How Dark Matter Originates from Black Holes

Russell Bagdoo
rbagdoo@gmail.com

In this paper, we discuss the possibility that black holes can indirectly and directly produce dark matter. As well as the possibility that neutron stars and hypothetical quark and boson stars could also produce it. We conjecture that, just as the relativistic jets emitted by radiation from the regions associated with high-mass black holes enable the creation of galaxies, the lateral jets of this same radiation enable the creation of dark matter in the regions surrounding the black hole. We disprove the ΛCDM theory, whose disproportionate cosmological constant leads to the "vacuum catastrophe". We argue that dark matter appeared after the Big Bang and that the production of the first lumps of the universe would have started with ordinary matter. By way of quantum physics, we explore the nature of dark matter and assume that dark matter and ordinary matter have hydrogen as their deep identity. During a quantum phase transition, molecular hydrogen would become analogous to a Cooper pair whose dibaryons behave like bosons. All matter particles at a certain threshold temperature become phased to form a coherent macroscopic wave of dark matter that has the characteristics of a soliton. When the crust of ordinary matter in hyper-condensed stars - the degeneracy pressure of quantum mechanics - overwhelms gravity, the soliton is repelled into space by "superdiffusion". Finally, we show that in many cases, a black hole can dissolve in whole or in part into dark matter. We hypothesize that there would be one or more other censorships between the event horizon and cosmic censorship. The trapped surface of one of these pre-Planck censorship would result in a quantum phase transition marking a change of state towards dark matter. This pre-Planck wall would trigger a spatial extension of the black hole into space in the form of a "macroscopic dark matter wave."

Keywords**:** dark matter, AGN, feedback, lateral feedback, change of state, quantum phase transition, macroscopic dark matter quantum wave, Q-Balls solitons, dibaryons, superdiffusion.

I Introduction

In this work, we focus on the dark matter that could come indirectly or directly from black holes, and also from hyper-massive stars on the way to becoming black holes, such as the neutron star, the quark star and the boson star. We also oppose the lambda-CDM model according to which dark matter was formed from the earliest moments of the universe.

The article is structured as follow. In Section 2, we show how dark matter comes indirectly from the black hole. Based on the active galactic nuclei (AGN) feedback theory which enables galaxies to be ignited, we deduce that "lateral feedback" is also possible to form dark matter. We demonstrate the efficiency of kinetic coupling of lateral outflows, and present formulas already tested for AGN feedback that can be applied to lateral feedback. In Section 3, we ask what the nature of dark matter might be. By way of quantum physics, we find that the relationship between ordinary matter and dark matter leads to the phenomenon of phase transition, a consequence of "Bose-Einstein condensate". Dark matter would never be more than a change of state that would go so far as to almost expose the quarks of hadrons. At a certain threshold temperature, all the particles in matter would phase to form a giant macroscopic wave with the characteristics of a soliton: a coherent macroscopic wave of dark matter. In section 4, we look at hyper-condensed stars on the way to becoming black holes: the neutron star, hypothetical quark stars and boson stars. The compression of baryonic matter in the core of these stars **would change the state of ordinary matter into dark matter through quantum phase transitions.** Dark matter would be composed of **dark matter waves (silitons) driven by dibaryons obeying bosonic quantum statistics.** Under conditions of threshold pressure and temperature, the crust of ordinary matter constituting the unstable degeneracy pressure of quantum mechanics overrides gravity. A "**superdiffusion"** phenomenon propagates dark matter waves through space. In section 5, we argue that dark matter appeared after the big bang and that the production of the first lumps of the universe would have been started with ordinary matter. We refute the ΛCDM theory with its cosmological constant that leads to the "vacuum catastrophe". We think that dark matter and ordinary matter have hydrogen as their deep identity. With the quantum phase transition, molecular hydrogen becomes analogous to a Cooper pair whose fermions behave like bosons. Section 6 is about how a black hole directly becomes dark matter. We show that in many cases, the black hole can dissolve completely or partially into dark matter. **We formulate that there would be another censorship between the event horizon and cosmic censorship. The trapped surface of this pre-Planck censorship would result in a quantum phase transition that would mark a change of state towards dark matter.** This pre-Planck wall would trigger a spatial expansion of the black hole into space in the form of a "dark bubble of soft matter" or a "macroscopic dark matter wave." We summarize and conclude in Section 7.

2 How dark matter comes indirectly from the black hole

The aim of this section is to present a model in which supermassive black holes act as catalysts in the dark matter formation process. Non-stellar emission from an active galactic nucleus (AGN) is thought to result from the accretion of matter by a supermassive black hole at the center of its host galaxy.

According to our scenario, black holes, through their intense accretion activity, and the energetic clouds they emit from the photon sphere (centrifugal force), collide with the gas heading towards the black hole, thus promoting a new phase transition and triggering the birth of dark matter. **We term "'lateral feedback" this outflow of energy from the photon sphere around the event horizon.**

Our scenario is a logical follow-up to the article by Joseph Silk, *et al*. dated February 2024 in Astrophysical Journal Letters [1], which suggests that energetic jets from a galactic nucleus can produce galaxies.

Since the 1980s, it has been postulated that AGNs play an important role in the evolution of galaxies. Over the past 2 decades, there has been an explosion of work attempting to link AGN-induced outflows to galaxy formation [2].

2.1 Feedback from AGNs

It has been observed that some of the matter absorbed by the black hole is ejected onto its rotation axis at speeds almost equal to those of light. These relativistic jets can travel enormous distances [3]. The most powerful ones emanate from supermassive black holes. The article by Joseph Silk reports that they examined the first galaxies observed by JWST, prior to GN-z11 [4, 5]. According to their model, AGNs would act as catalysts in the process of star creation. In this scenario, black holes, through their intense accretion activity and the energetic jets they emit, compress the surrounding gas, promoting the condensation of matter and triggering the birth of stars. Active feedback is the outflow of energy from a galactic nucleus to produce galaxies. It can ignite stars (“positive” feedback), but it can also prevent their production when the mass of the black hole is as massive as the mass of the galaxy, or when the energy of the jet heats up the cold gases and disperses them [6].

