The complete theory of everything: a proposal

Rahula T. R. Latchman
Gemma F. Lopez*

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Abstract

This paper presents a model that bridges the gap between general relativity and quantum mechanics by providing a new understanding of space and time. The core principle of this formulation is impermanence, the fact that energy is never static, which has non-obvious consequences at the quantum level and leads to a formulation of quantum gravity. The results allow for a new interpretation of black holes and a resolution of the black hole information paradox. The model also presents the causes leading to the Big Bang as well as the Universe evolution, offering a new perspective on galaxy formation and a natural explanation to the origin of dark matter, dark energy and the matter-antimatter asymmetry.

*E-mail address: gemma.fernandez.lopez@gmail.com

1 Introduction

Quantum field theory and general relativity have been the solid foundation of modern physics since the beginning of the 20th century. Demonstrating the robustness of their principles by accurate predictions and numerous insights on one side, on another their limitations have also become apparent. Efforts to incorporate the two theories within the context of one framework have not been successful [1, 2, 3]. This is a prerequisite for comprehending situations where the effects of both quantum mechanics and general relativity prove to be important, such as for black holes or at the beginning of the Universe for which a very high mass is concentrated in a small space. The hindrances that past attempts for unification presented, resulted in the quest for a more general theory and a re-examination of the fundamental structures so far accepted. The predominant view is that gravity should be explained within the frame of quantum mechanical principles, i.e., a theory of quantum gravity [4]. Numerous theories have been proposed, amongst the most successful of which are string theory and loop quantum gravity [5, 6, 7].

All theories up to this point have, directly or indirectly, a common fundament: they are described in the context of either a spatial or temporal framework, usually both [8, 9]. In this presentation, we question the very nature of space and time and through analysis demonstrate that they do not accord with a principle that is present at both macroscopic and microscopic levels of energy: impermanence.

It is shown that when impermanence is considered at subtler levels of energy, the conflict between quantum mechanics and general relativity can be resolved.

Understanding gravity beyond the concepts of space and time allows for a new interpretation of black holes and a resolution of the black hole information paradox.

Impermanence has two interrelated aspects that correspond to the arising and disintegration of energy. Quantum gravity is a consequence of the second one. A comprehensive understanding of energy requires also an explanation of the causes leading to its arising, which in this paper is analyzed at both macroscopic and microscopic levels, explaining the factors leading to the Big Bang on one side and the stability of matter on the other side.

The model offers a high degree of completeness as it allows the resolution of open questions such as dark matter, dark energy or the matter-antimatter asymmetry without the need for further assumptions.

2 Space and time

The AdS/CFT correspondence establishes that under certain conditions there is a link between gravity in anti-de Sitter space (AdS) and conformal field theory at its boundary [10]. Considered one of the core principles in string theory, it more generally suggests a possible duality between the gauge fields and gravity.

Using this correspondence, Ryu and Takanayagi showed that a particular definition of entanglement entropy in quantum field theory is equivalent to the Beckenstein-Hawking area law for the black hole entropy [11].

Subsequently, developing upon such principles, Van Raamsdonk expressed entanglement as a function of distance for two boundary regions of AdS and proposed that space is built from quantum entanglement [12].

The idea of space emerging from entanglement has since become an active field of research, at the core of which is the possibility to formulate a theory of quantum gravity. Understanding what the building blocks carrying this information are and how exactly do they generate space is an open question currently under debate.

If one analyses the concept of space in classical physics by critically examining how this is measured, one realizes that a notion of permanence is assumed. This is easy to see in a gedanken experiment between two points A and B where a light pulse is sent by an observer at A and a mirror at B reflects the light back to A; if the observer at A measures the time it took for the light to make a round trip, it can calculate the length between the two points.

This distance is a concept that assumes energy to be static. In actuality, the moment light reaches point B, what we call point A and the energy at this point is no longer the same as when light departed at the beginning of the experiment. To our knowledge, there is so far no mathematical formulation that effectively considers this change. On the contrary, current theories often presuppose the existence of a geometry.

One might argue that the problem is only due to an experimental restriction on the way measurements are performed, and that a more direct measurement could be envisioned at least theoretically, that would quantify the distance between A and B at a given moment.

Here we propose that all spatial constructs are not only based on a mistaken notion of permanence but also that they do not represent an actual property of energy, including the vacuum, as they contradict the fundamental principle of impermanence which this model is based upon. Space is thus a mere theoretical concept.

While it is a valid approximation in the context of classical physics where form is slowly changing, at quantum or subtle levels, energy can only be fully understood when considering impermanence.

Albeit discernible in our ordinary experience, the implications of impermanence at smaller scales are less obvious. It will here become apparent that quantum properties such as entanglement and quantum superposition are a consequence and mutually inclusive to the non-static nature of energy.

Classically, impermanence can be described as the moment to moment change of a given property under analysis. However, this definition has its limitations, and it is ultimately contradictory.

To understand this, we refer back to the example of light traveling between A and B and consider a given moment of time within its trajectory. Since energy cannot be static, it must arise and disintegrate within this time interval. From here we can deduce that trying to understand impermanence by dissecting moments will lead us into an infinite regression because each moment can be divided into smaller segments.

When time is considered within the boundaries of a moment, a notion of permanence is inherent to such an interval. By progressively dividing the moment into smaller components, we are taking away the boundaries from one point to the next, yet we are also affirming infinite smaller, which prevents light from reaching point B.

An alternative mathematical concept is needed that takes into account the fact that there is no unit of time without disintegration and therefore dismisses boundaries, yet not in the context of infinite smaller. Instead, it should allow for an arising that corresponds to complete disintegration by affirming the negation of moments being necessarily bound by time.

The above statement 'affirming the negation of moments' should be considered in the following two ways: firstly, it is stressing the importance of establishing an arising factor, in this case, represented by a moment of time. Although we now understand that just like space moments are only theoretical concepts, they are necessary to gain insights into the fundamental laws of nature. Failing to establish this initial point of analysis will result in a tendency to wrongly conclude that there are no properties that can be attributed to energy or even that there is no arising. Secondly, one is negating moments being bound by time, the separation between moments being merely conceptual. One can alternatively refer to this proposition as 'two points momentless', which has both an affirming (two points or two moments of time) and a negating aspect (momentless).

Summarizing, in this Chapter space and time have been reviewed through a perspective of non-static or impermanent energy and determined to be mere theoretical concepts. The negation of space does not imply that everything is found in the same location or that all things are one and the same. Distinctions can be established relatively and it is precisely because there are distinctions that a relative separation can be defined. Equally, negating moments of time does not imply the non-existence of a continuous arising of energy subject to a law of causality.

This conclusion represents a major conceptual shift from existing models, the consequences of which are the subject of this paper.

3 Energy and Vacuum

In its quest to understand the principles of matter, science searches for its smallest constituents. Different theoretical models propose distinct elementary units upon which fundamental forces can be defined. The Standard Model, for example, lists a set of fundamental particles all of which have been found experimentally. Later models aim at postulating a single elementary unit which should allow for a unified theory.

A fundamental particle can be defined as a partless unit with a given spatial extent. In the frame of this model and because space is only a theoretical notion, fundamental particles must be of the same theoretical nature. They, therefore, cannot represent the impermanent character of energy.

Instead, we propose that all energy is a reality of the vacuum, from which its different aspects arise. For clarity, we will use the terms gross and subtle degrees of energy to refer to the larger and smaller scales of matter, in order to avoid the spatial context that the later terms connote.

Impermanence has two aspects or principles which determine the evolution of subtle and gross degrees of energy, which will be here named generation and cancellation. They correspond to the fact that if energy is non-static, it must arise and disintegrate. These two are interdependent and should not be understood as arising in one moment and disintegrating in a subsequent one, following the discussion in Chapter 1 where isolated moments have been negated.

The generation aspects refer to the necessary factors for the various degrees of energy to arise and be stable. This stability should not be confused with a permanent reality; instead, these are causes upon which the continuous arising of a specific energy such as that of an electron is conditionally kept. Cancellation can be generalized as the tendency to decay into the ground state of the vacuum, a state of perfect annihilation or cancellation between particles and antiparticles.

Space emerging from entanglement

Chapter 2 established the fact that no energy can exist in isolated moments or locations. Consequently, it must arise interdependently or entangled. Space was categorized as merely theoretical. Despite it not representing a continuous arising, a definition of space can be established that facilitates the discussion and understanding of the relationship between gross and subtle degrees of energy.

Note that in the absence of distinctions, space is not measurable and therefore in our context not definable. Such is the case at the ground state of the vacuum, for which complete matter-antimatter annihilation is synonymous to perfect homogeneous conditions. It is, therefore, appropriate to define space concerning the degree of distinction or differentiation in a system, becoming more significant for increasing distinctions.

As a result, one can generally affirm that subtle degrees of energy would generally be closer than grosser ones due to them consisting of more simplistic and therefore of lower distinctions, whereas distances will become larger as energy becomes grosser and more complex.

Complexity can be defined relative to the ground state as the number of computational operations needed to transform the initial state into perfect cancellation. In this case, a decreasing or increasing space would be interpreted as a result of energy becoming more simplistic or more complex, respectively.

To gain clarity on the notion of distinction, we first point out its relation to entanglement in the following manner: if two particles A and B exist in a pure entangled state, it is not possible to assign distinct properties to A and B, only their shared state can be known. As a result, no separation or space can be designated between the particles. As the entanglement between particles decreases, distinctions become definable and their separation increases.

