most conservative.

Supersymmetry was assumed early in the universe, and the neutralino has proven to be the attractive candidate for dark matter. The main goal of the theory of supersymmetry, which is an extension of the Standard Model of particle physics, is to allow a step towards the unification of the strong interaction and the electroweak interaction. It introduces unification between fermions and bosons. If nature is supersymmetric, the sea of quantum particles contains all types of particles that exist in nature, including superpartners. Like neutrinos, superpartner particles would have been created in large numbers in the early universe, while strong and weak electromagnetic forces would have had the same force at a single very high temperature. As the universe expands and cools, these types of particles all disintegrated into lighter particles except the neutralino [6]. The most stable and lightest of the superpartner particles, neutralino, from about 10 to 10,000 GeV, is the main WIMP (weakly interacting massive particles) candidate for dark matter [7]. For direct observation, special experiments such as (CDMS) Cryogenic Dark Matter Search (CDMS) or LHC (Large Hadron Collider) seek to detect the rare impacts of WIMP in terrestrial detectors. For indirect observation, gamma-ray and neutrino telescopes looked for evidence of neutralino annihilation in regions with high dark matter density such as the galactic or solar center. So far, all attempts to detect wimps have failed. The fact is that the supersymmetry theory is not validated. Other avenues are of interest to experimenters, such as axions or sterile neutrinos.

In the article *What Connects Dark Matter and Black Holes* [8] we proposed another track that we continue in this paper. The idea is that dark matter is made up of substances from black holes, including sterile neutrinos associated with a magnetic charge. These neutrinos would not have been created during the big bang as the supersymmetric particles that would have supposedly been created in proportions identical to ordinary particles during the first microseconds of the big bang to evolve separately since. The surprise is that they would come from inside the black holes, from the primordial black holes to the present black holes. We know three species of neutrinos in the universe: it would suffice that a fourth exists, that it has concentrated in halo to completely immerse the galaxies to explain their accelerated rotation and solve suddenly the problem of dark matter. These neutrinos with magnetic charge would be magnetically neutral particles that rarely interact with ordinary matter, except through gravitation and possibly through the interactions of electromagnetic force (via magnetic fields) and weak [9].

Some sterile neutrinos with magnetic charge can have almost no mass, like the standard neutrino, or they can be incredibly heavy. They can be slow and congregate in dense clumps, or they can travel at almost the speed of light in a more or less evenly distributed cloud of matter. Slow sterile neutrinos with magnetic charge can behave like cold dark matter, while those that are light enough to move at speeds slightly below the speed of light are considered hot dark matter. Together, cold and hot sterile neutrinos with magnetic charge can make up most of the missing mass in our universe. Section 2 reveals the inversion of the four laws of Maxwell applied to vacuum which allows changing the electric charge into magnetic charge. We performed the same exercise with the four laws written in a different form in a previous article [8]. This reversal occurs as a result of matter and light energy crossing the black hole's event horizon. There is then a blackout, the "code 137.03" is violated, the charge e is transformed into the charge g, reality becomes inaccessible by light and magnetic monopoles are generated. Section 3 shows that dark matter is made up of neutrinos associated with the magnetic charge that comes from black holes. The cosmological diffuse background indicates a non-baryonic dark matter from the beginning of the universe. From time immemorial, including our own, active black holes would have produced magnetically charged neutrinos. These neutrinos would have proliferated with the intermediate black holes that would be the missing link between stellar black holes and supermassive black holes at the heart of almost all galaxies. Section 4 describes different ways that allow the emission into space of neutrinos associated with the magnetic charge: Hawking effect, thermal radiation, tunneling effect. Fluctuations occur after matter is absorbed by the black hole. Quantum forces behave as if they override gravitational force and trigger particle exits. Section 5 stresses the importance of magnetic fields in relation to the protection and distribution of visible and invisible matter. The energy of the magnetic fields of stars or pulsars acts on the halos around celestial objects. The halos form protective plasma. The energy transmitted to the neutrinos by the winds of magnetic fields can reach a level of result capable of leading to detectable glows. Section 6 finally discusses some of the consequences that follow from this model of sterile magnetic neutrinos.

2 Our theory for dark matter involves the inversion of Maxwell's laws: we find the magnetic charge (pole)

2.1 Violation of "code 137"

We know that the smallest electric charge exists experimentally [8]. With a purely electronic quantum condition, we obtain the value e (in CGS system) given approximately by

$$\hbar c/e^2 = 137.03. \qquad (1)$$

In formal jargon, the observed coupling constant $\boldsymbol{e}$,− the amplitude of emission or absorption of a real photon by a real electron, − is an enigmatic number whose experimental value revolves around $-0{,}08542455$. Instead, most physicists retain the inverse of its square $[(\mathbf{-0,08542455})^{\mathbf{2}}]^{\mathbf{-1}}$, approximately $\mathbf{137,03597}$ with an uncertainty of about 2 on the last digit. This number, which we will call "code 137", is a magic and luminous number given to man by Nature [10]

$$\frac{\boldsymbol{ke^2}}{\boldsymbol{\hbar c}} = \frac{\boldsymbol{ee}}{\boldsymbol{4\pi\varepsilon\hbar c}} = \mathbf{7,297354118 \times 10^{-3}} = \frac{\mathbf{1}}{\mathbf{137{,}03597}} \qquad (2)$$

Paul Dirac demonstrated in 1931 that the existence of magnetic monopoles was compatible with Maxwell's equations in the hypothesis of the quantification of the electrical charge [11]. His theory establishes a connection between the elemental electric charge (that of the electron) and the hypothetical elementary magnetic charge. It showed symmetry between electricity and magnetism, which is still completely foreign to established conceptions.

However, his theory turned out, when it was developed, to establish a connection between the smallest electric charge and the smallest magnetic pole, namely the equation

$$\hbar c/(eg) = 2. \qquad (3)$$

(g : quantum of magnetic pole, corresponding to the charge e).

Instead of finding a purely electronic quantum condition, such as (1), Dirac found reciprocity between electricity and magnetism, a connection between the magnetic pole quantum and the electronic charge. His theory would have the effect of creating a magnetic monopole. There would be symmetry between the pole and the charge.

If the charges and poles are so similar, why hasn't nature provided us with poles? (Poles have not been seen despite careful searches.) However, if poles are found they must have much larger charges than the unit electrical charges found on elementary particles such as the electron. So this universe cannot be completely symmetric between pole and charge on the microscopic level [12].

And if the universe was constructed in such a way that there is no electrical charge, but only magnetic poles not having the same value of pole strength as the fundamental charge strength, so that the left-hand side of equations (1) or (3) no longer corresponds to the experimental value 137 or the theoretical value 2, we think we would be in a total darkness that would have the appearance of a dark matter.

By substituting an elementary electric charge in the expression $\boldsymbol{e^2}$ by $\boldsymbol{g}$ the elementary force of the magnetic pole, the code 137 is violated and we can anticipate obtaining a number where black gives way to light.

$$\frac{\boldsymbol{keg}}{\hbar \boldsymbol{c}} = \frac{\boldsymbol{eg}}{\boldsymbol{4\pi\varepsilon}\hbar \boldsymbol{c}} \neq \mathbf{7,297354118} \times \mathbf{10^{-3}} \neq \frac{\mathbf{1}}{\mathbf{137,03597}} \tag{4}$$

We can imagine that the elements that make up this dark matter would be composed of elements charged magnetically, with electricity and the electric field considered as a relativistic consequence of the magnetic field, which involves reversing Maxwell's laws.