It was during the period 1998-2000 that AGN feedback and the role of AGN-induced outflows in galaxy evolution gained real momentum in the literature. This was initiated by a series of three seminal papers that confirmed earlier suggestions that black hole masses are closely correlated with the luminosities, velocity dispersions, and stellar masses of the bulges of their host galaxies [7, 8, 9]. Starting with Silk & Rees in 1998 [10, 11], analytical models have used simple arguments to show that if only a few percent of a quasar's luminosity is harnessed to drive a wind, they could create a galaxy-scale outflow and establish the scaling relationships between the black hole mass and the properties of the host bulge [10, 12]. Consequently, AGN have become a popular explanation for the observed 'excess energy' in galaxy clusters. The constant heating of hot gas around galaxies is sometimes referred to as the 'maintenance mode' of AGN feedback [6] and now has convincing evidence from observed X-ray cavities associated with radio jets and lobes. More than twenty-five years later, the role of AGN feedback in defining these scaling relationships remains [13, 14].

2.2 Lateral feedback (or how dark matter is formed)

For our part**, we believe that the enormous amount of light from the regions surrounding AGN can also influence the creation and evolution of dark matter.** With efficient mechanical coupling between the clouds of energy and charged particles crossing the outer line of the photon sphere, and the dust and gas with which they collide in the accretion zone. Suppose a rotating black hole formed by coalescence of one billion solar masses. The black hole will be surrounded by an accretion disc made of material sucked into the black hole, and falling in a spiral towards it. The matter of the accretion disc is at very high temperature and ionized, forming a plasma associated with a magnetic field. Electric and magnetic fields, electric currents, etc. form monstrous potential differences of the order of 10^{20} near the AGN. The dynamics of matter falling towards the black hole means that particles accelerated by these potential differences collide with photons in the photon sphere. The latter is a halo between the event horizon - the boundary from which one does not return when crossed - and the accretion disk [2].

2.3 Efficiency of kinetic coupling of *lateral* outflows

It is crucial to consider how the energy contained in a nuclear wind from the photon sphere is communicated to the accretion disk of a black hole to form a small-scale outflow. When it collides with the accretion medium, the wind decelerates through a "reverse shock" - **part of the energy returns to the photon sphere to be "large-scale outflow" that are relativistic jets – while causing a "secondary", small-scale outflow, composed of materials of ordinary matter and ordinary atomic matter shocked, ectomized, disatomized, become dark matter and swept away.**

The small-scale outflow composed of dark matter is said to be "energy-driven" **as long as some of the original nuclear wind energy retains a kinetic form. Much of it** has been used to work against the gravitational potential, ambient pressure, dynamic pressure of the incoming gas and, particularly, **its high thermal energy has been used to transform ordinary atomic matter into disatomized dark matter.** Therefore, we should expect the total kinetic powers of the outflow to be less than the total energy injection rate so that $\dot{E}_{kin} < \varepsilon_f L_{AGN}$. Indeed, Veilleux, *et al.* [15], who detect a small-scale wind and a large-scale molecular flow in the same system, estimate that $\lesssim 0.1$ of the kinetic power of the small-scale wind is transferred to the molecular flow.

2.4 Formulas for lateral feedback

Using Harrison's paper [16] as a starting point, we show some formulas established over the last seven decades on the luminosity, outflow, energetic jets and feedback of AGNs that initiate star birth. The importance of this exercise is that they can also be used to demonstrate outflows and lateral feedback from the photon sphere to the accretion zone.

2.4.1 *AGN luminosity*. "During the 1950s and 1960s, it was established that a massive and powerful energy source was required to explain the exceptional luminosities generated by a class of extragalactic objects now known as active galactic nuclei (AGN) [17, 18, 19]. The prevailing idea was the accretion of matter onto black holes residing within the nuclei of galaxies [20], that grow at a rate of M_{BH} and have bolometric luminosities of,

$$L_{AGN} = \frac{\eta_r}{(1-\eta_r)} M_{BH} c^2. \tag{1}$$

The inferred very high mass-to-energy conversion efficiency of $\eta_r \approx 0.1$ [21, 22] and high black hole masses (i.e., millions to billions that of the Sun) implies that over the lifetime of a typical black hole, the net energy emitted greatly exceeds the binding energy of their host galaxies [6]. It was quickly appreciated that the tremendous amount of energy from AGN could influence galaxy evolution. With effective mechanical (via the jets of charged particles observed in some AGN) or radiative coupling, it became clear that they could heat gas in and around galaxies [23, 24]".

2.4.2 *Outflows*. "In order to infer **the role of outflows in AGN feedback**, observers increasingly attempt to measure properties such as mass outflow rates, $\dot{M}_{out}$, kinetic powers,

$$\dot{E}_{kin} = \frac{\dot{M}_{out}}{2} (v_{out}^2 + A\sigma_{out}^2) \tag{2}$$

and momentum rates,

$$\dot{P} = \dot{M}_{out} v_{out} \; . \tag{3}$$

Here, v_{out} is the outflow velocity and A is a constant which determines the (uncertain) contribution of the velocity dispersion within the outflow, σ_{out} to the kinetic power [25]".

2.4.3 *Mass outflow rates. "*Mass outflow rates are usually calculated following

$$\dot{M}_{out} = B\frac{M_{out}\,v_{out}}{r_{out}} \quad (4)$$

where r_{out} is the outflow radii and M_{out} is the mass involved in the outflow. The constant B considers geometry assumptions and the fact that an instantaneous or time-averaged mass outflow rate is quoted, with $B = 1$ or $B = 3$ typically assumed (see discussion in [26]). Equation 4 is a baseline method used by many observational papers, and for studying galaxies from multiple epochs. Other approaches are also explored [27, 28, 29, 30]".