Note that an isolated system of two particles is a theoretical scenario and that a more realistic view must consider their interaction with the environ-

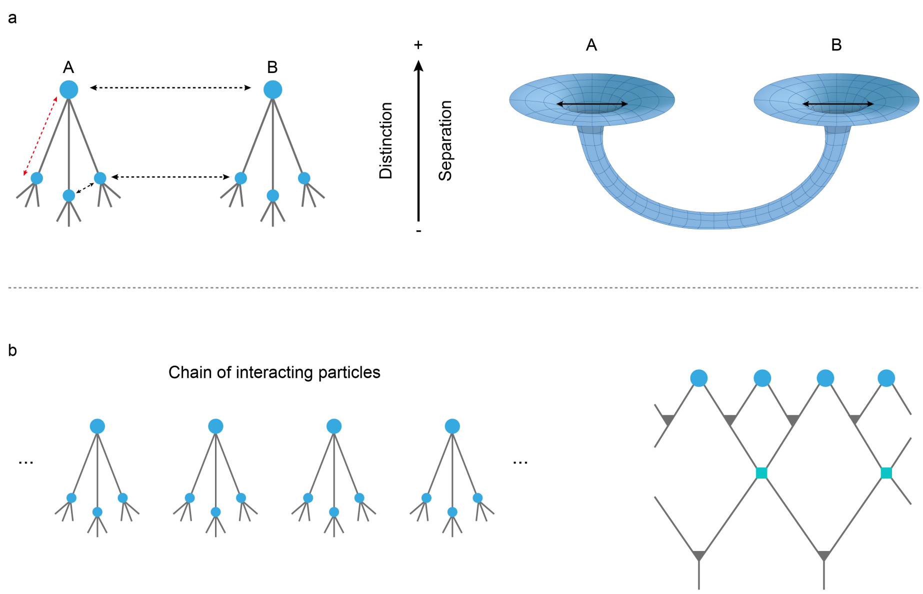

Figure 1: Example of the relationship between gross and subtle degrees of energy (left) and its spatial representation (right) for: a) Two entangled particles A and B and b) a set of interacting particles.

ment. The ground state of the vacuum is, in fact, the only case when space is not definable, which also corresponds to the highest entanglement.

This definition of space, which relation to entanglement has now been established, is particularly relevant when considering the interaction between gross and subtler degrees of energy. Our experimental observations indicate that at subtle levels energy is highly entangled or interrelated and we, therefore, expect comparatively smaller separations.

Generally, the distance between two systems is not absolute and depends on the degrees of energy under consideration.

In 2013, J. Maldacena and L. Susskind proposed that a pair of maximally entangled black holes is equivalent to their interior being connected by a wormhole [22], and suggested that wormholes might connect any entangled pair of particles.

The concept of space presented in this Chapter allows a novel interpretation of wormholes by considering the different gross and subtle degrees forming a system, as shown in Figure 1. In the case of two entangled particles A and B, the neck of the wormhole will correspond to the subtle degrees of energy of both A and B, through which the particles are entangled and for which we expect a lesser separation; the wormhole then becomes broader for grosser levels as the separation increases.

Lastly, we consider a set of strongly interacting particles. Figure 1 depicts the grosser and subtle decomposition of the particles and the corresponding spatial representation. This geometry resembles that of AdS-space and MERA diagrams, where the boundary here represents the grosser degrees of energy, and towards the center, the subtler aspects of energy are found.

The quantum information that is relevant for understanding the apparent space is the relation between gross and subtle degrees of energy within the system. To the question where is this information stored: there is no fundamental particles or entities to which the information can be assigned to; instead it is encoded in the continuous arising.

4 Cyclic cosmology and Second Law of Thermodynamics

Standard cosmological models predict that the Universe should expand uninterruptedly in the future. As evolution takes place, energy eventually becomes more simplistic, decaying into its subtle expressions. Usually, two hypotheses are made: firstly, dark energy is considered to be a cosmological constant that remains positive through the evolution and secondly, the validity of the second law of thermodynamics, which propels change towards higher entropy. The later also extrapolates an extremely low entropy at the beginning of the Universe, a seemingly particular circumstance the cause of which is still an open question. There is also no consensus on the properties that should describe this state.

The ground state of the vacuum is in this model not only the lowest entropic state possible, but it is also natural for it to be the initial state, as all energy is fundamentally vacuum energy.

Theories that assume the Universe starting point to be the vacuum, often postulate that the Big Bang took place as a result of quantum fluctuations [13]. Our presentation is not based on this assumption; in fact, while the

Universe is at the ground state, no fluctuations are initially possible. The reason behind it is that the vacuum has not yet developed a structure that allows for an arising, therefore lacking the energetic level possibilities for even virtual particles to briefly exist.

Our approach differs therefore from models that consider unchanging vacuum properties in favor of dynamical ones which do not only vary in time but will also be seen to be dependent on the relative spatial location.

The Universe evolution can be divided into two phases. In the first phase structures are developing from microscopic to macroscopic scales. In this phase, the energy levels possible in the vacuum change from initially subtle and few to grosser and more numerous. At some point in the evolution, gravity cannot sustain the larger structures which then start to break down. In the second phase, the process is reversed, decreasing from grosser to subtler levels until the ground state is reached.

Following the discussion on space in Chapter 3, the expansion of the Universe should be concordant with an increasing distinguishability as it is the case in the first phase of the Universe when grosser elements form. However, in the second phase, as energy becomes subtle and more uniform, space should contract. As a result, the initial and final states of the evolution are identical, implying the possibility of cycles. Note that the expansion and contraction of the Universe will appear different when either gross or subtle levels are considered.

Cyclic models such as these are incompatible with a positive cosmological constant and in conflict with the second law of thermodynamics. Initially formulated in the XIX century, the second law remains one of the pillars in modern physics and a point of agreement for the majority of scientists even when their views on modern physics might widely diverge. One of its primary achievement is the ability to define a direction of time for macroscopic processes, which has not been attained by means of more fundamental principles.

Classical and quantum laws that describe phenomena at the microscopic level have a time-reversal symmetry. This discrepancy is usually referred to as the arrow of time problem and is often exemplified by the expansion of a gas initially compressed in the corner of a box, a phenomenon that cannot be explained by merely looking at the collisions between molecules.

Here we will illustrate that the direction of evolution for the expanding gas can be derived solely by considering the interaction between the particles and the vacuum. We will then suggest a generalization of the second law of

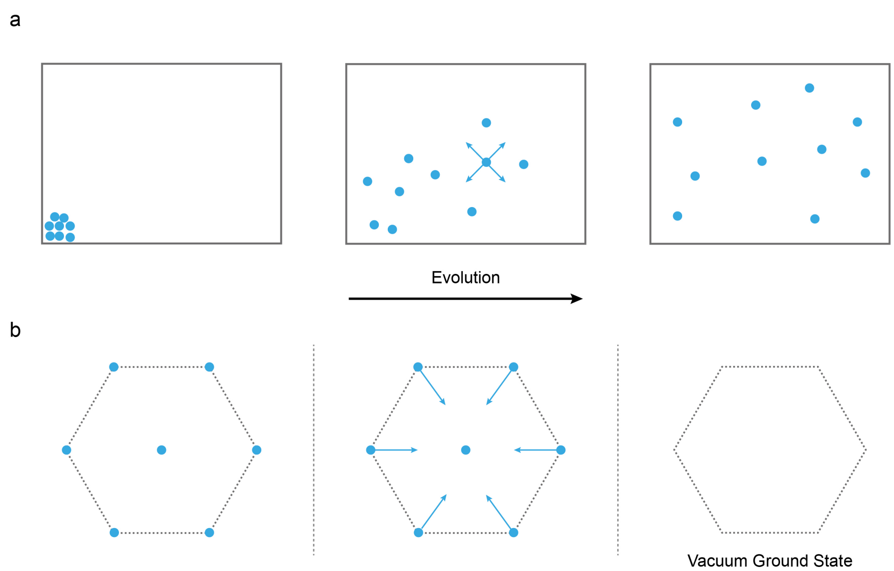

Figure 2: The evolution (from left to right) is presented for: a) the expansion of a gas contained in a laboratory box and b) the decay of a particle system at the last stage of the Universe. The arrows indicate the effect of cancellation on the particles, causing it to spread uniformly in the first case and to contract in the second one, a difference caused by the dynamics of the vacuum.

thermodynamics in terms of the principles of cancellation and generation.

The direct interaction between the gas molecules will be taken to be negligible compared to their interaction with the vacuum; through which they also indirectly interact. The principle of cancellation, which has been defined as the tendency for energy to decay into the ground state of the vacuum, dominates the evolution of this process. This tendency to decay should not be understood as a spontaneous process: cancellation has a continuous effect on the arising energy, whereas a process of spontaneous disintegration is not only probabilistic, but it also does not have any actual effect on matter before or after the event of decay.

To understand its effect on the gas of particles we first consider the situation in which they disintegrate entirely, which is the state towards which there is a tendency to evolve. The modification of the vacuum due to the disintegration of the particles is negligible: as it will be seen in the next chapters, the vacuum is sustained by much larger structures that provide their stability.

Spatially, the vacuum can be understood as being homogeneously distributed inside the laboratory box. Therefore, irrespective of the precise initial condition of the molecules and because the final state is that of the vacuum, the evolution towards it can be spatially conceived as a change of energy from their localized positions to a uniform spread of energy in the box. Even in the case when there is no complete disintegration, the effect of the vacuum on the arising energy of the particles will be that of a force acting to spread them uniformly. Note that the concept of force is theoretical, as it is based on the notions of space and time.