2.2 Inversion of Maxwell's Laws

The experimental dissymmetry of Maxwell's equations with respect to the electric-magnetic duality is related to the fact that the electric field is generated by the usual charges which give it a non-zero divergence, but the magnetic field is always of zero divergence because of the absence of corresponding punctual charge. Experimentally, the only source of the magnetic field comes from the existence of an electric current, that is to say a motion of electric charges.

We display Maxwell's equations as applied to free space, that is, in the absence of any dielectric or magnetic material [13]. The four fundamental equations in electromagnetism are

$$\oint E \cdot dA = \frac{e}{\epsilon_o} \tag{5}$$

$$\oint B \cdot dA = 0 \tag{6}$$

$$\oint E \cdot ds = -\frac{d\Phi_B}{dt} \tag{7}$$

$$\oint B \cdot ds = \mu_o I + \epsilon_o \mu_o \frac{d\Phi_E}{dt} \tag{8}$$

[E:electric field; B: magnetic field; A: closed surface; e: electric charge ($e = Q = q$); g: magnetic charge; Φ_B: magnetic flux; Φ_E: electric flux; ϵ_o: permittivity of space; μ_o: permeability of space; I: conduction current]

The first form of Gauss's law (Eq. 5) relates the electric field to electric charges. For the electrostatic field, whose lines begin and end on charges, it is equivalent to Colomb's law. However, Eq. 5 is a more general statement: the total electric flux through any closed surface equals the net charge inside that surface divided by ϵ_0. This law relates an electric field to the charge distribution that creates it; it also applies to induced electric fields for which the lines are closed loops.

Equation (6), which can be considered Gauss's law in magnetism, states that the net magnetic flux through a closed surface is zero. That is, the number of magnetic field lines that enter a closed volume must equal the number that leave that volume. This implies that magnetic field lines cannot begin or end at any point. If they did, it would mean that isolated magnetic monopoles existed at those points. The fact that isolated magnetic monopoles have not been observed in nature can be taken as a confirmation of Equation (6).

Equation 7 is Faraday's law of induction, which describes the creation of an electric field by a changing magnetic flux. This law states that the electromagnetic field, which is the line integral of the electric field around any closed path, equals the rate of change of magnetic flux through any surface area bounded by that path. One consequence of Faraday's law is the current induced in a conducting loop placed in a time-varying magnetic field. The negative sign of the right member means that the induced electric field is in the opposite sense to that of the integral. According to the Ampère-Maxwell law, a magnetic field is produced by a conduction current I and may also be associated with a changing electric flux.

Equation 8, usually called the Ampere-Maxwell law, is the generalized form of Ampère's law, which describes the creation of a magnetic field by an electric field and electric currents. The line integral of the magnetic field around any closed path is the sum of μ_o times the net current through that path and $\epsilon_o \mu_o$ times the rate of change of electric flux through any surface bounded by that path. The positive sign means that the magnetic field is in the same sense as that of the integral [14].

Assuming there is a magnetic charge (pole) and a magnetic current but no corresponding electrical counterpart, the equations would be asymmetric being fully subject to the magnetic charge. Maxwell's equations then become:

$$\oint B \cdot dA = \frac{g}{\epsilon_o} \quad (9)$$

$$\oint E \cdot dA = 0 \quad (10)$$

$$\oint B \cdot ds = -\frac{d\Phi_E}{dt} \quad (11)$$

$$\oint E \cdot ds = \mu_o I + \epsilon_o \mu_o \frac{d\Phi_B}{dt} \quad (12)$$

The equations are still asymmetrical but no longer subject to the electric charge. Equations 10 and 11 seem to miss something on their right sides. To see exactly what they are missing, we need to explain the meaning of $\nabla \cdot E$, also called divergence of E or simply of div$E$. Let V be a volume surrounded by a surface S in space. $\nabla \cdot E$ integrated on the volume V gives 4π times the total amount of electric charge e contained in V. Similarly, $\nabla \cdot E$ evaluated at point × gives 4π times the electric charge density at ×. Hence, Equation 10 indicates that there is no electric charge at any point in space. Basically, moving charges are equivalent to currents. But because the above reversed Maxwell's equations assume that there is no electric charge in dark matter, there is no electric current J_e on the right side of Equation 11. Equations 9 and 12 seem to have won something on their right sides. This means that $\nabla \cdot B$ integrated on the volume V surrounded by a surface S in space gives 4π times the total quantity of magnetic charge g contained in V. Similarly, $\nabla \cdot B$ evaluated at the point × gives 4π times the density of magnetic charge. As a result, Equation 9 indicates that there is a magnetic charge at any point in space.

Because the Maxwell equations above assume that there is a magnetic charge, there is a magnetic current J_g on the right side of Equation 12. Therefore, the absence of electric charge and the presence of magnetic charge reverse the asymmetry.

In fact, the electrical charge would become a magnetic charge, which would result in an attribution reversal, so that electricity should be considered as a secondary phenomenon whose existence depends on the flow of a magnetic current. The overthrow, in addition to the darkness caused, would in a way make that there would be free magnetic poles when there would be no more free electric charges. Magnetic monopoles would exchange "dark photons".

Note: There is no question of continuing by presenting a critical analysis of the hypothesis of Maxwell's "inverted" laws, because these must not be considered in an absolute sense, as if the nature of dark matter had to conform precisely to these laws. It is only a simplistic schema of reality, a kind of approximation, an image. As such, it corresponds to reality, even if it does not identify with reality.

Having the “inverted” Maxwell's laws we must expect the conservation of “magnetic charges”. Effectively, if there are magnetic charges, generally called poles, those poles would provide a source of magnetic field just as an electric charge provides a source of electric field. Magnetic poles would have properties analogous to those of electric charges. Each pole would emit $4\pi g$ lines of magnetic field B, where g is the strength of the pole (corresponding to the charge e). If charges and poles were similar and symmetric in principle, we could have a universe made of protons, which have no electric charge but hold a unit magnetic pole strength, and electrons with no charge but with an opposite magnetic pole strength.

We could observe that magnetic charge is conserved; the net charge, or the amount of positive pole minus the amount of negative pole, will be conserved. Like the electric charge is conserved, the net charge, or the amount of positive charge minus the amount of negative charge, will be conserved in an isolated system

However, if there are monopoles, and modern unified theories of elementary particles suggest that very heavy monopoles may exist, they must have much larger charges than the electrical charges found on elementary particles such as the electron. So this universe cannot be completely symmetric between pole and charge on the microscopic level.

2.3 Magnetoelectric Force

The inversion that we have just presented shows that there would be a dark magnetoelectric force (ME) with a dark photonic wave, just as there is an electromagnetic force (EM) with a photonic wave. Dirac's theory ensures that the magnetic monopole can coexist with an electric charge in ordinary matter. Maxwell's laws are not reversed, they are completed in order to obtain a perfect symmetry: $E \neq 0$, $B \neq 0$. According to our hypothesis of the inversion of the laws of Maxwell, the magnetic charge would replace the electric charge: $E = 0$, $B \neq 0$. There would only be a magnetic charge, which evicted the electrical charge.

We suggest the existence of an electric charge (known electric monopole) in ordinary matter and a magnetic charge (unofficial light magnetic monopole) in dark matter. With rare exceptions, there is no coexistence of the two charges in ordinary matter or in dark matter. There would be no electric monopole in dark matter just as there would apparently be no magnetic monopole in ordinary matter.