2.4.4 *Outflow masses*. "Determining the mass in a particular gas phase is very challenging. For warm emission-line outflows a common approach is to determine the gas mass from the emission line luminosity associated with the outflow ($L_{el,out}$) and the electron density (n_e) [31] following,

$$M_{out} = C\frac{L_{el,out}}{n_e}\,. \quad (5)$$

Here M_{out} is the total mass of gas involved in the outflow and in the case of calculations based on the assumption of a mass-conserving shell at a particular radius, this represents the total mass in a spherical or conical volume of radius r with a constant gas density throughout the volume. C is an adopted value that depends on the emission line used and the corresponding assumptions. Ideally hydrogen recombination lines (e.g., $H\beta$ or $H\alpha$) should be used because they are relatively insensitive to the ionisation state and elemental abundances in the outflow. However, C is still temperature dependent [31] and for Type 1 AGN there is the challenge of removing the broad line region contribution to the emission-line profiles. The bright $[O\ 111]\lambda5007$ line is sometimes used as an alternative, but the value of C is very uncertain, also depending on the ionisation state and oxygen abundance of the gas [32]. The value of $L_{el,out}$ can also be uncertain at the factor of a few level, or greater, when the outflows are difficult to isolate in the spectra and/or when the level of extinction is not constrained [33, 34]. The largest source of uncertainty for warm ionised outflow masses is probably the electron density n_e".

2.5 Theoretical expectation for lateral feedback from AGN

In a first attempt at following AGN feedback in a hydrodynamic simulation of a galaxy merger, di Matteo, *et al.* [35] let black holes, modelled as sink particles, inject thermal energy into their vicinity continuously at a rate $\dot{E}_{feed}$, proportional to their accretion rate, according to

$$\dot{E}_{feed} = \varepsilon_f \eta_r M_{BH} c^2. \quad (6)$$

The product $\varepsilon_f \eta_r$ sets the efficiency at which the accreted rest-mass energy is transferred into surrounding gas resolution elements due to AGN feedback. A term $(1-\eta_r)^{-1}$ in Equation 6 is neglected in this and other studies; however, for $\eta_r = 0.1$, ignoring this term has a negligible effect (see Equation 1). The 'feedback efficiency' ε_f, a free parameter, determines the fraction of the AGN bolometric luminosity that couples to gas in the vicinity of the black hole. Di Matteo, *et al.* calibrated ε_f to the value required to reproduce the normalisation of the local $M_{BH} - \sigma$. This gave $\varepsilon_f = 5\%$, a feedback efficiency which has since become established as a reference value in both theoretical and observational studies of AGN feedback.

Since the scales relevant to black hole accretion and the ejection of AGN winds are not resolved in galaxy formation simulations, how 'sub grid' AGN feedback models relate to a fundamental physical driving mechanism is often unclear.

In our view, the product $\varepsilon_f \eta_r$ defines the efficiency with which rest mass energy from the photon sphere is transferred into the resolving gas elements of the accretion zone due to lateral feedback from AGNs.

In some instances, fundamental theoretical models do motivate feedback efficiencies of $\varepsilon_f = 5\%$. **These theoretical models could be applied to lateral feedback, i.e. the ejection of AGN winds onto the gas and dust of the accretion disc. Drawing on King [12], we can consider a fast wind launched laterally (not ejected along the black hole's rotational axis) from the black hole's photon** at a mass rate M_w and a speed v_w, i.e. with kinetic power $\dot{E}_w = (1/2)\dot{M}_w v_w^2$. Assuming that the energy contained in this nuclear wind is entirely kinetic and that it is driven through Thomson scattering [36], i.e. $\dot{M}_w v_w \approx L/c$, it follows that,

$$\varepsilon_f = 0.05 \left(\frac{n_r}{0.1}\right)^{-1} \left(\frac{v_w}{0.1c}\right)^2. \quad (7)$$

Efficiencies of $\sim 5\%$ may therefore arise naturally **if the lateral feedback proceeds via the collision between the accretion zone and an inner wind coming from the photons sphere** with speed $\sim 0.1c$, as is the case for observed ultrafast outflows and broad-absorption line winds [12]. However, the strong scaling $\varepsilon_f \propto v_w^2$, implies that a slower inner wind, possibly driven at the dusty torus scale with $v_w = 1000 kms^{-1}$ [37], may only yield efficiencies of $\varepsilon_f = 0.006\%$.

2.5.1 *Obscuration of massive galaxies according to Silk.* "For massive galaxies, Silk, J., *et al.* [1] have found that at high redshifts, cooling of QSO winds ($\sim 3000\, km\, s^{-1}$) occurs above $z \sim 6$ for host-galaxy gas column densities $\lesssim 10^{23}\ cm^{-2}$. This range characterizes the transition to momentum-driven feedback as *z* increases. Such molecular column densities are inferred from theory and observations and indicate that it is not the "classical" torus obscuring the AGN, but the galaxy's ISM itself [38]. The minimum obscuration along the line of sight for transitioning from momentum-driven to energy-driven outflows is

$$N_{cool} \approx 10^{23} cm^{-2} \left(\frac{v_s}{3000\ km\ s^{-2}}\right)^2, \quad (8)$$

where v_s is the feedback outflow velocity. Even Compton-thick obscuring host galaxies with no X-ray detections may well exceed this cooling column by more than 1 order of magnitude. All of these high-redshift objects should have cooled, momentum-driven winds and outflows. For the relevant range of cooling columns $N_{cool} \approx 10^{23} cm^{-2}$, with Compton depths $0{,}1 - 1.0$, the AGN will be obscured. While this simple estimate assumes a spherical outflow, geometrical arguments suggest that in the more general case of directed outflows, $high - z$ AGN are always buried or obscured along the cooling momentum-driven outflow. In this case, viewed from the side, one would not see the full outflow velocity. Observable effects might, however, include turbulence, narrow line emission, and dust".