Regarding the entropy of the configuration in this example, we suggest that the final stage has lower entropy, as the particles become highly entangled with the vacuum during their expansion, indirectly increasing their mutual correlation. The final stage is of a lower complexity as it is closer to the vacuum.

The evolution of an interacting system of particles dominated by cancellation will not always result in their expansion. A crucial element to determine its direction is to understand how the vacuum changes during the process.

Consider for example a system of seven particles at the last stage of the Universe decaying towards perfect cancellation and suppose that they form a hexagon with six of the particles located at the corners and one at its center as depicted in Figure 2.

It has already been stated that space is not definable at the ground state of the vacuum. The use of the hexagonal figure, however, will aid the visualization of the decay dynamics. When all particles have decayed into the vacuum, the hexagon can be seen as having the property where the corners and center become each other; they are indistinguishable, and therefore no separation can be defined between them.

Spatially, we can look at the decay process from the perspective of the initial stage: it will appear as if all energy is being pulled together as space contracts towards a single point, in Figure 2 exemplified by the center. In actuality, it is not the case of space reducing; instead, energy is becoming more simplistic, lowering its entropy.

Generally, we suggest that entropy will decrease when cancellation is dominant and increase when generation presides.

An example of a process dominated by generation is the Big Bang, when energy increases in complexity as it emerges from the ground state. If one relates entropy to complexity one naturally expects it to increase in the first phase of the Universe when grosser structures are being formed and decrease in the second phase when energy becomes more simplistic.

Summarizing, in this chapter we presented a generalization of the second law of thermodynamics. Our discussion gave an example of how cancellation can explain the evolution of a system of particles fundamentally. It has been shown that the quantum vacuum and its dynamics are crucially important in determining the direction of change; this is also the main difference to classical thermodynamics for which no net effect of the vacuum on the particles is expected. The new formulation of the law does not restrict entropy to be always increasing, in this way addressing one of the main criticism that cosmological cyclic models face [14, 15].

An essential object of study would be to understand how these principles apply to a condition such as the beginning of the Universe. Two of its leading causes or generation factors will be discussed in the following chapter.

5 Generation aspects: Potential and Light

Previous to the Big Bang, the Universe is in a state of perfect cancellation. In this circumstance, there is no arising or disintegration of energy upon which the principles of generation and cancellation could exert an influence. Nevertheless, this is not a state devoid of properties. If quantum mechanics is valid at this point, information from the previous cycle of the Universe should be conserved and influence the features of the next one.

Figure 3 illustrates the end and subsequent beginning of a cycle. Analog to the example given in Chapter 4, the last constituents of a cycle are located at the corners and center of a hexagon. This hexagon is representative of any given configuration.

Here we propose that the information on the dimensions is kept during the time of perfect cancellation. Dimensions are not an energy per se and should also not be understood as static space. One can define the location of one energy in comparison to another, yet there is no separation between the two energies. This information contains the traits leading to the distinguishability and therefore the different degrees of energy from subtle to gross that will possibly arise in the next cycle.

For example, in Figure 3 the hexagon at the ground state represents the potential dimensions of the arising first level. This potential is effecting the state of perfect cancellation and constitutes one of the generation factors responsible for the release of energy at the Big Bang.

The potential hexagon can be understood as acting upon itself at every point, at the corners and center between which there is no separation. It is this effect that eventually leads to the release of energy.

Alternatively, the effect of the dimensions on the vacuum can be understood by considering the entanglement between the ground state and the potential first stage. This interaction is time-dependent and eventually results in the Big Bang.

The concept of potential is crucial in this model and will be seen to have an important role not only at the beginning of the Universe but also at each stage of its evolution. Potential is a direct consequence of impermanence or momentless, reflecting the fact that cause and effect are not entirely independent. For example, if one considers a subatomic particle in one moment and its causally corresponding subsequent ensuing in the next one, these two energies must be entangled. This can be proven by contradiction, by realizing that the two could only be independent if they arise in separate moments of time. However, as discussed in Chapter 2, independent moments reflect a static notion of energy that contradicts impermanence.

The same conclusion can be applied to relate the different stages of the Universe by introducing the concept of potential. In this case, we cannot affirm that for example the ground state is entangled with the first stage because the Big Bang has not yet occurred while the Universe is at the stage of perfect cancellation. Nevertheless, there is a relationship between the

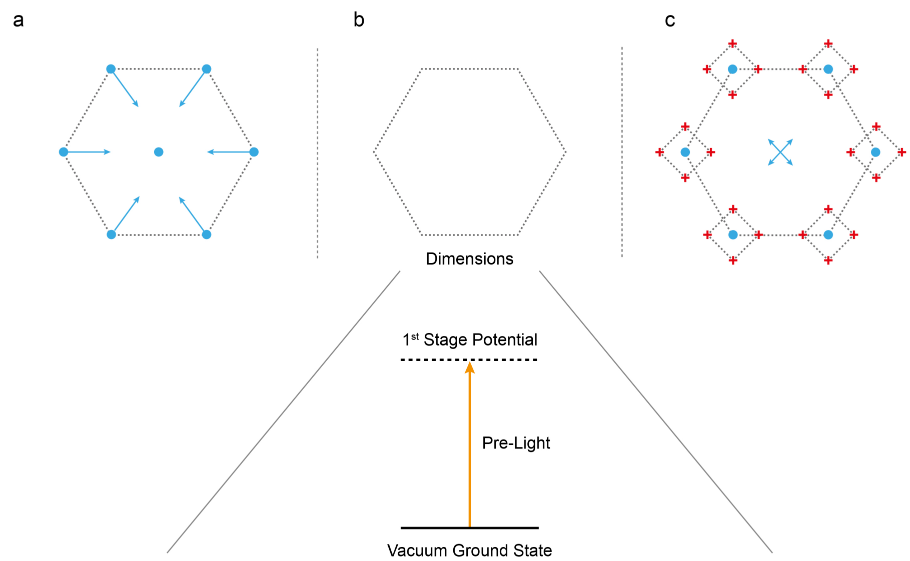

Figure 3: Transition between: a) the end of a Universe cycle, represented by 7 particles located at the corners and center of an hexagon and c) the subsequent beginning of the next one, which arises with similar properties, in this case also in the context of an hexagon from which the galactic systems will be formed. b) At the ground state of the vacuum the information on the dimensions is kept. The evolution takes place through pre-light interaction with the potential first stage.

two stages that is reflected in the entanglement between the arising and the potential next stage.

Potential should not just be interpreted as a probability factor of a future event to happen. It has an actual effect on the arising energy, in a similar manner that cancellation exerts a force on energy and is not just a probability for it to decay. Potential is in this sense its counterpart in the context of generation.

Light

So far a situation has been described where information can be conserved even in the absence of an arising energy, a unique scenario which naturally results in a quest to ascertain what the carrier of the information could be.

We answer this question by establishing the hypothesis that light is responsible for carrying the information on the dimensions. In this model, light is considered a vacuum distinct from matter and antimatter, although the three will have an interdependent relationship. We also note that at the ground state light cannot express in terms of a frequency and therefore it is more appropriate to refer to it as pre-light.

A second hypothesis is made regarding how vacuums of different stages interact: it is here postulated that pre-light mediates the interaction between the ground state and the potential first stage, as depicted in Figure 3.

Summarizing, although there is no movement of energy and no quantum fluctuations, a model has been presented that allows for an evolution to take place from an initial vacuum ground state. A direction of time is natural due to impermanence, which manifests as an entanglement between the present stage and the potential subsequent one. Pre-light interacts with the vacuum and propels the evolution of the cycle outside of perfect cancellation. This release of energy is very specific in its dimensions or properties and will be similar to the previous cycle. The harmonic energy levels for the matter, light and vacuum are developing, as well as the potential of the second stage, which generation will take place in a similar manner.

Until now, the release of energy at the beginning of the Universe has been discussed without considering its antimatter counterpart. Antimatter will be the subject of the next chapter, which will also investigate the possible origin of the matter-antimatter asymmetry, one of the most significant unknown factors at these early stages.

6 Matter-antimatter asymmetry

The idea that particles arise from the vacuum in conjunction with their antiparticle counterparts seems to be in contradiction with the fact that the visible Universe is mainly composed of matter. The Standard Model does not predict any process that would result in an uneven production of the two. If an even formation is assumed, another possibility would be that antimatter is located in a separate region of space, isolated from matter. However, our knowledge of the Universe based on astronomical observations makes this possibility very unlikely.

Understanding the origin of antimatter is necessary to gain a more in-depth view of the cause for this asymmetry. When Dirac initially presented its concept [16], it was in the context of a vacuum model that consisted of an infinite particle sea with negative energy. Antimatter was interpreted as the hole left in the vacuum as a result of the excitation of one of the particles into positive energy states. This view was later on replaced by the quantum field theory interpretation which considers antiparticles to be real particles rather than quasiparticles.

A novel interpretation of antimatter will be here proposed by defining it as the decay of matter towards the vacuum. Antimatter is, therefore, a consequence of the cancellation principle which, as mentioned in Chapter 4, has a continuous effect on energy. Effectively, the tendency of particles to decay can be viewed as a pull of energy on matter which will necessarily have similar properties.