2.4 Sterile Neutrinos associated “with magnetic charge”

To penetrate the mystery of dark matter, we think that it is a different electromagnetism, a *magnetoelectrology*, with the necessity of qualifying this variant as a "new force". And that it is also a new particle: sterile neutrino associated with magnetic charge.

Physicists know three types of neutrinos. Since the 1970s, many researchers have assumed that there is a fourth type, a "sterile" neutrino, much heavier, but which would interact even less than the others with ordinary matter. Its mass is unknown and could take any value between less than $1\ eV$ and $10^{15}\ GeV$. It is a right chirality neutrino or a left chirality antineutrino that can be added to the standard model and can take part in phenomena such as the mixing of neutrinos.

If this sterile neutrino exists, we further conjecture the existence of a fifth type of neutrino: a sterile neutrino linked to magnetic charge, that would belong to dark matter and that would be a magnetic monopole. The term *sterile magnetic neutrino* (v_g) is used to distinguish it from *sterile neutrino*. They are two hypothetical types of neutrino that do not interact through any of the fundamental interactions of the Standard Model of particle physics except gravity. But while the sterile neutrino is electrically neutral with respect to the charge e, and does not question it, the sterile magnetic neutrino comes from the permutation of the electric charge into a magnetic charge. This *sterile neutrino* would depend on a magnetic charge g that would be undetectable since it is not an integral multiple of the conventional electric charge. According to our conjecture, dark matter would consist of invisible sterile magnetic neutrinos that swarm in the universe and exert a gravitational attraction everywhere [8].

3 Dark Matter constituted of sterile magnetic neutrinos from primordial and classical black holes

3.1 The cosmological diffuse background indicates a non-baryonic dark matter from the beginning of the universe

Thanks to astronomical observations, astrophysicists have come to rule out the baryonic trail for dark matter and conclude that the universe is filled with an unknown substance fundamentally different from anything astronomers have observed with their telescopes, or measured in their laboratories. To understand, you have to go back to the beginnings of the universe, when it was filled with very hot plasma of atomic nuclei and electrons. Photons were trapped because they constantly interacted with charged particles in the plasma. Then around 380,000 years, the temperature, which decreases with the expansion of the universe, became low enough for nuclei and electrons to combine into neutral atoms. The photons were then able to propagate and constitute a radiation still detectable today and rich in information on the primordial universe, the cosmic background radiation. Although the temperature associated with this radiation is globally homogeneous over the entire sky, the *WMAP* and *Planck* satellites have detected small thermal fluctuations, of relative amplitude reaching 10^{-5}. They correspond to more or less dense zones in the primordial plasma. Overdensity areas have attracted more and more matter over time and have given rise to large structures, clusters and galaxies.

However, given the weakness of the initial fluctuations, and if only baryonic matter is taken into account, the build-up effect was not strong and rapid enough to produce the large structures seen today. We know, thanks to primordial nucleosynthesis, that the density of baryonic matter reaches a maximum of 5% of the theoretical critical density which would make the universe globally Euclidean (flat), as the observations suggest. It is therefore necessary to add to the primordial plasma a non-baryonic dark matter [15].

3.2 Dark matter would be made up of sterile neutrinos associated with the magnetic charge issued from black holes

We have imagined a non-baryonic ingredient that does not interact with ordinary matter other than through its gravitational effects, but that helps increase the efficiency of large structure formation: sterile neutrinos with magnetic charge. These would come from black holes, as much from young black holes, including those that are still born today, as from older black holes and very old black holes, said primordial. However, confirmed black holes - stellar black holes and supermassive black holes - would be insufficient to fill these sterile magnetically charged neutrinos [16]. It is necessary to appeal to the primordial black holes: the Hawking black holes appeared in the first second of the universe, and the intermediate massive black holes appeared after the primordial nucleosynthesis which gave birth to the first nuclei of atoms, between about 50 days and 380,000 years old. Note that by primordial epoch, we are not only talking here of the first second of age which united the great interactions, but also of the primordial epoch which followed primordial nucleosynthesis. For the first tens of thousands of years, before recombination, the universe is yet very young, is still in a state of very high energy and temperature, and is still subject to quantum gravity.

3.3 Cosmological reasoning from particles and fluctuations

Prior to recombination, ionized matter was bound to radiation. Radiation can be considered as a set of particles, or a gas of photons. These photons are constantly in collision with the free electrons of the ionized matter. Through these encounters, we can say that they are coupled. This means that whatever can happen to the radiation will also happen to the electrons. On the other hand, as the electrons are charged electrically in a negative way, they also attract the nuclei which are positively charged – it is not as strong a coupling as if each electron were connected to a nucleus inside an atom, but there's still a coupling. Nothing can happen to matter without it also happening to radiation, and vice versa. If, for example, a multiplication of fluctuations causes photons to concentrate in a certain region of the universe, the electrons are forced to follow the radiation.

Abnormal concentrations of matter create black holes. These are subject to the principle of contraction: in order for the black hole to contract, it must lose gravitational energy and, for it to lose it, it must be evacuated. There is no more light to oppose the contraction since by inversion of the laws of electromagnetism the electric charge is transformed into magnetic charge, thus creating neutrinos associated with the magnetic charge. It is the latter who will escape without undergoing any interaction. Their presence will then only translate into what they take with them, a good amount of energy and impulse that escapes observation.

These magnetically charged neutrinos increase the mass of the universe. The formation of black holes is governed by gravitation. The more mass there is in the universe, the faster the concentration of fluctuations. These neutrinos could accentuate these fluctuations. Thus the missing particles would come from the black holes themselves which reject an invisible and undetectable matter, the sterile neutrinos with magnetic charge, true magnetic monopoles.

The fact that this hidden mass is sterile may be of some benefit. Even if in the days of recombination there were concentrations of this massive component, these would not necessarily have left traces on the radiation, unlike ordinary matter which was coupled to radiation. The missing mass or the "dark mass" could very well have been subject to significant fluctuations at the time of the recombination without this leading to the corresponding fluctuations on the radiation, from which we infer that this does not contradict the observations available of cosmological radiation, in which we do not see these fluctuations. The observation problem would thus be solved, as well as that of the nature of this mass [17].

3.4 The mini black holes born less than a second after the Big Bang would have quickly evaporated, leaving a shower of light and sterile magnetic neutrinos

In 1967, Yakov Zeldovich imagined that small black holes may have formed in the early universe. The density was such that small regions could collapse on themselves into black holes without going through the star stage. The size of these primordial black holes is limited by causality: in the first moments of the cosmos, too distant points did not have time to interact; they cannot therefore be included in the collapse of the same region. Thus, a black hole formed some 10^{-21} seconds after the big bang would have a radius of barely one billionth of a millimeter and a maximum mass of the order of 10^{14} kilograms. S. Hawking discovered that black holes evaporate. The mechanism he proposed combines quantum mechanics and gravity. The temperature rises as the black hole loses mass, and therefore energy. When the black hole has lost most of its mass, evaporation gets carried away and the object disappears in a final burst of energetic particles [18].

We claim that they would have evacuated mostly sterile magnetic neutrinos before disappearing into primordial plasma.

In the 1990s, theorists then thought of micro-black holes formed in the first second of the universe, of the order of a nanometer, but weighing a hundredth of the mass of the Moon, except that their evaporation would have been detected by gamma satellites in the 2000s [16].

They too could have disappeared by evacuating sterile neutrinos associated with magnetic charge.