3 On the nature of dark matter

From the outset, we challenge the current Lambda Cold Dark Matter (ΛCDM) model of standard cosmology, according to which the universe from the beginning has essentially been made up of dark matter accompanied by a gas of ordinary matter. The presence of omnipresent dark matter from the beginning of the universe is an apriorism that is not based on any theory, experiment, observation, or measurement. In the eyes of many scientists today, the introduction of dark matter, which originally pervaded the universe, is as reasonable as the "luminiferous aether" before the twentieth century, which constituted the universal sea in which electromagnetic waves propagate. With the "dark aether" one can say anything about early cosmology. The underlying theoretical framework of the ΛCDM conjecture is based on the standard brightness-distance calibration extended to supernovae (which remains to be confirmed) which suggests that the universe is undergoing an acceleration of its expansion. It would be the consequence of a positive cosmological constant, of an energy of the vacuum in the absence of matter, fabulously superior to anything that can be drawn from observations [39, 40].

In our view, dark matter was born gradually well after the beginning of the universe and galaxies did not wait for it for more than a billion years to form. We mentioned above the idea that supermassive black holes, with a mass between a hundred and a million times the mass of the Sun, could behave as **intense accelerators of creation, by materializing and increasing the density of dark matter around.** We have shown that the clash between the energy from the lateral outflows of the photon sphere and the gas and dust of the accretion disk superheats ordinary matter. In this hellish atmosphere, where accelerated particles collide with bosons, where accelerated photons meet other photons, one might think that particle-antiparticle pairs would constantly be created and materialized, via $E = mc^2$ of energy-mass equivalence.

Could it be otherwise? We believe that the removal of all that is atomic from ordinary matter by excessive heat preserves only the parts that are inherently different from familiar atoms. This “de-baryonization” could, through the jets it triggers, provide a “glimpse” of quarks and gluons. These are non-individual particles linked by a color charge weakened at short range. We believe there is a fundamental relationship between the lateral retraction that causes overheating and feedback, the jet-like outflow of energy from a black hole to effect galaxy production. **The black hole would be at the origin of both dark matter and galaxies.**

But what is this dark matter made of?
In Section 2, we conjectured that the origin of dark matter was due to the lateral retraction of black holes. To discover its nature in relation to black holes, it seems inevitable to go through quantum physics. The development of nuclear physics and technologies has shown that elementary particles are transformable. All particles are made up of energy and represent the different forms that energy must take to become matter [41]. Intermediate-mass black holes could, in practice, **act as accelerators of dark matter creation** and strongly modify the distribution of dark matter in their vicinity.

In 1818, Fresnel demonstrated that light was a wave. He imagined the ether as a universal medium for its propagation. Einstein declared that the ether did not exist after the failure of experiments to verify that the speed of light obeyed Galilean law of velocity composition. Today, according to cosmologists, over 80% of matter is in non-baryonic form. They believe that dark matter fills the cosmos, disrupts the motion of galaxies, and bends light in its path. Experiments to determine its nature and properties have failed. They admit to having no precise idea of its form.

3.1 Dark matter might not be so dark after all.

Let us suppose that dark matter, of lower density than baryonic matter, is driven towards the peripheries by the centrifugal force of the spinning black hole, and that it lies between the accretion disk formed by matter falling towards the black hole and the so-called absolute vacuum [2]. What would we see of such dark matter plunged into the vacuum? Would it emit any radiation? Following the classical ideas of general relativity, it would be gravitationally attracted to ordinary matter and would rotate with the accretion disk in the case of a spinning black hole. Neither dark matter nor black holes produce radiation according to the theory of general relativity. The latter's verdict is clear, but does not consider quantum mechanics, for which the *vacuum* can never be completely empty. If we observe a small region of the vacuum, the position is known with precision and, as a result of Heisenberg's uncertainty relations, the velocity (or impulse) must be uncertain. This means that there are vacuum fluctuations in the form of high-speed particles. According to Stephen Hawking's calculations [42], some of the particles making up the vacuum fluctuations fall into the hole, while others escape as radiation. In fact, a black hole emits electromagnetic radiation (and therefore light) in exactly the same way as any body emits light when heated. So we can speak of the temperature of a black hole. But won't the same apply to the dark matter between the black hole and the vacuum subject to the black hole's ever-intense gravitational field? By assigning it a well-defined temperature, one could also construct a coherent theory of dark matter within the framework of thermodynamics and statistical mechanics. Like any body at this temperature, it should emit high-energy photons (gamma rays) or neutrinos.

In addition to black holes (stellar-mass, intermediate-mass, supermassive), other stellar objects can, in principle, interact with dark matter. If the density of dark matter is high enough, as in the center of galactic halos, or even in the primordial mini-halos where the first stars were formed, the possibility exists that the rate of creation of dark matter particles could increase in the periphery of stars to the point of injecting enough energy into the core of stars located in these extreme environments to modify their structure and evolution [41].

3.2 Superposition of states

Quantum physics also allows us to imagine the existence of *superpositions of states*: if a system possesses several possible quantum states, it may not only be in one of them, but it may also be in a hybrid state from these basic states, a “coherent superposition” of these states. **We can cite the case of an atom lying in the superposition of a dark state and a bright state.** In the mid-1980s, experimental advances made it possible to observe the fluorescence of a single atom: a single trapped ion was observed to evolve randomly between periods when it is invisible and periods when it fluoresces intensely. Under the effect of a coupling laser, the ion is in a linear superposition of two states, bright and dark. If illuminated by an auxiliary probe laser, the ion in the bright state scatters many detectable photons, while in the dark state no photons from the auxiliary laser are scattered. Such behavior has been observed with microscopic objects (electrons, photons, atoms, molecules) and mesoscopic objects (electric currents in nanocircuits) [43].