This definition does not a priori appear to resolve the asymmetry problem. Conversely, it supports the idea that matter and antimatter arise in equal numbers. If this is the case, one must conclude that although there is a simultaneous arising of both energies, there are factors that prevent their cancellation.

Each particle has an antiparticle counterpart, yet for them not to annihilate some of their properties must significantly differ. Antimatter cannot arise as a gross localized particle like matter because in proximity it would lead to cancellation. Thus, we propose that antimatter has a more dispersed

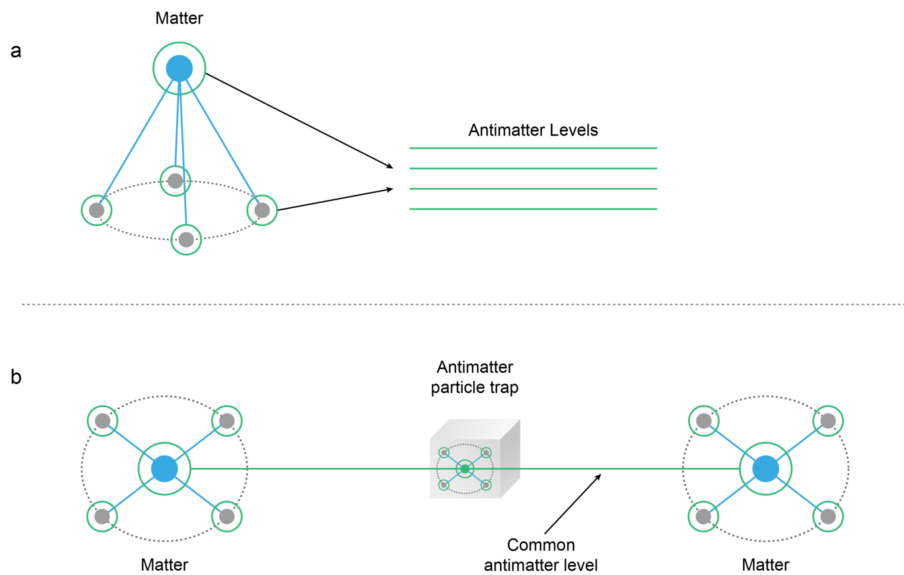

Figure 4: a) The delocalized nature of antimatter as energy levels (green lines) and its relationship to localized gross and subtle degrees of matter. b) Two matter particles (left and right) represent the conditions for the presence of a specific potential antimatter which is modified in the antimatter laboratory trap.

or delocalized wavefunction.

As a consequence of not arising as a localized entity, the probability for the two to annihilate reduces, making matter more stable in the first phase of the Universe.

During this phase, antimatter plays a passive role, as it does not function to annihilate matter; instead, it will be seen to have a critical function regarding the formation of the vacuum structure. It is in the second phase when antimatter is active, and cancellation with matter becomes increasingly predominant, which results in a higher energy density until the state of perfect annihilation is achieved. The dimensions define the Universe own self parameter and limit of expansion, evolving in cycles.

Spatially, one can say that while galaxies are forming in localized positions, antimatter is dispersed in the Universe. Its distribution is however not random; instead, it will, later on, be seen that there is a collective organization forming an energy level structure which in turn aids the stability of matter. Similar to matter, antimatter consists of subtle and gross degrees of energy.

Figure 4 schematically depicts an atom and its corresponding antimatter. The atom just like any gross object is made up of subtler building blocks, and these have their antimatter counterparts, represented by the surrounding green circles. This antimatter is not localized near the atoms; instead, they are linked to energy levels formed within the galaxy. Antimatter cannot be a stable energy, either it forms and quickly disintegrates, or it exists in the form of potential. This suggests that experiments that trap antimatter could be conditioning these energy levels in a way that prevents the disintegration of antimatter that otherwise would take place.

Lastly, we note that if antimatter is present in some form in the Universe, it should result in an observable effect. Indeed in Chapter 12, its effects will be attributed to astronomical phenomena that have been measured, the cause of which has so far not been identified.

7 Black holes and Information Paradox

In 1974 Hawking predicted that black holes can evaporate through a phenomenon now known as Hawking radiation [17]. This is a purely quantum occurrence that takes place when a virtual particle and antiparticle arise from the vacuum near a black hole. Usually, virtual particles are short-lived and will annihilate back into the vacuum. However, in this case, one of the particles might fall into the black hole if it is located near the event horizon, a point of no return: once crossed it cannot go back out. Meanwhile, the other particle might escape the gravitational potential. As a result, the black hole emits particles or Hawking radiation; a loss of energy that must translate in its evaporation.

Soon after the discovery of Hawking radiation, the black hole information paradox was postulated [18]. The information loss is not caused by particles falling into the black hole, by which information might be inaccessible but still contained within the system. The conflict arises because as the black hole evaporates completely, eventually the only remnant will be the emitted radiation. This type of evolution represents a loss of information and is non-unitary: even if the initial state was pure, the final radiation is in a mixed state which is in principle independent of the initial one. It seems therefore that the process violates a fundamental principle of quantum mechanics.

During the last 40 years, the paradox has been intensively investigated and several proposals have been made which often conclude that some of the principles of either quantum field theory or general relativity need to be abandoned [19, 20, 21]. Thus far, no satisfactory solution has been found. The lack of a theoretical model at the singularity of the black hole makes it a challenge to describe the exact mechanism of evaporation.

Specifically, we will be here concerned in gaining clarity on the mechanism by which the black hole loses its mass. Although a simple argument on energy conservation should have convinced us that the black hole reduces its mass by Hawking radiation, it is nevertheless a puzzling conclusion; ordinarily one would expect that particles that fall into the black hole contribute to increasing its mass.

In this model, not only this assumption will be questioned but also it will be suggested that the paradox occurs due to equating black hole evaporation with mass loss.

Relating these two is, in fact, the only possibility in the context of our current interpretation of general relativity, where a highly compact mass causes the high gravitational field at the black hole center.

Without modifying the geometrical interpretation of the black hole that general relativity offers, we propose a new interpretation where the gravitation at the center is due to subtle degrees of energy, whereas grosser or more massive degrees populate the periphery. A continuous variation on the degree of grossity should be found between the two extremes, forming the

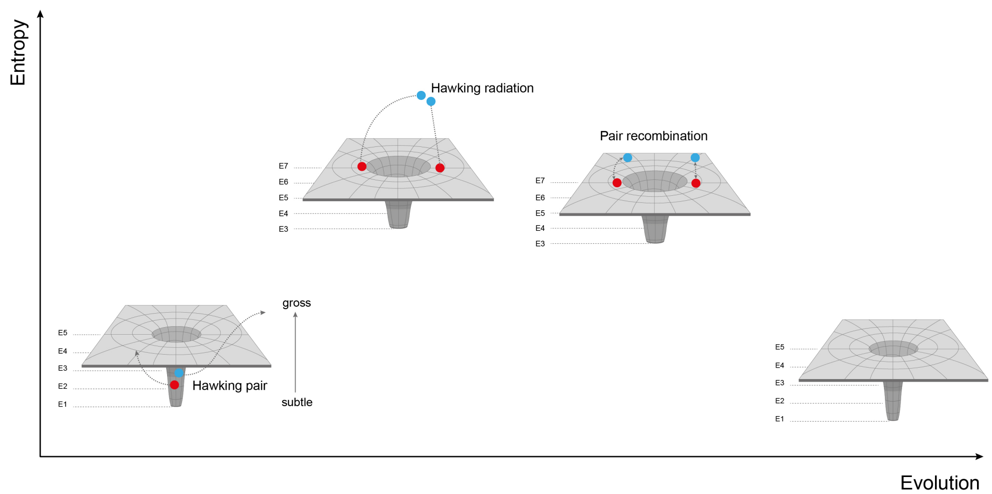

Figure 5: Black hole evaporation cycle (chronologically from left to right). Hawking pairs formed near the center of the black hole result in a decrease of its depth. The antimatter pair (red) becomes a part of the grosser reservoir at the periphery, whereas the matter pair (blue) leaves the black hole. In the second phase of the Universe, when cancellation becomes more dominant, the pairs recombine, forming new black holes and eventually decaying into the ground state of the vacuum.

black hole curvature. Such interpretation is consistent with the notion of space given in Chapter 3, where subtle, less distinguishable, states are less distant.

Additionally, it will be here assumed that the degrees of energy forming the black hole correspond to antimatter states. The conclusions that will be derived regarding the information paradox are however equivalent if matter states are considered.

This model does not intend to satisfy the conditions of conventional theoretical black holes in general relativity; instead, it aspires to represent the properties of astronomical black holes more accurately.

Figure 5 depicts a black hole and its process of evaporation. For a black hole to evaporate, a reduction of its center depth is necessary. The depth will be larger for black holes composed of a higher degree of subtle energy, corresponding to a stronger gravitational pull. Towards the center of the black hole subtle energy will express in the form of virtual particles, quickly arising and disintegrating; representing the subtlest form of relative vacuum. The relative vacuum at the center is different than the relative vacuum at the periphery, where energy expresses in grosser forms.

The extrapolation of the highest subtlety or ideal black hole would be the ground state of the vacuum or perfect cancellation, which geometrically could naively be interpreted as a singularity. In actuality, space is in this case not definable, as discussed in Chapter 3.

Black hole evaporation takes place when Hawking particles arise from the subtler aspects of the vacuum at the center: subtler degrees of energy reduce in favor of the development of grosser ones.