They also thought about the formation of billions of massive primordial black holes, but their influence on the movement of stars has not been seen.

3.5 Formation of Intermediate-mass black hole

In this universe dominated by particle physics, fluctuations could have been created in the beginning which would have the characteristics necessary to play the role of fluctuations pre-intermediate black holes. The intermediate primordial black holes would have been born after primordial nuclear nucleosynthesis, between a few weeks after the big bang and 380,000 years. It is at this time, wrongly considered as non-event by current cosmology, which would be born these monstrous objects of size between 100 and 1 million solar masses. Huge clouds of gas, instead of fragmenting to make stars, would have turned directly into a black hole, under specific circumstances, which would have caused all the gas to fall back towards the center and drag it into a spinning disc.

The nuclear reactions of the condensed gases inside the black holes are still so energetic that a huge flow of sterile magnetic neutrinos is blown out of the black hole by exceeding its gravitational force.

The fluctuations lost some force with the expansion, and then became pre-galactic fluctuations. In vast clouds of gas of the young universe, whose properties were different from today, would have been born extremely massive and very slightly metallic stars (poor in chemical elements other than hydrogen and helium). By collapsing on themselves once their fuel was used up, these stars ejected very little matter and could give rise to black holes of intermediate mass. We can also assume that these stars can merge and create a supermassive star that collapses into a black hole of tens of thousands of solar masses.

These black holes would act as seeds for the formation of the first galaxies and quasars. Their existence is suspected at the centre of dwarf galaxies and globular star clusters. The accretion of matter as well as the absorption of less massive black holes would allow them to quickly attain the characteristics of supermassive black holes [19]. These weigh millions, if not billions, of solar masses. They are found at the center of quasars and massive galaxies less than a billion years after the Big Bang: they were able to acquire such a gigantic mass in such a short time as thanks to the intermediate black holes formed very early in the history of the universe. Thus, the intermediate primordial black holes could be the missing link between the classic black holes of stellar mass and the supermassive black holes [20, 21].

Dark matter is made up of undetectable magnetic neutrinos emanating from all black holes.

3.6 Intermediate primordial black holes linked to dark matter and the formation of galaxies

Sterile magnetic neutrinos from black holes would therefore form a relatively large part of the dark matter. Many astronomers believe that dark matter is mainly made up of intermediate primordial black holes, which is something else. They argue that primordial black hole clusters could solve the so-called dwarf galaxy problem, namely the apparent lack of small satellite galaxies that are theoretically expected to form around massive galaxies such as the Milky Way. Their simulations predict the existence of numerous dark matter minihalos orbiting massive galaxies. Each of these minihalos should house a dwarf galaxy, and there should be hundreds of them surrounding the Milky Way. However, astronomers have found far fewer dwarf galaxies than expected. The galaxy formation simulations also predict a population of galaxies of intermediate size, between dwarfs and massive. Such objects would be large enough to easily form stars and would be easily visible. Nevertheless, they have not been found by astronomers who search the surroundings of the Milky Way. Explanations are given: they would be present, but difficult to detect because too little light; or the simulations would overestimate the number of these dwarf galaxies, because they would not correctly reproduce the influence of ordinary matter on the formation of dwarf galaxies; thousands more are predicted to be detected in orbit around the Milky Way using ultra-sensitive wide-field cameras [21].

Our explanation is that this undetectable dark matter is composed of sterile magnetic neutrinos arising from black holes. Hot hydrogen clouds formed intermediate black holes that blew outward neutrinos associated with magnetic charge. Our interpretation for the missing galaxies, as much dwarf and intermediate, is that massive primordial black holes present in the heart of dwarf or intermediate-sized galaxies would block star formation due to gas accretion and eject formed stars as well as sterile magnetic neutrinos. This is why these galaxies remain invisible for most records.

4 How sterile magnetic neutrinos are evaporated from black holes

4.1 Hawking Effect

In 1974, Stephen Hawking assumed that black holes are not completely black but radiate with a well-defined temperature. Hawking's discovery revealed deep conceptual links between gravity, quantum theory, and thermodynamics. Hawking's inference was that black holes actually emit something. They glow, rather than being completely "black," and in doing so they gradually lose mass. Thus, a black hole isolated in space will actually "evaporate". Hawking's ideas on "black hole evaporation" was a by a major breakthrough in our understanding of nature [22].

4.2 Our conception

However, if we have the impression that the laws of black hole physics are now basically all "known" and that the job of a theoretical physicist is only to explain the observed phenomena in terms of these known laws, we are largely wrong. The fact that general relativity ceases to be relayed by quantum physics and that the conservation laws of the baryon and lepton are violated means that the laws of physics currently known have only a limited scope of validity.

We assume that the creation of quantum particles occurs not only outside the black hole, but also inside, near the event horizon. What is inside a black hole? The singularity theorem assures us that some sort of spacetime singularity will be found inside a black hole. For the type of black hole formed by spherical collapse, this spacetime singularity is all-encompassing in the sense that any observer who enters the black hole will get pulled into it. Must this be the case for all types of black holes? The answer is no. Inside a body collapsing into a black hole, one might subsequently expect to observe the creation of particles

Our aim is, first, to show three methods of emitting particles from inside the black hole to the outside and, second, to claim that these particles form dark matter. Our theoretical investigation of the particle emission process suggests **the black hole as a black body** that emits particles with a characteristic spectrum which depends only on its temperature, the **Hawking effect** (the creation of quantum particles inside and outside the event horizon), and the **quantum tunnel effect**. At first glance, not all theorists will agree, seeing antinomies, categorically opting for blackbody thermal radiation, or Hawking radiation, or quantum tunnel effect. We believe, however, that these different versions are not mutually exclusive [23].

4.3 Thermal radiation from black bodies and from black holes

When Hawking discovered the creation of thermal particles near a black hole, he found that, at late times, the rate of particle "emission' to large distances does *not* drop off to zero but, rather, approaches a steady, nonzero rate. Even more surprising, this steady particle flux has precisely the character of thermal mission. By *thermal emission* we mean the following: If an ordinary body is kept in exact thermodynamic equilibrium at temperature T^0, it will emit particles with a characteristic spectrum that depends only on its temperature, not the detailed nature of the body. Such a body in exact equilibrium is referred to as a *blackbody.* This process of thermal emission of the black body is completely different in character from the process of spontaneous creation of particles near a black hole.

In principle, particles are emitted by a perfect blackbody and when the temperature is extremely high (greater than a billion degrees centigrade) the emission of massive particles will be important and one will observe all species of massive particles. A perfect blackbody at temperatures lower than a billion degrees would also emit the other massless particles, such the neutrino. When the temperature is extremely low (a few degrees centigrade), one will observe only photons, that is, electromagnetic radiation and, presumably, the "graviton" or "quantum of the gravitational field" [23].

The photon picture allows us easily to understand the chief qualitative properties of black-body radiation. First, the principles of statistical mechanics tell us that the typical photon energy is proportional to the temperature ($E = KT^0$), while Einstein's rule tells us that any photon's wavelength is inversely proportional to the photon energy ($\lambda E = hc$). Hence, putting these two rules together, the typical wavelength of photons in black-body radiation is inversely proportional to the temperature ($\lambda KT^0 = hc$). To put it quantitatively, the typical wavelength near which most of the energy of black-body radiation is concentrated is 0.29 centimeters at a temperature of $1^0K(1K - 273.15 = -272.1C^o)$, and proportionally less at higher temperatures [24].