Nothing *a priori* prohibits it with macroscopic objects in quantum formalism [44]. Superconductors and superfluids are systems which, although macroscopic, exhibit quantum behavior. If quantum behavior is observed with larger and larger objects, where does the boundary lie? Schrödinger gave an amusing illustration in the form of the cat, which could be both dead and alive, two incompatible states. Why aren't we observing the coherent superposition of the states of dark matter and bright baryonic matter in the real world of matter? Why isn't 25% of the critical density of matter in the universe the state of non-baryonic dark matter? Hence the idea of supersymmetry, which associates a fermion with each boson and vice versa.

Physicists invoke “quantum decoherence” to explain the impossibility of superposed states of macroscopic objects. Decoherence must occur as soon as a quantum system interacts with the outside world. **Let's take the example of an AGN whose jets are aimed at dark regions, considered dark matter (and not hydrogen or helium gases). If the jets are powerful enough, couldn't they cause quantum incoherence? Matter would then begin to glow like ordinary matter.** (Not to be confused with the ignition of stars by gases heated by jets).

However, none of the many solutions currently proposed provides a satisfactory explanation for all the observations. This anomaly forces us to rethink our approach to cosmology and physics. Our trail leads us to particles made up of ordinary matter (or baryonic matter), but which would not be visible (quarks). The suggested relationship between ordinary matter and dark matter resembles the phenomenon of phase transition.

3.3 Phase transitions

The cosmology of the first moments after the big bang provides a framework for understanding how, thanks to phase changes, the intensity and influence of the three forces on matter began to diverge. Physicists believe that between Planck's time and a hundredth of a second after the big bang, the universe would have behaved in a similar way, undergoing at least two phase transitions. At temperatures above 10^{28} degrees Kelvin (K), the three non-gravitational forces appear as a single force, exhibiting the highest possible degree of symmetry. When the temperature dropped below 10^{28} K, the symmetry between the forces at the highest temperatures was broken as the expansion cooled. The strong force separated. The weak and electromagnetic forces remained bound, the universe cooled to 10^{15} K – about a hundred million times the temperature at the core of the Sun – when it underwent the second phase transition: the weak and electromagnetic forces detached from their previous, more symmetrical union. These two-phase transitions gave rise to the three non-gravitational interactions that crystallized in different ways [45].

And at the other extreme, the expanding and cooling universe is currently at a temperature of 2.7^o K ($-270.45°C$). At a very low temperature we also witness a phase transition for superconduction and superfluidity. Superconductivity, i.e. the disappearance of the electrical resistivity of certain conductors, occurs at temperatures close to absolute zero
($-273.15°C$), and the superfluidity of liquid helium, i.e. the abrupt jump from helium gas to liquid helium and the disappearance of its viscosity, is triggered below the critical temperature of around 2.18^o K (i.e. $-270.97°C$). As with the photo-electric effect, lasers, transistors and so on, quantum mechanics is the key to understanding these exotic properties of matter: they are the **consequences of the Bose-Einstein condensate, the condensation of all particles into a single matter wave** [46, 43].

Between these two extremes, phase transition refers to changes among the fundamental states of matter: solid, liquid and gas, and in rare cases, plasma. These are ordinary phenomena. For example, water can be solid, liquid or gaseous. Water that turns to ice has reduced rotational symmetry, and water that turns to steam has even more symmetries. Although the phase transitions of water induce abrupt changes in symmetry, the transformations of water phases from one to the other are phase transitions of the same substance. Ordinary matter and dark matter would represent two phases of the same substance. In this simple example of a water transition, H_2O is a gas if we start above one hundred degrees Celsius. In this form, the system has more symmetries than water, since the released molecules are no longer stuck together. As the temperature drops below one hundred degrees, symmetry is reduced and a phase transition from gas to liquid takes place. At zero degrees

Celsius, the phase transition from liquid to solid water induces an abrupt decrease in symmetry [45].

3.4 Change of state

Dark matter would never be more than a **change of state** and, when the macroscopic wave is formed at a certain **excessive threshold temperature** (point **λ**), all the particles of the matter considered will come into phase on the same wave and constitute a **coherent phase**. While in ordinary matter we would see the heat generated *diffuse* from one to the next, and the rise in temperature gradually become uniform, erasing the variations of the source, in the "superdiffused nucleon", we see a wave propagating which carries without attenuating them, the periodic variations of the source. In short, the heat, which was only disorder, itself becomes organized. Whereas ordinarily it diffuses and spreads like a vapor that is blown, here it propagates in an undulating manner, like a sound [43]. This is similar to a **soliton**, which is a solitary wave that behaves like a "particle" in that after colliding with another soliton, its amplitude, shape, and velocity are conserved. It is a localized "translational wave" (a gravity wave propagating in the direction of the stream) resulting from a balance between nonlinear (system in which the change of the output is not proportional to the change of the input) and dispersive effects [47, 48].

3.5 Symmetry breaking and pairing

We find that when there is excessive hadron compression and heat, it resembles the phase transitions of the early, hot, dense universe. And when there is excessive hadron compression and cooling, it resembles the phase transitions of today's cold universe. In both cases, there are threshold temperatures accompanied by a break in symmetry. We can imagine that when symmetry is broken at a threshold temperature, the quark and the antiquark go in the same direction, similar to the Cooper pair state responsible for superconductivity. An electron in a metal is repelled by other electrons due to their similar charges, but it is attracted by positive ions, so that other electrons will also be attracted. Pairing occurs when the interaction between electrons due to the displaced ions overcomes the electronic repulsion. The electric charge of the electrons is at the same time screened by the positive ions, which reduces their effective force felt at a distance [49]. In the case of excessive hadron compression and heat, which resembles the phase transitions of the early universe, the pairing of the trio of quarks at the **λ** point can be explained in a similar way: the quark is bound to the other quarks because of their different color charges which are constantly changing, but it is attracted by the virtual antiquarks constituting the quantum vacuum of the nucleon. These antiquarks tend to clump around a quark of the appropriate color; a red quark thus attracts a cloud of antired antiquarks. This causes a "polarization" of the vacuum, that is, a net displacement of the color charge that creates a kind of screen around the quark. The result should be, as in the case of electromagnetism, a partial neutralization of the "color" charge that decreases the "color" charge of the central quark. But the additional contribution of gluons turns the tables: the virtual gluons in the vacuum are colored and respond to the presence of a quark. It turns out that the gluon coat behaves in the opposite way to the quark coat and reinforces the "color" charge of the central quark instead of neutralizing it. Virtual gluons therefore oppose virtual quarks, and the calculation indicates that the gluons win and that **the "color" charge of a quark is increased by the vacuum, not decreased. The net result is that the effective color charge increases with distance instead of decreasing**. **This explains why the quark pairing holds over time** [50]. **And also why we would have a macroscopic dark matter wave.**