It will be here assumed that there is a process by which the two virtual particles separate, one of which will form part of the black hole while the other is radiated outside its confinement. In the next chapters, a possible mechanism allowing this separation will be presented.

We would now like to understand how this black hole model affects the information paradox.

An argument posited by Almheiri et al. in [23] suggested that if monogamy entanglement is to be preserved, the radiation could not be entangled with both its Hawking pair and the black hole degrees of freedom. As a consequence, a firewall should be present at the event horizon that destroys the information, which contradicts the concept of smooth horizon as conceived in general relativity.

An attempt to resolve the later paradox was given by J. Maldacena and

L. Susskind [22] when they proposed that the black hole internal degrees of freedom are connected to the Hawking radiation, particularly by the formation of wormholes and therefore are not independent. Whether a firewall will be present or not will depend on the nature of the Einstein-Rosen bridge connecting the two.

The internal structure proposed here indicates that the fate of the particle will differ depending on the type of particle, matter or antimatter, that remains at the black hole.

In case the remaining is an antimatter particle it will eventually become a part of the grosser aspects of the black hole, at the periphery. This process might result in some decoherence as the particle decays towards the antimatter reservoir, but there is no quantum information loss.

The corresponding Hawking pair becomes entangled with the black hole structure as a whole without a violation of the monogamy principle. In fact, from the moment the Hawking pair is created there is a connection to the black hole internal degrees of freedom rather than it being a pair isolated from its causal environment.

If the remaining particle is matter based, it will tend to annihilate with the grosser antimatter degrees that form the black hole, in a process that simulates a firewall. It is in this case impossible for the remaining particle to become a part of the internal degrees of freedom of the black hole.

This annihilation will increase the center depth, preventing the black hole evaporation. We note that in this situation the Hawking particle leaving the black hole will also tend to annihilate with the matter present in the Universe. There is no controversy in this case and also no information loss when the totality of the Universe is considered.

D. Marolf presented a further source of conflict based on entropic considerations [24]: the Bekenstein-Hawking entropy is proportional to the area of the black hole, and traditionally one expects this one to reduce as the black hole evaporates; from the other side, the von Neumann entropy is expected to increase for each emitted Hawking radiation particle. The Beckenstein-Hawking entropy must be larger than the second one, so at some point in the evolution, a contradiction becomes apparent.

In our model, antimatter particles remaining at the black hole will increase the area of the periphery, increasing the Beckenstein-Hawking entropy. It is reasonable to expect an increase in entropy during the process of evaporation, as the degree of complexity is higher when grosser forms of energy are generated.

Black hole evaporation does, in fact, resemble the Universe evolution. Starting with an ideal black hole or perfect cancellation, which has the lowest entropy, a process of evaporation is equivalent to the generation of grosser degrees of energy and higher entropy. In the context of the Universe evolution we see that the complete evaporation of a black hole is not necessarily the end of its cycle. It is possible to consider the recombination of the Hawking radiation products, particles and antiparticles which annihilation will not only result in the formation of newer black holes but will eventually lead to the ground state of the vacuum or ideal black hole as the Universe cycle is completed.

This analogy is not coincidental. The role of black holes in the Universe evolution will be discussed in detail in the next chapters.

8 First stages of the Universe

The black hole model described in Chapter 7 uniquely associates strong gravitational fields with subtler energy levels. This correlation will enable the possibility to define black holes at very early stages of the Universe, clarifying the origin of astronomical observations that have remained unclear so far. Mainly this is the case for supermassive black holes whose origin cannot be accounted for in models that describe black hole formation by gravitational collapse, merging or matter accretion [25, 26]. The importance of black holes in the Universe is in this model such that there is no stage of the evolution that does not contain them.

Figure 6 depicts the formation of the first and second stage. The Big Bang takes place as a result of a great release of energy. Matter and antimatter are both equally produced from the vacuum yet exhibit different properties; particularly in Chapter 6 it was suggested that antimatter is more delocalized than matter. Here we propose that the two undergo a more substantial differentiation or separation that prevents their annihilation. This is the case because the decay of matter is not occurring randomly in space; instead, it is responsible for the formation of black holes. Here, a black hole type like the one described in Chapter 7 is considered, for which the subtle levels are formed due to the decay of subtle matter towards the center of the black hole and the grosser ones correspond to the decay of grosser matter towards the periphery.

The description of the evolution is analogous to the black hole evapora-

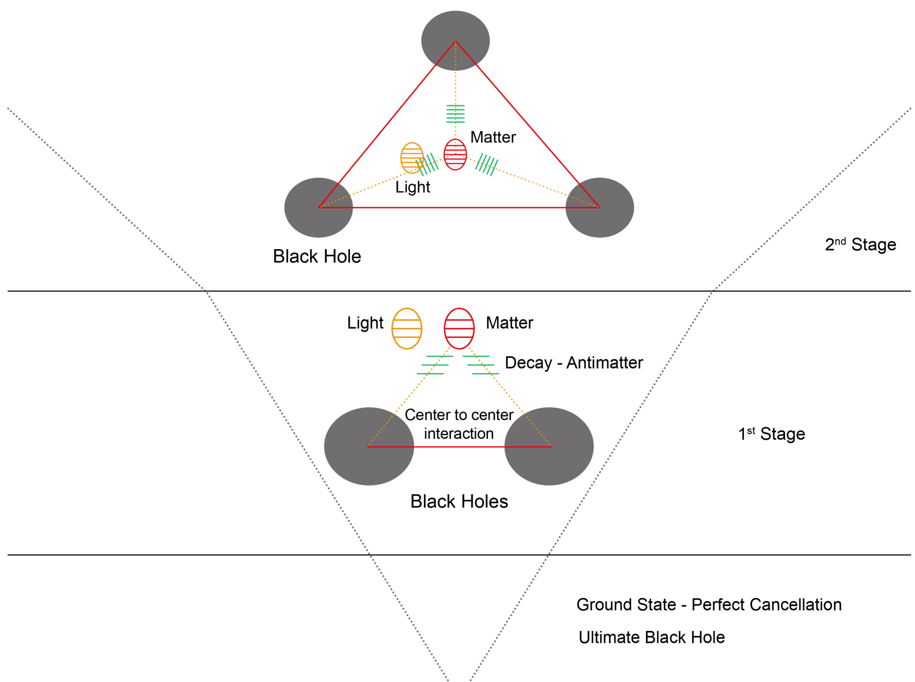

Figure 6: Generation of the first two stages of the Universe from the ground state of the vacuum (chronologically from bottom to top). The main elements responsible are depicted: the arising of matter (red energy levels) arises due to its interaction with light (yellow energy levels); its decay (green energy levels) simulataneously leads to the formation of black holes (black dots). At the second stage the number of black holes increases, their smaller size in the Figure indicate that their gravitational potential or center depth has become smaller.

tion. We will assume that the mechanism through which matter can leave the confinements of the black hole is its interaction with light.

Figure 6 illustrates two black holes being formed at the first stage from the decay of arising matter. This number is only representative of the fact that a single black hole cannot allow for the Big Bang to take place, yet it does not represent the actual number produced.

The mutual interaction between the two black holes forms an energy potential, which has both a generation and cancellation aspect, which results in the definition of the first quantized harmonic levels at which antimatter is now able to express. Note that this black hole formation is simultaneous and interdependent with the arising of matter and light. It is not a case where matter is arising first and secondly its decay forms the black holes. Matter needs the black hole separation for its generation, without which matter and antimatter will annihilate into perfect cancellation. It is an interdependent process, where the different events should be considered as occurring simultaneously. Therefore just as the first antimatter harmonic levels are formed, so do the subtle harmonic matter and light expressions generate.

The two black holes are naturally arising in an entangled state. A high degree of entanglement or interaction is to be expected for subtle degrees of energy, i.e., between the black holes centers. This interaction is due to cancellation and it is such that it will try to pull the two black holes together. Keeping the black hole separation is, therefore, one of the necessary factors for the stability of matter.

The generation of the second stage of the Universe will take place in a similar manner as the first one. Thus, one expects a second generation of black holes arising, which will be more numerous and grosser in its energy composition. At the same time, grosser matter structures and lower frequency components of light are allowed.

A new perspective and interpretation of several astronomical observations is available when this model is considered. One of the first insights it provides is a reason why black holes are found at the center of most galaxies. Additionally, it offers an explanation on the correlation between the black hole and the galaxy mass often observed. Our model shows that there is not just a correlation between the two mass factors, but that the two are strongly entangled. The effects of this interdependent arising will be explored in more detail in chapters 12 and 13.

The presence of supermassive black holes at younger stages of the Universe is a natural occurrence in this model because black holes main contribution to its gravitational potential comes from subtle degrees of energy. If this is the case, the evolution of galaxies can be reformulated. For example, we consider the two primary types of galaxies observed, spiral and elliptical. Their properties are quite distinct [27, 28]: whereas spirals have a more flat or two-dimensional shape, elliptical ones are more three dimensional. Elliptical galaxies have supermassive black holes at its center and up to today, the most conventionally accepted view is that they are the result of galaxy mergers. The merging of two black holes is the way massive black holes in elliptical galaxies are explained.