4.4 According to the theory of Relation

We have seen previously in the paper *The Equation of the Universe* [25] that the basic equation of the theory of the Relation is reduced to

$$k\mathrm{e}^2 = \mathrm{M}_{\mathrm{VP}}^2\,\mathrm{t_o c}. \qquad (13)$$

[$k\mathrm{e}^2$ is the electrostatic force between the squared charge of two protons in the same nucleus. The value of Coulomb's constant k is $1/4\pi\varepsilon_o = 8{,}9875 \times 10^9\,\mathrm{Nm^2/coul^2}$. The value of the constant ε_o called vacuum permittivity is $1/4\pi\varepsilon_o = 8{,}9875 \times 10^9\,\mathrm{Nm^2/coul^2}$. The term $\mathrm{M}_{\mathrm{VP}}^2$ represents the squared mass of two protons in a single nucleus subjected to gravitational force. $\mathrm{M_{vp}}$ is the relativized mass of the proton: $\mathrm{M_{op}}/(1 -$

$\mathrm{v}^2/\mathrm{c}^2)^{1/2}$. The term $\mathrm{t_o}$ represents the "irreversible" universal time of the expanding universe which is flowing at the speed of light.]

This equation can also be written

$$(k\mathrm{e}^2 = \mathrm{M}_{\mathrm{VP}}^2\,\mathrm{t_o c} = \mathrm{M}_{\mathrm{VP}}^2\,2\mathrm{GM^o/c^2} = \mathrm{M}_{\mathrm{VP}}^2\;h/\mathrm{m_o c} = \mathrm{M}_{\mathrm{VP}}^2\,hc/KT^o;\quad k\mathrm{e}^2/\mathrm{M}_{\mathrm{VP}}^2 \;=\; hc/KT^o), \tag{14}$$

$$\text{hence } T^o \;= \mathrm{M}_{\mathrm{VP}}^2\,hc/k\mathrm{e}^2K. \tag{15}$$

The temperature T^o is proportional to the quantum gravitational mass ($\mathrm{M}_{\mathrm{VP}}^2$) as well as to the photon mass-energy $\mathrm{m_o}$ ($KT^o = \mathrm{m_o}c^2$).

Note that in this model, the speed of the relativized protons is identified with the estimated speed of the recession of galaxies and that it determines all other variables. We found reasonable to adopt the speed $2/3\mathrm{c}$. Since this is dependent on astronomical observations which are constantly evolving, the speed will be adjusted accordingly.

$$k\mathrm{e}^2 \;= [\mathrm{M_{op}}/(1-\mathrm{v}^2/\mathrm{c}^2)^{1/2}]^2 hc/KT^o \tag{16}$$

$$2.3\times10^{-28}\ \mathrm{kg\,m^3s^{-2}} = (2.2439\times10^{-27}\ \mathrm{kg})^2 hc/KT^o$$

$$T^o = \;[(2.2439\times10^{-27}\ \mathrm{kg})^2\;hc/K] \div 2.3\times10^{-28}\ \mathrm{kg\,m^3s^{-2}} = {\sim}1.3\mathrm{K}$$

Considering π

$$T^o = \;[(2.2439\times10^{-2}\ \ \mathrm{kg})^2\;hc\pi/K] \div 2.3\times10^{-2}\ \ \mathrm{kg\,m^3s^{-2}} = {\sim}4.2\mathrm{K} \tag{17}$$

On the other hand, if we put $k\mathrm{e}^2 = \mathrm{M}_{\mathrm{VP}}^2\,\mathrm{t_o c} = \mathrm{M}_{\mathrm{VP}}^2\,2\mathrm{GM^o/c^2}$, we get

$$k\mathrm{e}^2\mathrm{c}^2/2G = \;\mathrm{M}_{\mathrm{VP}}^2\,\mathrm{M^o} \tag{18}$$

$$(k\mathrm{e}^2/\mathrm{M}_{\mathrm{VP}}^2 \;= 2\mathrm{GM^o/c^2};\quad k\mathrm{e}^2\mathrm{c}^2 = 2G\mathrm{M}_{\mathrm{VP}}^2\,\mathrm{M^o})$$

We see that $\mathrm{M}_{\mathrm{VP}}^2$ transforms into $\mathrm{M^o}$, and vice versa: the quantum gravitational mass is inversely proportional to the classical gravitational mass. The latter is the mass of the black hole, in the expression $2\mathrm{GM^o/c^2}$ of the Schwarzschild radius.

In our opinion, there is more than a merely coincidence between the Hawking thermal emission of the black hole and the thermal radiation of the black body, there is a truly remarkable correspondence, even a deep and fundamental law of nature: the temperature rises when black body or black hole emits radiation.

4.5 Hawking thermal radiation: spontaneous creation of particles near the black hole

The evaporation of the black hole is based on exotic quantum mechanical processes occurring near small (and large) black holes causing the spontaneous creation of particles. S.W. Hawking suggested that small black holes may have been created during the time of the young universe by fluctuations in density, that is, by variations in density from one place to another, which creates the chaotic and turbulent movement of matter and radiation. According to his theory, each black hole loses mass until, reaching Planck's mass, it disappears in a shower of radiation. But this process applies as much to stellar black holes and others as to mini black holes. In fact, he discovered that when quantum mechanics come into play all black holes cease to be perfectly black and radiate minimal amounts of energy.

Quantum field theory indicates particle creation near a rotating black hole. Calculations show that pairs of particles (that is, a particle and its antiparticle) will be spontaneously created in the strong gravitational field outside a rotating black hole. All species of particles will be created (electron-positron pairs, neutrino-antineutrino pairs, photon pairs, and so on), but the more massive the particle the less copiously it will be produced. This quantum particle creation effect was expected to occur only for all rotating black holes. For collapse to a Schwarzschild black hole, one expected no particle creation to occur at late times following the collapse. However, Hawking found thermal particle creation near a nonrotating black hole. Given enough time, they would release, in the form of radiation, all the matter and energy they had ever swallowed. Stellar-mass black holes would take 10^{66} years to evaporate. Supermassive holes, the remnants of long-dead quasars, would take even longer – more than 10^{90} years for the largest discovered in galactic nuclei.

The parameter R_S, known as the Schwarzschild radius, of a body of mass M is defined by $R_S = 2GM/c^2$. The boundary of a black hole is called the event horizon. By definition, once one cross the event horizon and enters a black hole, one can never again go back to the distant part of the space-time where the gravitational field is weak. One the other hand, an observer who remains outside the black hole can never see anything that takes place inside the black hole. The singularity theorem assures that some sort of spacetime singularity will be found inside a black hole, but not everything that enters the black hole must go into the singularity. Roughly speaking, there is a truly infinite amount of spacetime contained within the black hole and, although Hawking's evaporation process is only important to microscopic black holes these days, it turns out that in an ever-expanding universe even the largest holes would eventually be affected [22].

One consequence of the process of black hole formation and evaporation is that it apparently violates the laws of conservation of baryons stating that in any process the total number of baryons minus the total number of antibaryons cannot be changed (same for the leptons). One further consequence is that in the last step of the evaporation process, the dimensional arguments indicate that general relativity breaks down and must be replaced by a quantum theory of gravity.