3.6 Discussion: Macroscopic quantum wave of dark matter

The dark matter observed as a result of collective behaviour can only raise questions that highlight aspects that call for a more advanced theory [43], such as absolute freedom which would surpass asymptotic freedom. Asymptotic freedom is the concept that effective color charges, which govern the power of strong interaction, become smaller at short distances. Suppose that a set of quarks not far from asymptotic freedom (i.e., with a small finite value of the color charge as the distance to a quark approaches zero) is heated further, could we not reasonably expect these quarks to become increasingly free, without any resistance, and to behave like free quarks in ordinary matter? There don't seem to be any free quarks in ordinary matter. The idea is that as the distance to a quark gets closer and closer to zero, the effective color charge deep within its cloud gets closer and closer to zero, but never quite reaches it.

How can one claim that there is a lasting pairing of quarks when the isolated quarks and gluons are never observed? Even if the isolated quarks and gluons are never observed, the experimenters were able to see them through the flux they induce. These are jets observed as products of high-energy collisions in accelerators. Beams of electrons and positrons, circulating in opposite directions, were accelerated by the LEP machine to reach enormous energies. The two beams crossed at a few points, where collisions occurred. The Large Hadron Collider (LHC), which uses protons instead of electrons and positrons, operated at higher energies. The comparison between theoretical predictions and experimental results from hundreds of millions of collisions was made with precision and in detail. Asymptotic freedom allowed them to interpret the jets as the visible manifestation of the underlying quarks, antiquarks, and gluons [51].

At short distances, the force between quarks is therefore abolished, which is the opposite of what happens in electromagnetism. But zero color charge means complete freedom, mathematically approximated asymptotically, meaning that as the distance from a quark approaches zero, the effective color charge deep within its cloud approaches zero, but never reaches it. This is the behavior required to explain the slavery of quarks. And which could explain the stability of the macroscopic dark matter wave.

4 Neutron stars, quark stars and boson stars

The extreme compression of baryonic matter at the heart of hyper-condensed stars **would change the state of ordinary matter into dark matter through quantum phase transitions. At a threshold temperature, before collapsing into the black hole, coalescence would take place: atoms of fermion pairs would then obey the same quantum statistics as photons and electron pairs.** The gluons linking the two baryons of a **dibaryon** would be reinforced by virtual gluons. Dark matter would be composed of quasi-free quarks still subject to the principle of Confinement. The transformation from the baryonic to the bosonic state reduces the Fermi energy of the system, making it highly unstable under conditions of high pressure and temperature. At some point, the crust of ordinary matter constituting the degeneracy pressure of quantum mechanics becomes a **superdiffusion** and overrides gravity. And the newly formed dark matter would be superdiffused into space as a **soliton**.

4.1 Neutron stars

A star can become a white dwarf when its constituent electrons degenerate. When electrons are grouped together, the exclusion principle forces most of them to high velocity. This motion generates a degenerate pressure capable of holding a star against gravitational collapse [52].

Considering quantum formulas, the average kinetic energy per electron is $(h^2\, N^{2/3})/m_e R^2$. This repulsive energy is opposed by the gravitational energy per nucleus, $(G\, N\, m_H^2)/R$. Equilibrium is achieved when the two energies are equal

$$(h^2\, N^{2/3})/m_e R^2 \; = (G\, N\, m_H^2)/R. \qquad (9)$$

(m_e: mass of the electron; N: number of atomic nuclei; m_H: mass of the proton; R: radius of the star; M: mass of the star)

From this formula follows the formula for calculating the size of a white dwarf

$$R = h^2/[G\, m_e\, m_H^2\, (M/m_H)^{1/3}]. \qquad (10)$$

Knowing that a white dwarf has about the mass of the Sun $2 \times 10^{30}\ kg$, we find a value for its radius of the order of 6,000 kilometers, i.e. the size of the Earth.

A neutron star is analogous to a white dwarf star, in which the degenerate pressure between neutrons, rather than that of electrons, provides the force that opposes gravity. The equilibrium of a neutron star formally obeys the same laws, except that the degree of compactness is such that we're only dealing with neutrons of mass m_H. Simply replace m_e (electron mass) by m_H in formula (15) to obtain the radius of such an object.

$$R = h^2/[G\, m_H\, m_H^2\, (M/m_H)^{1/3}]. \qquad (11)$$

We find a value a thousand times lower, of the order of about 2 kilometers or just a little more. The mass per unit volume is a *billion* times greater, of the order of the density of the proton itself. The average density of the atomic nucleus is $\rho = M/V \simeq 2 \times 10^{14}\ g/cm^3$, which represents 10^{38} nucleons/cm^3 [53].

Neutron stars appear to be as stable as the hydrogen atom. But have we reached a state of maximum condensation? It seems not for general relativity. By the latter's normal standards, degenerate pressure could not continue indefinitely and would give way to an unstoppable gravitational collapse which, by tearing, as it were, the fabric of space-time, would create a "temporal edge," i.e. a singularity, a boundary where space-time ceases to exist. **Has quantum mechanics truly been defeated? We believe that in some cases it has the last word. We propose that baryonic matter could transform into dark matter in neutron stars.** Following the instability created by the motional energy of neutrons at relativistic speed, a quantum transition phase would occur. Kinetic energy would bind the hadrons together, endowing them with boson-like behavior. Before protons and neutrons from the neutron star transform into a quarks-gluons plasma, baryons from these layers of ordinary matter would pair up to transform into a dark matter wave.