Our model allows a possible new interpretation: namely, those elliptical galaxies were formed at an earlier stage in the Universe than spiral ones, containing more massive black holes because the vacuum at their center corresponds to a previous stage of the Universe, thus more subtle. As the Universe evolves, the size of the galaxy black hole decreases, and at the same time its periphery increases, leading to a more two-dimensional appearance. The evolution from elliptical to spiral shows the increase in complexity that one would expect as grosser degrees of energy form. Elliptical galaxies have typically no new star formation, consistent with this model by which galaxies of a previous stage of the Universe should become inactive when the new generation is formed. In traditional models, where elliptical galaxies evolve from the merging of spiral ones, there is a need to clarify why no new stars are being formed, a phenomenon called galaxy quenching [29], for which the cause remains unknown.

Summarizing, all properties of elliptical galaxies seem to correspond to earlier galaxies in our model, including the black hole size, the simplicity of its shape and the small periphery as well as the older star population. As the next stage of the Universe gives rise to the newer generation of galaxies, amongst which could be the spiral type, these are expected to have a more complex structure, generally smaller black holes and large periphery, as well as being a source of new star formation.

Dark Energy and dynamical vacuum

In 1998 astronomers found evidence that the Universe expansion is accelerating [30]. This observation contradicted the expectations at the time when it was thought that long after the Big Bang, the expansion would eventually slow down. The cause for the disparity was attributed to the, at the time unknown, dark energy. It was not until the establishment of quantum physics that an interpretation of dark energy was made available, mainly due to its different perspective on the vacuum, which was no longer seen as an empty space but a place where virtual particles continuously arise and disintegrate. These virtual excitations are associated with vacuum energy or dark energy, which will increase as space expands, contributing to further expansion.

A priori a satisfactory explanation, there is however a discrepancy between the theoretical value in quantum field theory and its experimental measurement of approximately 120 orders of magnitude, also known as the cosmological constant problem.

In order to understand dark energy from the point of view of this presentation, a model of the vacuum is needed. Here we propose that the vacuum should be understood in the context of the antimatter structure of the Universe. This structure is formed by the black holes on one side and their interconnected relationship on the other, forming a net of antimatter states in a configuration that resembles a solid structure with black holes at its knots instead of the nucleus and a corresponding antimatter energy level structure. The stability of this net is a prerequisite for the generation of the corresponding matter at each stage.

According to our presentation, a change in the expansion of the Universe is expected at the beginning of each stage of evolution, for which there is an increase in the grossity of the harmonic levels and the number of black holes. Particularly the formation of new harmonic levels corresponds to a growth of dimensions.

On the second phase of the Universe, when the net can no longer be sustained, its disintegration leads inevitably to a change in the sign of dark energy and the contraction of space.

9 Quantum gravity

The black hole model presented in Chapter 7 suggested a new possibility of understanding gravity in terms of the degree of subtlety. This conclusion was derived from considering the classical geometry of black holes according to general relativity and the definition of space from Chapter 3. This proposition is only partially satisfactory, as it is based on the theoretical notion of space. In this Chapter, we would like to understand gravity from the fundamental principles of this model. Specifically, it will be here proposed that

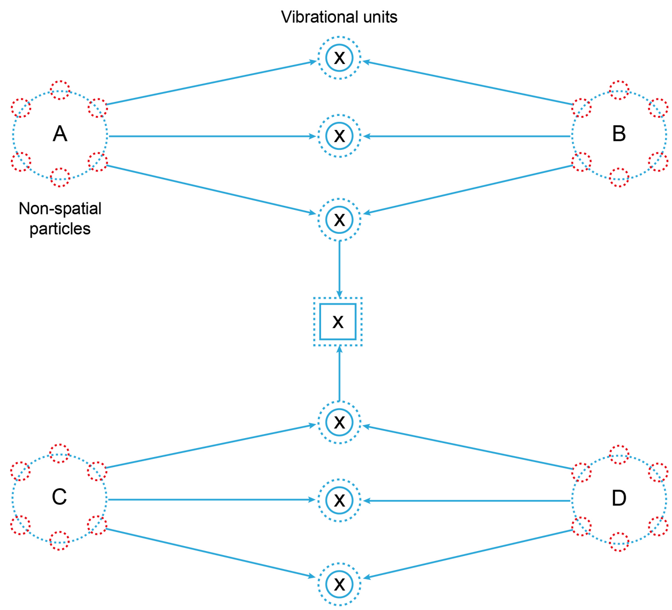

Figure 7: Example of four interacting particles (A, B, C and D), composed of their subtler non-spatial aspects, and how vibrational units (blue particles denoted by "x") can form from the vacuum as a result of the principles of cancellation and generation. The vibrational units interact through cancellation and tend to decay towards a subtler degree of energy (square box, "x").

gravity derives from cancellation.

A consequence of the negation of space is that at some subtle level of energy all energy must be entangled. Traditionally, entanglement can be conceptually challenging as it describes a situation where no knowledge can be obtained from the individual parts of a system, and only the collective wavefunction can be described.

Consider for example a system of two particles A and B: it is because energy cannot be confined in the context of a spatial construct, whether in a particle or waveform, that it is not possible to ascribe an energy to A and a separate one to B. Therefore, due to impermanence, the only possibility to correctly describe the arising energy of any system is as a whole.

Figure 7 shows four interacting particles. They are composed of sub-particles denominated as non-spatial, in order to indicate the lack of spatial confinement and the fact that no fundamental particle can be found at subtler levels. In the example drawn, each particle is formed of six non-spatial particles and it is a condition that the arising energy must fulfill, i.e., the fact that each particle has to have six non-spatial particles forming it. This condition is imposed by the specific quantum information that is kept during the evolution from one moment to the next.

Here we suggest that the location of a non-locational non-spatial particle is what gives the impression of energy and an understanding of energy being in one location measurable in relation to another.

Due to cancellation energy will tend to move away from being localized; therefore all non-spatial particles will pull towards each other as they seek to reach a state without distinction and more uniform, towards the ground state of the vacuum. Here we propose that gravity and the strong nuclear force both derive from this energy pull. The strength of their magnitude and properties differ due to them occurring within different types of vacuum or degrees of grossity.

We note that although space was used to illustrate the black hole model, it is the very notion of space that classically does not allow for a more in-depth understanding of gravity. Based on impermanence the relation between different particles is clarified and the effect of entanglement on their interaction naturally provides a link between quantum mechanics and gravity. Space conflates energy of different moments of time as existing inherently, a mistaken view that results in energy being separate and from which entanglement is not a realistic possibility.

Impermanence is also the reason why energy can be in two different locations without contradiction, in a state of quantum superposition.

The pull between different non-spatial particles can be interpreted as the movement of the particles towards each other. This movement results in a vibration of energy. Figure 7 schematically shows how the pull between the different non-spatial components of four particles results in a range of vibrational units. At the same time, these vibrational units also pull towards each other as they have a propensity to decay towards lower subtle states. This is showing how energy arises from the vacuum, without the need for fundamental particles, as a result of the combination of both the principle of cancellation and generation.

10 Two types of vacuum

This Chapter presents a classification of the vacuum into two different aspects. Rather than two types of particles, they represent two expressions or qualities of energy which are found in all degrees of energy from subtle to gross in a repeatable pattern. This classification affects only matter and antimatter; it does therefore not include light.

We will present a definition for these two energy types in the context of an example at gross degrees of energy such as a galaxy. Within this galaxy, two types of behavior can be distinguished when we compare black holes vs. stars. The energy at the black hole is dominated by cancellation, going from gross to subtle, or in other words, there is a tendency for energy to decay towards the center. We will refer to this type of energy as inward or positive. Stars exhibit the opposite trait, where energy is being generated from subtle to gross, a type of vacuum that will be referred to as outward or negative. The existence of a strong correlation and entanglement between positive and negative energies in the galaxy has indirectly been established in Chapter 8, when the generation of matter and antimatter from the vacuum during the formation of the first arising stages of the Universe was discussed. Here, we suggest that this interdependent relationship causes a crucially important balance between the two types of vacuum, which is a major contributing factor to the stability of the galaxy during its cycle.

Just as black holes subtlest level is not the ground state of the vacuum, the energy at the star is also arising from a specific level of energy, which has a correspondence with the black hole subtleties. As a result, one should find that the type of gross and subtle levels forming stars during the expansion of the Universe evolves in a lineage parallel and correlated with the type of black hole succession, for which the depth of the black hole decreases as the Universe grows.

Another consequence of the relationship between the positive and negative vacuum is that whereas a black hole can evaporate, newer ones will be formed to keep the balance between the two energies. Finally, we note that in the example given, outward and inward energies correspond to matter, for the star, and antimatter, for the black hole, respectively. This association is not a necessary feature for other degrees of energy as we shall see.