Particle creation in the vicinity of a black hole results in a flux of particles escaping to large distances. The temperature T^o of the thermal emission in inversely proportional to the mass $\mathrm{M^o}$ of the black hole. Particles are assumed to obey the principles of quantum theory, but the gravitational field that causes the creation of particles is considered a classical (i.e., not quantum) entity described by the general relativity theory. Thus, in the immediate vicinity of the event horizon, the "emission" of a Schwarzschild black hole of mass $\mathrm{M^o}$ turns out to be identical in all points to the thermal emission of a perfect black body at a temperature T^o above the absolute zero given by

$$T^o = hc^3/2G\mathrm{M^o}K \tag{19}$$

$(\mathrm{t_o c} = 2\mathrm{GM^o}/c^2 = \mathrm{h/m_o c} = hc/KT^o\ ;\ 2\mathrm{GM^o}/\mathrm{c}^2 = hc/KT^o;\ \ T^o = hc^3/2G\mathrm{M^o}K)$

The temperature T^o of the thermal emission in inversely proportional to the mass $\mathrm{M^o}$ of the black hole. Let us find the temperature for the Planck mass (Planck mass: $(h\ c\ /G)^{1/2} = 5{,}4 \times 10^{-8} kg$.

$$T^o = hc^3/2GK\ 5{,}4 \times 10^{-8} = \sim 1{,}8 \times 10^{32}\mathrm{K}. \tag{20}$$

It is noted that the mass $\mathrm{M^o}$ decreases when the temperature increases, which is in perfect agreement with the theory of the Relation. Assuming the mass of the universe is about $1{,}55 \times 10^{52} kg$, the temperature will be close to 2,7K.

$$T^o = hc^3/(2GK\ 1{,}55 \times 10^{52} kg)/2.3 \times 10^{-28}\ \mathrm{kg\ m^3 s^{-2}} = \sim 2{,}7\mathrm{K}. \tag{21}$$

Note that in the latter case, we divide by $2.3 \times 10^{-28}\ \mathrm{kg\ m^3 s^{-2}}$ while we do not do it for the first case. This is explained in Relation theory because we have two scales of orders of value for the same equation. In the first case, there is 10^{60} between Planck's mass and the current mass of the universe. In the second case, which concerns radiation, there is 10^{120} (value of the cosmological constant) between the "mass" of the photon which has stretched 10^{60} from Planck's value to settle at $\sim 10^{-68} kg$ $(\mathrm{t_o c} = 2\mathrm{GM^o}/\mathrm{c}^2 = h/mc; m = \sim 10^{-68} kg)$ while in the other direction but for the same time the Planck mass has "swelled" 10^{60} to come the current mass of the universe ($\sim 10^{52} kg$), hence a difference of the order of 10^{120} between radiation and current matter [23].

4.6 Quantum tunnel effect

In quantum mechanics it appears that phenomena prohibited by the laws of classical physics, such as the escape of a particle out of a black hole, have a chance to occur. This chance is small, of course, but nonetheless real. The mechanism responsible for this escape is called *tunnel effect*; it allows a particle to cross a “classic” barrier. By "classical" barrier we mean what would constitute an insurmountable obstacle if only the laws of classical physics were in play.

Just as a neutron star can spontaneously decay and become a black hole, so any piece of matter-energy inside the black hole can undergo a similar evolution, to cross a barrier of potential thanks to the quantum tunnel effect, and thus lose mass in the form of dark energy. But although this dark matter does not have enough energy to jump over the rim of the potential well of the event horizon and end up out of the black hole, it can squeeze through the barrier by means of the tunnel effect.

The important point is that in any case the black hole that comes from the collapse of ordinary matter (white dwarf, neutron star with or without the intervention of gravity) up to the state of black hole, can transform ordinary matter into dark matter, due to the magnetic charge resulting from a reversal of Maxwell’s laws, then evacuates it out of the black hole by the quantum tunnel effect [26].

5 Sterile magnetic neutrino interacts with magnetism and weak force

5.1 Sterile neutrino with magnetic charge receives energy from magnetic fields of stars or pulsars

Magnetic fields have been detected almost everywhere in the universe: planets, stars, galaxies, and the largest webs can cover clusters of galaxies. Although these galactic magnetic field lines are only a billionth of the power of a typical fridge magnet, they more than make up for this shortcoming with their large size.

The Milky Way galaxy has its own magnetic field. It is thousands of times weaker compared to Earth. In a spinning star or accretion disk (gravitational capture of mass), electrons and ions tend to move at different speeds and on different paths. This leads to a separation of electric charges and the appearance of an electric field. According to the law of induction, an electric field generates a magnetic field. The interstellar medium receiving matter from stars, thanks to stellar winds or supernova explosions, would thus acquire a magnetic field. It is possible that these injected star fields could be amplified by a new "dynamo" (a weak magnetic field amplified by the transfer of part of the mechanical energy of a rotating gas) and end up resembling a galactic field. When a galaxy expels interstellar gas, the intergalactic medium could be seeded by these magnetic fields with a dynamo acting as an amplifier to bring their intensity to that seen in galaxy clusters. Astronomers have discovered that the intensities of magnetic fields near supermassive black holes at the center of these galaxies can be as strong as their intense gravitational fields. In general, magnetic forces are only important if the energy density in the magnetic field is of the same order of magnitude as the internal energy of the gas. In fact, the accretion discs surrounding black holes would generate magnetic fields capable of expelling matter from the vicinity to form very energetic outlets called "jets". The latter would also carry magnetic fields to surrounding galaxies and intergalactic space [27].

There appears to be a relationship between the distribution of magnetic fields from baryonic matter and that of dark matter. Such a correlation can make it possible to detect in the cosmos the trace of this dark matter beyond its sole gravitational presence. The idea is to assume that magnetic fields, even if they are distributed diffusely, have areas strong enough that dark matter particles can sometimes interact with weak force [28]. By postulating that dark matter is composed of a neutrino with a positive magnetic charge (pole +) and a neutrino with negative magnetic charge (pole −), then a collision between two of these neutrinos produces a pair of photons or another pair particle-antiparticle, for example an electron and a positron. In the first case, the goal is to look for an excess of photons. However, since dark matter particles are likely to have a low velocity, it is expected that their mutual annihilation will give rise to photons located in a relatively narrow energy band. It is in search of a kind of emission line more or less marked that many astrophysicists devote themselves, but here again, the difficulty is to extract a signal of dark matter from the high-energy "noise" produced by much more conventional astrophysical processes.

On a galactic scale, many researchers believe that X-rays come from conventional sources such as ionized elements, while gamma-rays come from more ordinary sources, such as **pulsars.** Without venturing to assert that the path of sterile magnetic neutrinos is the only right path, we give it as much credit, if not more, than the path of pulsars or that of atomic processes involving phosphorus, sulfur or chlorine highly ionized.

On the outskirts of the Milky Way, there are "ultra-diffuse dwarf galaxies". In other words, galaxies of very small size and very poor in stars, like Eridamus 11. There would be in these dwarf galaxies a thousand times more dark matter than visible matter which constitutes gas and stars. If this dark matter is made of sterile magnetic neutrinos, they must from time to time **be immersed in a magnetic field from stars.** The magnetic charges of the neutrinos then receive kinetic energy from these magnetic fields, which sooner or later leads to the annihilation of these particles and the appearance of an X-ray glow.

In this case, a process of dynamo amplification of magnetic fields may be at work: in early 2020, ESA's XMM-Newton discovered burning gas in the Milky Way halo: gas hiding in the halo reaches much hotter temperatures than previously thought and has a different chemical composition than expected. The halo of the Milky Way (and any galaxy) would contain not one but three different components of hot gas, the hottest of them being a factor ten hotter than previously thought.