Thus, the boson behavior of assembled fermions causes the quantum repulsion radius that opposes gravity to become an outward-directed wave. As if the radius were increasing. Dark energy (not to be confused with the dark energy of the cosmological constant) then increases while the gravitational radius stops decreasing toward fatal collapse. The energy of gravitation is transformed to fuel this superdiffusion.

The conclusion is that a new event can occur before a tipping point causes the star to fall in on itself. When temperature and pressure reach a threshold value, a phase transition occurs that transforms two baryons (fermions) into a dibaryon (six quarks) [54] with the properties of a boson. A “critical” temperature induces a change of state in matter, which becomes a macroscopic quantum wave of “dark” matter. A kind **of “Bose-Einstein dispersion” (inverse of a Bose-Einstein condensate)** comes into play [55], which would have the effect of a dark explosion superdiffusing a dark matter wave in a sort of bubble.

4.1.1 Discussion: How neutron stars turn into dark matter

To conceive of this macroscopic quantum wave of dark matter, we need to consider that, at the quantum level, the same reality can present contradictory and complementary aspects through different phenomena. The quantum being is a hybrid being, half-corpuscle half-wave − a “corpuswave”. It is neither a wave nor a corpuscle but can be involved in both wave and corpuscular phenomena, and it is through the complementarity of these two categories of phenomena that quantum objectivity can take shape. To achieve this, however, we need theoretical tools and operational concepts. This wave-corpuscle duality led Louis de Broglie to associate a wave with a beam of electrons, the so-called de Broglie wave, with the simple relations:

$$\lambda = h/p \qquad (12)$$

$$v = E/h \qquad (13)$$

It was the analogy between interference observed with a beam of impulse $\vec{p}$ and kinetic energy $\vec{E}$, and that observed with an electromagnetic plane wave of wavelength λ and frequency v, that led to this wave function.

Following Hawking [42], a black hole emits electromagnetic radiation and has the temperature of a black hole. Wouldn't the same apply to dark matter between the black hole and the vacuum subjected to the black hole's gravitational field? Couldn't we build a theory of dark matter within the framework of thermodynamics and statistical mechanics? One could imagine a dark matter quantum wave represented by a complex number dependent on time t and position $\vec{r}$, in analogy with an electromagnetic wave:

$$\psi \alpha e^{-i(Et-\vec{\ }\vec{r})/h} \qquad (14)$$

(Beam of pulse $\vec{p}$ and kinetic energy $\vec{E}$)
Just as in electromagnetism, amplitudes must be summed (which leads to interference) and then the squared modulus taken to obtain the energy density. These complex wave functions are probability amplitudes. For a phenomenon that can occur via several indistinguishable paths, the total probability amplitude will be the sum of the various amplitudes, and the probability will be the square modulus of the total amplitude [46].

4.1.2 ***From a wave perspective***, this phenomenon occurs in the absence of any force: it is not caused by interactions between particles, such as the phase transition from water to steam or ice. Thus, if the temperature of the nucleons is increased, their agitation increases, the wavelengths associated with the movement will decrease and the nucleons will collide and be deflected. But at the same time, the color charge weakens, the wavelengths associated with the quarks will lengthen and the quarks will be able to diffract on each other. Then they will be able to pass through each other without hindering each other, and they will continue on their way without having suffered any real shock. It may follow that above a certain temperature, a sudden «drop in resistance» could be observed, which results from the wave properties of the material [49].

Thus, we would have beyond the asymptotic freedom of quarks a **quantum wave of dark matter**, instead of an anarchy. **An important fraction of quarks spreads in a global quantum wave. This phase transition is due to the indiscernibility of quarks which are likely to overlap to form a macroscopic dark matter wave.**

This macroscopic wave of dark matter constitutes a system in very weak interaction with ordinary matter. Despite this, it can possess dynamic behaviors: **it can present oscillations in the dark or more complex temporal behaviors, or even be in a stationary state, i.e. invariant over time.** Consider the example of an aircraft whose trajectory has been controlled by an autopilot: as long as the servo works, the aircraft is in a stationary state due to atmospheric fluctuations that are permanently corrected by the servo. This regulatory mechanism is a non-linear phenomenon. It is understood that the stationary state thus obtained, which has a boundary with the atmosphere, can also describe the limit between dark matter and ordinary matter [43].

4.1.3 ***From a particle physics perspective***, quarks are fermions that have a spin of $1/2$. For a baryon state of spin $3/2$ (Ω^-) in a given direction, the three quarks of the same flavor must be in the same state: spin projection in this direction equal to $1/2$. Such a configuration is forbidden by the Pauli exclusion principle: two fermions (and even less three fermions) cannot be in the same quantum state. To resolve this paradox, an internal color symmetry was introduced. Each quark flavor exists in three colors. The three quarks that make up the spin $3/2$ baryon in a given direction are identical in flavor and spin, but they differ in their colors.

Quarks that do not obey the Pauli exclusion principle, although they have spin 1/2, are thought to be "parafermions." They retain their exotic characteristics—fractional charge, confinement, and color—**but they differ in their directions (spins).** In fact, it is during the transition from ordinary matter to dark matter that pairs of fermions form integer spin bosons [46].

Scientists have suggested that dark matter is made up of hexaquarks [56, 57], a particle comprising six quarks or antiquarks of any flavor. Six quarks assembled in this way could produce a particle with a charge of zero color. For example, the hexaquark could contain six quarks from two very strongly bound baryons (a dibaryon), or three quarks and three antiquarks [58]. According to the standard model of particle physics, dibaryons would be stable once formed. In 2014, a potential dibaryon was detected at the Jülich Research Center, with an energy of around 2,380 MeV, a result that confirms observations from 2011[59, 60]. This particle, which existed for 10^{-23} seconds, was named "$d^*(2380)$" [61]. This particle is thought to be composed of three up quarks and three down quarks. It has been proposed as a constituent of dark matter [62, 63, 64].