In the rest of the Chapter, we discuss how the distinction between the two types of vacuum arises at the beginning of the Universe. This is of particular interest given that initially this distinction is not present, energy is in an

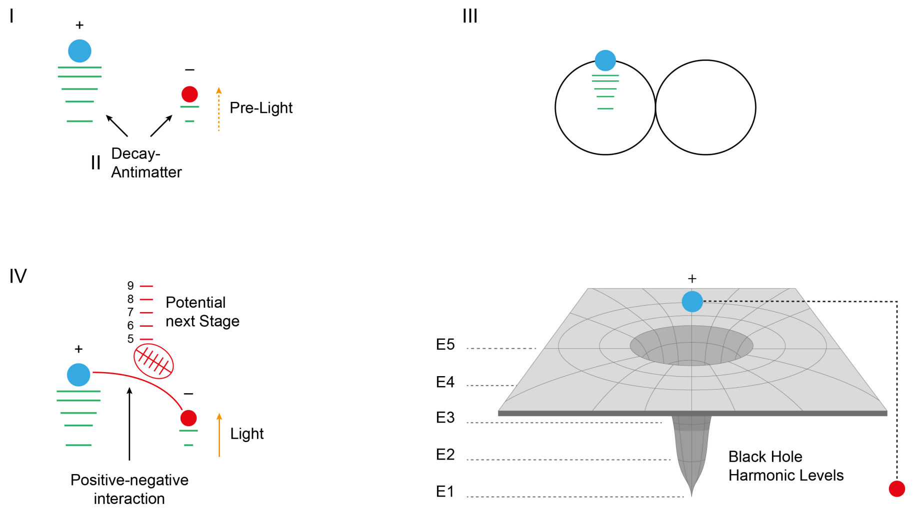

Figure 8: Arising of positive and negative vacuum from the amorphic state at the beginning of the Universe in stages: I) and II) pre-positive (blue dot) and pre-negative (red-dot) vacuum become distinct through the interaction with pre-light, although there is no arising of energy at this stage; the decay of the pre-vacuum forms the pre-antimatter (green lines); III) the right side of the Figure represents the arising of energy and formation of black holes and IV) formation of the potential levels of the next stage (red energy levels) through the interaction between positive and negative vacuum.

amorphic state. Outer and inward vacuums are here discussed with a focus on the matter aspects. Before postulating a possible cause responsible for the division between the two types of vacuum, we direct our attention to the fact that when black holes form at the first stage of evolution one necessarily requires the simultaneous arising of at least two different energies, one subtle and one gross in order to allow for the black hole structure.

Because the evolution of energy has a direction where subtle is developing into grosser, it must be the case that the two aspects correspond to: i) a first stage or more primitive energy and ii) a second stage or more advanced energy, both of which arise entangled.

There is however a greater difference between these two energies than their degree of subtlety: their interaction with light. In this model, we propose that light interacts only with the first stage and not with the second one.

The first stage, being the subtler one, will also have a faster decay followed by an arising due to the interaction with light, propelling the arising of energy. Rapid decay results in rapid release. Therefore this type of energy is dominated by generation, becoming outward or negative.

Its faster decay also results in it being a lighter energy than the second stage, which is slower decaying and heavier. Because the later does not interact with light, it is mainly dominated by cancellation, therefore an inward or positive vacuum.

Generally, we postulate that light interacts only with the outward or negative energy and not with the inward or positive one. We also suggest that this differentiation eventually leads to the two types of electric charge, positive and negative.

Figure 8 shows the progression from the ground state of the vacuum into the formation of the two stages in four steps, allowing us to identify the role of each contributing factor. In the first step, the potential of the negative or first stage vacuum becomes prevalent. This one interacts with pre-light. Here there is not yet an actual arising of energy; instead, these are potentialities affecting the ground state and its evolution. On a second step, the next grosser degree of energy or pre-positive energy emerges, in the Figure depicted as a fifth level of energy which does not interact with pre-light. Both also have corresponding pre-antimatter components. Here the vacuum is evolving through its interaction with pre-light, resulting in an increase of the probability for the division between pre-negative and pre-positive to become factual. Eventually, a great release of energy takes place, as depicted in the third step. This release is simultaneous with the formation of black holes. The interaction between the two black holes determines the type of structure antimatter forms. The two interacting peripheries must be kept separate. It is at the periphery where energy is arising first. Although being two distinct types of energy, there is an interaction between the positive and negative vacuum. One can, therefore, say that although light does not interact directly with the positive, it does so in an indirect way through the positive-negative coupling. The interaction between the two is responsible for the generation of the next harmonic levels, which arise first in potential as depicted in the fourth step of Figure 8.

Finally, we go back to the grosser aspects of the black hole and star in the galaxy. If light interacts only with the negative vacuum, this could be an explanation for why black holes do not emit light.

The proposition of light interacting only with the outward vacuum is consistent with the fact that this negative vacuum is dominated by generation, for which light has been seen to play a significant role and with the hypothesis that light is not affecting energies that in its majority are dominated by cancellation.

11 Black hole interaction levels

The chronology of the first phase of the Universe has been described as a succession of stages, each one representing an increasing number of black holes. One might conclude that a trail of larger and larger black holes should be part of the arising energy at the present stage. However, our position implicitly negated this possibility, which would violate energy conservation principles and is incompatible with our description of the vacuum, which in its majority is defined by the black hole type. For example, the cancellation from the black holes at the initial stages cannot exist now. Here we propose that additional to the black holes at the current state, only those corresponding to the immediately preceding stage should be findable.

Three generations of black holes are depicted in Figure 9. The black holes are depicted by circles whose relative size represents the strength of their gravitational potential. The middle of the three rows illustrates the current black hole level. Preceding it, is the previous generation stage, composed of larger and older black holes, with the deepest center and subtlest cancellation. The third row represents the potential of the next stage, not yet arisen. The generation of this next stage is a transition that will occur at the expense of a reduction or ceasing of cancellation of the older or previous stage black holes.

The properties of cancellation are being transferred as well as transformed as the Universe grows. The transformation from subtler degrees of cancellation in older black holes to grosser aspects for younger ones needs to be in accordance with energy conservation principles. This view also challenges the usual conception that black holes will be isolated systems in space with almost no connection between each other. In this model, there is a connection between black holes at different stages that leads to this fluctuation or movement of energy as the Universe develops. The polygonal boxes in

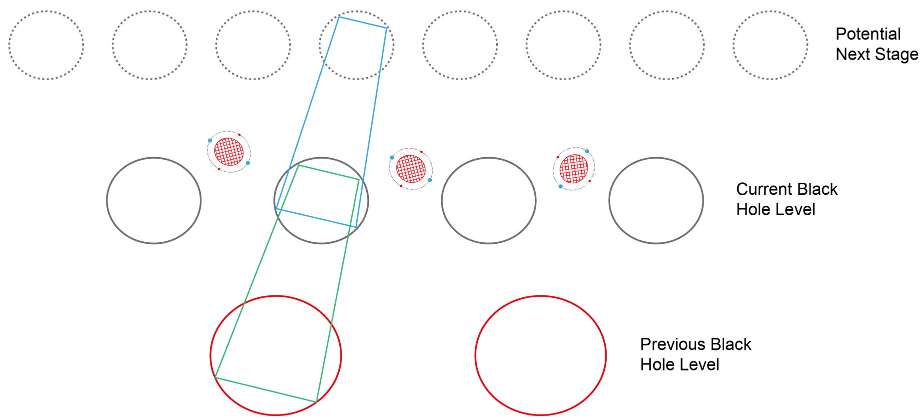

Figure 9: Three generation stages of black holes: the bottom row represents a generation previous to the current stage, where the more massive black holes are found; at the middle is the current generation, the galaxies are depicted between them, and at the top row the potential next generation is depicted. The polygonal figures between the black holes represent their interdependent or entangled relationship.

Figure 9, connecting pairs of black holes of different stages, represent their interconnected or entangled reality. The polygon between the two upper rows represents the entanglement between the current black hole level and the potential of the next stage, necessary for its stability and which evolution eventually leads to the arising of newer black holes. The propensity for forward evolution through the next potential stage is a contributing factor to the stability of the black holes of the current level. The later are in turn providing stability to the immediately preceding black hole stage.

12 Dark matter

In the next chapters, we discuss in more detail the effect of black holes and antimatter on the stability of matter structures.

The generation and evolution of black holes have been described in Chapter 11 as a transformation and transference of the properties of cancellation from one generation to the next. The stability of a given black hole stage was ascribed to the next level or potential black hole stage. Another implicit factor to their stability is matter itself. In fact, both matter and the system of black holes or antimatter are interdependent: their sustainability depends on each other. As introduced in Chapter 8, antimatter is distributed in the following manner: the subtlest level will be found at the black hole center, whereas grosser ones are found more towards the outer part or periphery.

Furthermore, there is a level of potential antimatter, which is not expressed in the form of particles or gross energy; if it did it would result in cancellation of the matter components in the galaxy. The characteristics of this potential harmonic net are also a description of the vacuum. An example is depicted in Figure 10. The vacuum will not only be dynamical during the evolution of the Universe, where the harmonic levels of the potential net will become grosser in the expansive phase of the Universe and subtler in the contracting phase, its features also depend on the location in space. More specifically, the potential net varies depending on the distance to the black hole. This variation is depicted in Figure 10 for a given distance range. Closer to the black hole, the potential consists of subtler and fewer levels, whereas the net becomes grosser and larger for further distances within the periphery of the black hole.

This distribution has two major effects on matter. The first one is that not all degrees of matter can subsist equally in all regions of a galaxy. For

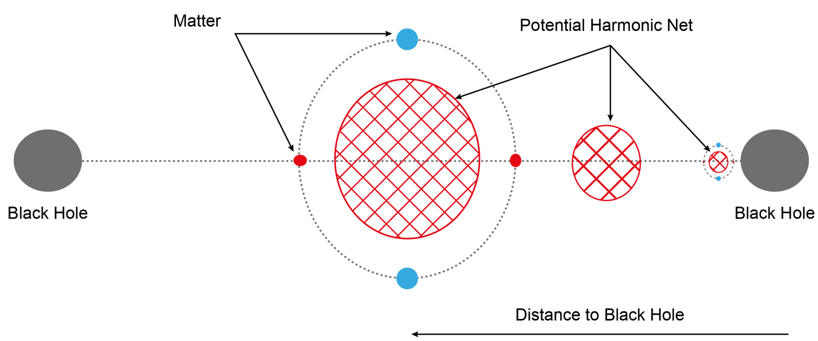

Figure 10: Antimatter net forming the vacuum and its dependency on the distance to the black hole. The net has a smaller number of lines to indicate that is more subtle near the black hole, whereas further from the black hole one finds the grosser potential antimatter, drawn by a more dense net. Two black holes are depicted to indicate that at least two black holes are needed to sustain the vacuum structure.

example, grosser levels cannot exist near the black hole because the potential net consists of subtle degrees of antimatter.