Faint gamma-rays have been detected in the heart of the Milky Way or coming from the center of galaxy clusters. This suggests magnetically charged neutrinos which have a low mass (of the order of KeV). A magnetic neutrino can disintegrate spontaneously. The encounter of dark matter with a magnetic field could further accentuate this disintegration. Just as it could cause neutrino-antineutrino collisions.

The light produced by dark matter annihilation is made up of high-energy photons, gamma-rays, whose energy is comparable to the mass of dark matter particles. A greater gamma-ray glow at the heart of the Milky Way could emanate from stronger sterile magnetic neutrinos of the dark matter. In the case of the WIMP hypothesis, this mass is between about ten and ten thousand times the mass of a proton, which corresponds to energy between 10 GeV and 10 TeV.

Even though the annihilation rate in the universe is very low on average, some residual annihilations could occur in areas of the universe with overdensity, such as galactic halos. Astrophysicists have suggested that the radiation produced by annihilation of dark matter can be observed with gamma-ray telescopes, which is an indirect way of proving the existence of dark matter. The latter is larger in galaxy clusters, mainly in the central part of the cluster. In these clusters, there are more stars, and certainly more black holes [19].

We assume that these black holes emitted sterile magnetic neutrinos that form this dominant dark matter.

Astrophysicists have observed that it is near massive celestial objects - white dwarfs, neutron stars, supernova, quasar, pulsar – that dark matter halos are almost nonexistent.
Nevertheless, due to the magnetic charge of sterile neutrinos, one would expect a concentration of halos around these celestial objects which have high density and strong magnetic field. As this is not the case, one could see a fatal danger for the thesis of the magnetic charge associated with sterile neutrinos. This argument is specious because whatever the nature of the dark particles, their low density clouds are immediately absorbed by the gigantic gravitational pull of these ultra-massive celestial objects. And if

we temporarily disregard gravitational attraction, wouldn't the magnetic charge of sterile neutrinos force dark matter to concentrate around these magnetic objects? Certainly not, because the star's magnetic field B, extending over the distance L from the halo, would transfer the gBL fraction of its total energy to sterile magnetic neutrinos relatively to rest. These latter would gain considerable kinetic energy and move apart in one direction or the other. Thus, the magnetic charge of sterile neutrinos could not force dark matter to shape a halo around a dense magnetic object like a neutron star, a pulsar or a magnetar, and that is what is found.

5.2 Sterile magnetic neutrino linked to the protection and distribution of visible and invisible matter

1) The shape of the gravitational field of the Galaxy, related to the distribution of visible and invisible matter, is rather spherical. However, visible matter in the Milky Way, including molecular hydrogen gas, is distributed in a flattened disc. Ordinary matter cannot therefore give the gravitational potential of the Galaxy its sphericity. The dark matter hypothesis is therefore necessary, not only with regard to the sphericity of the gravitational potential of the Milky Way, but also to explain the dynamics of galaxies and structures on a larger scale.

This supposed distribution of dark matter works for a good number of spiral galaxies. Numerical simulations of the formation of galaxies and their dark matter halo show that the latter has a spherical density and inversely proportional to the distance r from the center of the galaxy, that is to say a density profile in $1/r$. Strictly speaking, density does not become infinite at the centre: it is replaced by a small core of constant density. Assuming this dark matter halo with a small core and a $1/r$ profile, we get the right gas velocity profile in some galaxies.

We can imagine that the dark matter halo, which is a hypothetical component of a galaxy that envelops the galactic disk and extends well beyond the visible limits of the galaxy, forms a kind of protective belt like the Van Allen belts. Neutrinos associated with a positive magnetic pole and neutrinos associated with a negative magnetic pole that make up dark matter may be thought to have polarized to shape a dark magnetic field around the galaxy. Winds of dark matter, composed of sterile magnetic neutrinos, arrive from other galaxies. Such winds are plasmas. When these ionized winds, more or less warm, pass through the halo, they are nothing but magnetic poles, positive and negative, cutting lines of force. They are therefore able to produce dark electricity. By trapping the winds of dark matter, the dark magnetic field deflects these energetic magnetic monopoles and protects the galaxy's gaseous atmosphere from destruction. We can also anticipate winds that pass through the halo and add energy that accelerates unpolarized neutrinos near the galaxy. When these magnetically charged particles interact with the hydrogen gases that envelop the galaxy, they transmit their energy and cause the gases to glow.

2) But this distribution of dark matter does not work for a large number of galaxies, especially those with **low-surface**-brightness. Astrophysicists have noticed, since the beginning of the century, a correlation between the size of the core of constant density of dark matter necessary to obtain the good dynamics of rotation of the gas and the size of the baryonic matter disc. In other words, the more diffuse and extensive the galaxy, the larger its core of constant density of dark matter is itself. So there seems to be a direct relationship between the distribution of ordinary matter and that of dark matter. Such a strong correlation is difficult to explain if dark matter and baryonic matter interact only by gravitation or other very weak forces.

To explain the correlation between the core of dark matter and the distribution of ordinary matter, it is necessary a coupling between these two components of matter. As part of our model on sterile magnetic neutrinos, they may be sensitive to ordinary magnetic fields. These galaxies are very diffuse and very few stars form in them; gas predominates, hot gases, such as molecular hydrogen (H_2), which are difficult to observe [15].

For us, these gases can contain a lot of ferromagnetic dust which can interact with sterile magnetic neutrinos in dark matter. We assume that in low-surface-brightness galaxies, the magnetic aspect of baryons and the magnetic aspect of sterile neutrinos issued from black holes attract, harpoon, and exchange energy.

It is this kind of interaction, or cramping (gripping), on the cosmological scale, not foreseen by galactic formation simulations, that explains the direct relationship between the distribution of ordinary matter and that of dark matter. A strong correlation becomes easy to explain if baryonic matter and dark matter interact with the dark magnetic force, and not only through gravity or other weak forces.

3) But to understand the relationship between magnetic fields and sterile neutrinos with magnetic charge, let’s go back to the 1940s, when scientists (H. Alvin, F. Hoyle, Bondy & Gold, etc.) understood that electromagnetic forces must have played an important role in the formation of astronomical systems. Before the existence of a magnetic field in galaxies was proved, the Soviet astronomer V. Dombrovski and his American colleague WA Hiltner independently observed a curious phenomenon: the light of a star, passing through the visual ray, it that is to say, following the line which goes from the star to the eye of an observer, turned out to be polarized, and this all the more so as the ray of light encountered more dark matter on its way. Astrophysicists wondered why this is so. No

matter how dark matter holds light, shouldn't it just weaken it instead of polarize it? The only explanation that specialists could come up with was that the dark matter may have consisted of an accumulation of grains of ferromagnetic dust. Under the effect of the magnetic field, the grains of dust polarized the light [29].

Our explanation is that dark matter consists of an accumulation of sterile magnetic neutrinos tapered like tiny needles. Under the influence of the magnetic field, neutrinos similarly orient themselves in space and polarize light.

5.3 Glows of gamma-rays in the dark: dark matter or pulsars

In 2009, Dan Hooper, theorist at the Fermi National Accelerator Laboratory (Fermilab) in Batavia, Illinois, and his colleague Lisa Goodenough discovered the unexplained glow of gamma-rays while studying data from NASA's Fermi Gamma-ray Space Telescope. An excess of gamma-rays at an energy of 130 GeV in the direction of the galactic center. A difficult explanation to find in the framework of classical astrophysical models, but which echoes models of particle physics called «supersymmetric models». They immediately suggested that this glow that envelops the heart of the galaxy could be evidence of dark matter [30]. The opposite idea is to attribute an astrophysical origin to these high energy photons and to presuppose that they come from a set of individualized sources like pulsars. In 2015, Tracy Slatyer, particle astrophysicist at the Massachusetts Institute of Technology (MIT) at Cambridge, and her colleagues seemed to demonstrate that all the excess of the galactic centre could come from a population of pulsars too weak for Fermi to solve individually, which had the effect of cooling interest in dark matter. However, in 2019, Slatyer and MIT postdoc Rebecca Leane found a problem with the various spatial models or models used to subtract other contributions to gamma-ray flux, reviving hope for a true dark matter signal [31].

Distinguishing between dark matter or ordinary matter requires the ability to map a possible excess of high-energy photons with good angular resolution, but unfortunately the telescopes that might be suitable are among the most myopic. Particle theorists say the excess of the galactic center is likely to remain too ambiguous to be decisively analyzed.

However, more recently, rays of the order of keV have been observed, involving lighter particles. This result was obtained in a hitherto relatively little explored energy band, in the field of the kiloelectrovolt. Between 2014 and 2016, several teams of astrophysicists observed from the center of galaxy clusters an X-ray (gamma) spectral line with an energy of about 3.5 keV. These excess energy have been detected by several X telescopes, the European *XMM-Newton* and then the Japanese *Hitomi*. This precise spectral line does not correspond to anything known and seems very real, that is to say statistically significant. According to Kevork Abazajian, an American physicist who works at the University of California, the only remaining hypothesis to explain the existence of these photons appearing to come from where there is the darkest matter is that they would come from the decay of sterile neutrinos. He considers that all dark matter consists of such sterile 7 keV neutrinos. As they are a bit heavy, they would decay, producing "normal" neutrinos and photons. He demonstrated in an article by what mechanism sterile 7 keV neutrinos can be produced and be at the origin of the unknown gamma lines observed at 3.5 keV, an energy which is said to be half their mass.

Dessert *et al*. tested the hypothesis of an unidentified astronomical X-ray emission line, interpreted as being caused by the decay of a dark matter particle, using observations from the XMM-Newton space telescope (X-ray Multi-Mirror Mission). Analyzing regions of white sky with a total exposure time of about a year, they found no evidence of the predicted line, ruling out the previously proposed dark matter interpretation [32].

5.4 Academic hypothesis

In this section, we do not resist the temptation to address specific equations of possible gamma-ray production, both interstellar and intergalactic, from cosmic neutrino-antineutrino annihilation. These equations are all the more highly speculative as they come from sterile magnetic neutrinos. Nonetheless, they are justified by the importance of finding evidence for the existence of dark matter and sources of gamma-rays [33].

Gamma-rays undergo negligible absorption in most cases of astrophysical interest and travel in straight lines from their sources. In this, they differ from cosmic rays which, being charged particles, see their movements continuously modified by interactions with cosmic magnetic fields. Therefore, much can be learned about the sources and interactions of cosmic rays by studying the spatial and energetic distribution of the γ-rays they produce.

Gamma-ray production from cosmic neutrino-antineutrino annihilation.

Neutrinos and antineutrinos can interact magnetoelectrically and thus annihilate each other to produce gamma-rays (γ-rays). This annihilation can occur in the following ways.

1- A free antineutrino can annihilate with a free neutrino to produce, most often, two γ-rays:

$$\bar{v}_g + v_g \rightarrow \gamma + \gamma \qquad (22)$$

2- A low energy neutrino and antineutrino can first combine to form a positronium-like system, consisting of a neutrino and an antineutrino bound together in an exotic and unstable atom that we will call "antineutrinium" (which we will refer to as with the symbol $\dot{v}$). The system can then annihilate into two, three or more γ-rays (ζ is the number of γ-rays):

$$\bar{v}_g + v_g \to \dot{v}_g \to \zeta\gamma \tag{23}$$

Absorption of gamma-rays by interaction with dark matter

There are two types of interactions to consider here. The first involves the conversion of a γ-ray into a neutrino-antineutrino pair in the magnetostatic field of a charged magnetic particle or a sterile magnetically charged neutrino. If we denote such a charge field by the symbol MCF, such an interaction can be symbolically written as

$$\gamma + MCF \to \bar{v}_g + v_g + MCF \tag{24}$$

The conversion interaction, or production of pairs as it is usually called, has a cross section which involves an additional factor of the fine structure constant, $\alpha = g^2/hc$ (g is a magnetic charge), because it involves an intermediate interaction with a magnetostatic field.

The second type of γ-ray absorption process in matter is the scattering interaction

$$\gamma + v_g \to \gamma + v_g \tag{25}$$

Compton scattering does not eliminate the γ-ray per se, but will in all probability result in the transfer of some of the energy of the γ-ray towards the neutrino, thus absorbing the energy from the γ-ray. For the γ-ray of energy $E_\gamma \ll mc^2$, almost all of the energy of the γ-ray is absorbed, and then we can consider that the γ-ray has "disappeared". The ideal would be to define an "absorption cross section" σ_a, such that

$$\sigma_a = (\Delta E_\gamma / E_\gamma)\sigma_c \tag{26}$$

where ΔE_γ is the average amount of energy transferred from the γ-ray to the neutrino.

In the case of high energy $\bar{v}_g - v_g$ annihilation, reactions of the form

$$\bar{v}_g + v_g \to \ bosons \ \to photons \ + \gamma \tag{27}$$

can be considered, as well as the annihilation of types

$$\bar{v}_g + v_g \to \ \bar{v}_g + v_g + \gamma. \tag{28}$$

6 Conclusion

The existence or nonexistence of dark matter in the universe is a question of importance in the fields of cosmology and particle physics. Since the existence of large amounts of dark matter in the universe was proposed to account for the condensation of matter into galaxies, physicists have found more and more evidence that it is real, but not a only sign of the substance itself. Omnipresent throughout the cosmos and elusive, it has resisted any attempt at detection, whether by astronomers or particle physicists. Far from giving up, they try a lot of things until they find something that works, bearing in mind that the negative results are just as important as the positive ones. For the past 40 years or so, most have agreed that most of the missing mass is not in condensed form (Macho). The commonly held idea since is that much of the dark mass is made up of a non-baryonic substance. In this regard, we have proposed for dark matter the existence of a large quantity of neutrinos and antineutrinos associated with the magnetic charge. And since the existence of this type of sterile magnetic neutrino is inexplicable in the current state of our knowledge, we have altered the laws of known electromagnetism to explain the metamorphosis of electric charge into magnetic charge in the black hole. According to our model, these neutrinos come from black holes: it is not the black holes which constitute the dark matter but mainly the magnetic neutrinos generated by these black holes [8].

Can this model be scientifically proven? We would not be wrong to fear that the research on this question could be mislay with the confusing proliferation of other models, requiring many years of futile work, while searching for something that may, *a priori*, be undetectable. This would join the problem of ether (energy of the vacuum), or the theoretical impasse implied by the hidden variables which must remain forever unobservable within a relativistic theory. However, we believe that the status of dark matter consisting of magnetic neutrinos would be better assessed if compared to quarks in particle physics which also cannot be observed directly, due to their confinement. Let's dream that physics will highlight several predictions that arise from the existence of magnetic neutrinos and will be inexplicable in any theory that does not make this hypothesis.

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