As a consequence, particle decay rate due to cancellation is dependent on the type of harmonic net environment in which it arises, being more rapid near the black hole where gravitation is stronger than in outer regions of the periphery or for weaker gravitation.

The second effect is given by the attractive interaction between matter and antimatter due to cancellation. This one can be divided into two aspects. The first one is the interaction between matter and the actual antimatter at the black hole, by which matter will feel a gravitational pull towards the black hole center, like the one described in general relativity. The second one is the interaction between matter and the potential antimatter net.

Here we propose that the vacuum or potential net will have a significant effect on matter, even when it is not expressing in terms of actual energy and that it manifests in what has been referred to as dark matter. Several characteristics concluded from the observations on dark matter in galaxies are in agreement with this proposition [31, 32]. The first one is the fact that dark matter does not interact with light. The model here presented postulated a categorization of energy into two types, positive and negative, where only the negative aspects interact with light. In the case of a galaxy, the black hole, including both subtle and grosser aspects of antimatter as well as the potential antimatter, corresponds to a positive vacuum and therefore does not interact with light. Additionally, as we are considering the potential net, one does not expect a strong interaction with matter. A second inference from astronomical observations is the fact that dark matter is not distributed in localized areas or conglomerates as it is the case with matter, rather it appears to be more dispersed, which coincides with the assumption made in Chapter 6 of antimatter being delocalized.

Finally, we note that the extension or distribution of the grosser harmonic potential levels should vary depending on the galaxy or black hole type. Following the evaporation model presented in Chapter7, one expects the periphery to be larger for black holes formed at later stages in the Universe and respectively smaller for black holes formed at early ones, where it also becomes apparent why and how dark matter is a crucial element in the formation and stability of galaxies. This is consistent with the observations that showed that dark matter plays a smaller role in galaxies at early stages [33].

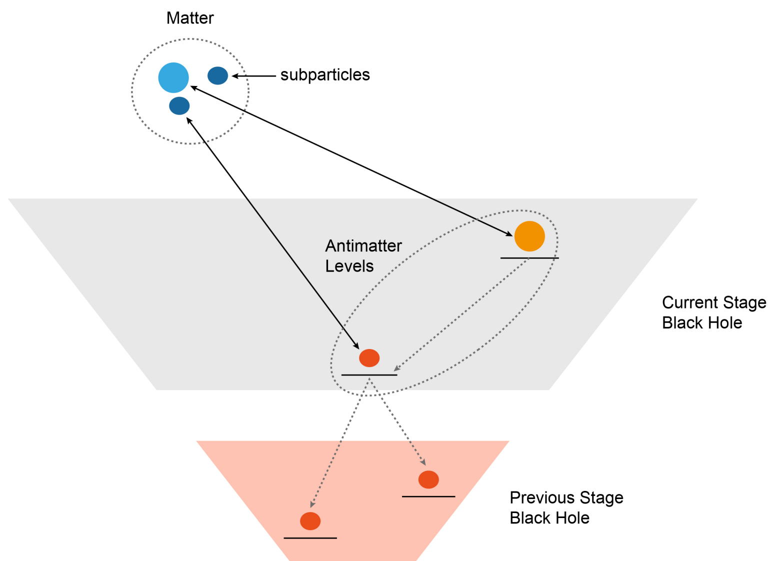

Figure 11: Matter particle decay and its relation to the black hole. The large blue dot represents the grosser degrees of matter, which are linked to grosser antimatter levels (orange dot); whereas subtler degrees (smaller blue dots) relate to the subtler antimatter (red dots). The grey top black hole represents a new black hole formed at the current stage and the bottom red one is a black hole of a previous stage, which therefore contains subtler aspects of antimatter.

13 Matter stability and Black Holes

Matter and antimatter are not static energies; they are continuously arising and disintegrating. Our experimental observations show that not all particles decay in the same way and some of them are found not to decay. In this Chapter, we give a possible explanation for these differences.

For this presentation, we consider only the decay that is caused by the interaction with the vacuum or antimatter due to cancellation. Chapter 12 showed the effect that potential antimatter has in the galaxy, leading to matter being gravitationally pulled within the galaxy.

Here, we will consider the effect of the black hole antimatter levels on matter by taking as an example a particle and the sub-particle elements that compose it as drawn in Figure 11. Each matter component has a corresponding antimatter counterpart, where its grosser degrees interact with the grosser antimatter degrees at the periphery and subtler ones to its corresponding subtle antimatter towards the center of the black hole.

Within the context of the nearby black hole, there is a limitation to how subtle matter can decay. This is a consequence of the fact that the black hole center is not the ground state of the vacuum, but a specific subtle level of energy. As a result, there will be a subtle level of matter which will be particularly stable in the context of the cycle of the galaxy.

The stability of such particles will however not be absolute because the current stage black hole is linked to a previous stage black hole, where this level of antimatter level is subject to further decay.

Figure 12 exemplifies how the particle stability changes during the evolution from one stage to the following one. The initial or previous stage depicts the quark as being one of the grossest possible energy, with its corresponding sub-particles. The surrounding dotted line represents the potential next level of energy, which in this case is the proton. Both quark and its sub-particles have their corresponding antimatter particles at the black hole. The antiquark is drawn more towards the periphery, whereas the corresponding antimatter sub-particles are the subtlest level at the center. The dotted line around the black hole represents the next potential antimatter level.

Once the current stage is generated, the proton becomes the grossest energy level possible. The stable sub-particle is now the quark, which antiquark is found at the center of the new black hole.

The antiquark potential of the previous stage black hole is connected to the antiquark at the current black hole. The evolution from one stage to the next has stabilized the outer antimatter potential and at the present stage we have two points of antiquark, one where is found only in potential and another where is actual. The stability of the antiquark and current black hole is interdependent to the generation of matter. We, therefore, can say that matter at the current stage is responsible for the stability of the previous stage black hole, to which is linked through the corresponding antimatter, and the reason why it does not cancel. There is a fluctuation of energy from one stage to another and an entangled relationship that is being kept between the two stages of evolution, allowing for the stability.

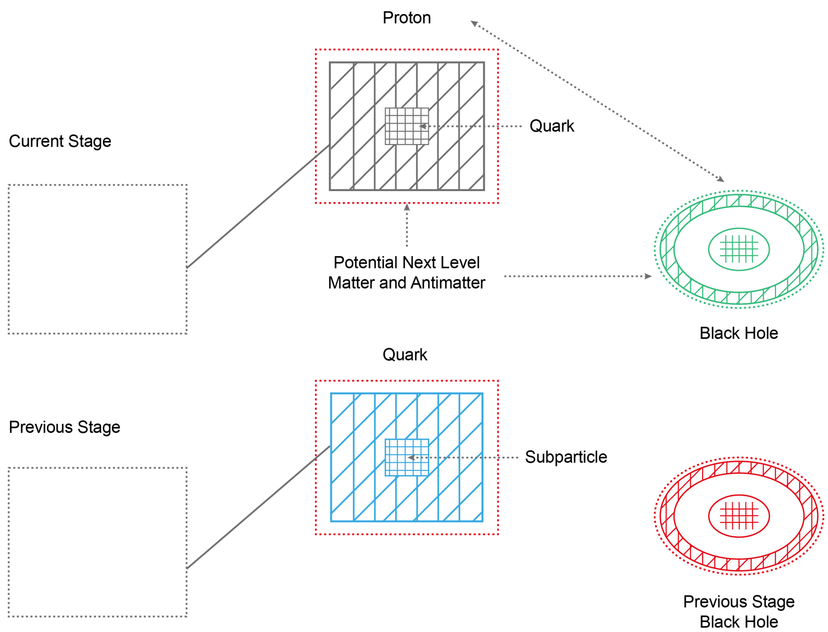

Figure 12: Evolution (from bottom to top) from the stage of matter (middle column) of quark (solid outer blue square) and its sub-particles (solid inner blue square) to a proton (solid outer grey square) and the quarks (solid innergrey square). On the right side the black holes of each stage and their relation to matter are represented (the line pattern fillings of antimatter at the black hole correspond with the line patterns of matter aspects inside the squares in the middle row). The dotted lines both around the black holes and the outer square represent the potential antimatter and matter (this one is also drawn separedtly at the left column).

14 Conclusion

Summarizing, this paper presented a model that identifies the cause of the conflict between general relativity and quantum mechanics as resulting from a static notion of energy that is present in any model based on space and time. Removing this limitation, aspects of quantum mechanics such as entanglement appear to be natural.

A comprehensive description of the fundamental principles of energy has been presented, allowing a new way of understanding black holes, antimatter and the quantum vacuum and its dynamics during the evolution of the Universe.

The requirements for a new mathematical basis have been presented to provide guidance to a mathematical formulation that should seek to verify or question the consistency and validity of this model.

Recent technological advancements such as the measurment of gravitational waves from the merging of black holes [34] and the first image of a black hole [35] will allow the design of specific experiments to understand the plausibility of the black hole model here presented.

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