There is a theory that strange particles such as hyperons [65, 66] and dibaryons [67, 68] could form inside a neutron star, altering its mass/radius ratio in a way that could be detectable. As a result, measurements of neutron stars could establish constraints on the possible properties of dibaryons [69]. Some might think that a large proportion of a neutron star's neutrons could turn into hyperons and merge into dibaryons at the start of its collapse into a black hole. These dibaryons would rapidly dissolve in the quark-gluon plasma during the collapse.

According to our view, these dibaryons would instead pass into a dark matter state, instead of dissolving into a quark-gluon plasma. The system of discernible particles would have reached a pressure and temperature of degeneracy that would render the particles indistinguishable, i.e. they would apparently obey the effects of Fermi or Bose statistics. At this degeneracy temperature, hadrons assemble into dibaryons, or what look like hydrogen molecules. This pairing of two baryons into a dibaryon, or of three quarks and three antiquarks into a hexaquark, would form a boson, to which the Pauli exclusion principle does not apply, allowing the existence of a population occupying the same state [70]. These dark bosons of integer spin (0, 1) correspond to a scalar field whose mean value is not zero in vacuum.

This field is responsible for **antiscreening**: as the distance to a quark approaches zero, the effective color charge deep within its cloud gets closer and closer to zero but never reaches it. Asymptotic freedom becomes a form of “vacuum polarization”, in which empty space screens an imposed charge. **This grid causes the virtual particles to take corrective action in the opposite direction. A subtle feedback effect.**

The tendency for all fermion pairs in a body to diffuse into the same fundamental quantum state is responsible for the special properties of **superdiffusion**. This term can be translated into repulsion at small or medium distances, into expansion-diffusion that would lead the substance of the quasi-black hole to a type close to the flat universe.

4.2 Quark stars

4.2.1 Quasi-chromodynamic matter that transforms into dark matter in quark stars

According to general theoretical considerations, the interior of a neutron star should have a solid crust and a liquid core, or even a superfluid, practically devoid of viscosity. The pressure exerted by "nuclear matter" at densities approaching 10^{14} grams per cubic centimeter is not precisely known. At the very core, where the density can reach several times 10^{14} grams per cubic centimeter, the nature of the matter is even more uncertain. It is possible that the mixture of elementary particles in the core of a neutron star condenses into “quark nuggets” - a solid composed of crumbled proton and neutron fragments. These quark nuggets suggest the transition of a neutron star into a quark star, composed mainly of quarks. A quark star would be analogous to a neutron star, in which the degenerate pressure between quarks, rather than neutrons, provides the force that opposes gravity [52].

4.2.2 Quark stars and chromodynamic matter

In 1965, Soviet physicists D. Ivanenko and D. Kurdgelaidze [71] showed that inside a neutron star, if the pressure is high enough, degenerate neutrons can collapse, releasing their quarks. Such matter composed of free quarks is called "chromodynamic matter".

Indeed, at the center of a neutron star, the pressure and temperature conditions are so extreme that the neutrons are confined against each other. By virtue of the Pauli exclusion principle, there comes a point where the neutrons cannot come any closer; a degeneracy pressure then appears and opposes the gravitational contraction of the star. If the mass of the neutron star increases further, the equilibrium is broken, gravity overcomes the degeneracy pressure and theoretically, the neutrons, composed of up and down quarks, could collapse and fuse by releasing their quarks. The core of the star would then become a degenerate liquid of deconfined quarks, behaving like a Fermi liquid. **The result would be a hybrid quark star, composed of both neutrons and quarks.** Such a star would be halfway between a neutron star and a black hole, both in terms of mass and density. Chromodynamic matter would then have a very high Fermi energy (energy of the highest occupied quantum state), making it highly unstable [72].

What can happen then? Currently, two options are available. We propose a third.

The first option considers that a quark star with an extremely short lifetime would dissociate almost instantaneously during a chaotic phase transition and collapse into a black hole according to the rules of general relativity.

The second is that chromodynamic matter could exist stably under high pressures and temperatures, like those at the center of a neutron star. Hence the idea of **strange quarks and strange stars**. In 1971, physicist Arnold Bodmer demonstrated that nuclear matter could collapse into stable strange matter [73]. In 1984, Edward Witten also demonstrated this, adding that this stability could be achieved under zero critical pressure [74]. This hypothesis, known as the Bodmer-Witten hypothesis, allows for the existence of stable "strange stars". Witten demonstrated that they could have formed in the early universe, just before the quarks-gluons plasma transformed into the first protons and neutrons. Zones of the quark-gluon plasma could have collapsed to form quark stars, which then rapidly transformed into stable strange stars, theoretically still existing today. In 1994, Fridolin Weber, *et al.* [75] showed that during the phase transition from degenerate neutrons to degenerate quarks, strange quarks appear to form a new stable state of matter. The transformation of up and down quarks into strange quarks reduces the Fermi energy of the system, making it more stable under low pressure and temperature conditions. The probability of detecting quark stars is very low, due to their similarity to neutron stars and their instability. In 2025, although some possible candidates are listed, no strange stars have yet been identified with certainty.

Chromodynamic matter is still poorly understood, and the phase transition between neutron matter and chromodynamic matter is not well known. Scientists have been able to recreate quark-gluon plasma at the LHC, but only at temperatures of around 10^{12} K, leading to its almost immediate decay. The conditions at the heart of a neutron star - very high pressure and temperatures above 10^{12} K - cannot be artificially recreated.

4.2.3 Ordinary matter turns into dark matter in quark stars

We submit a third option, that of baryonic matter transforming into dark matter in quark stars. A neutron star consists of several layers, each with a different composition, while a quark star would consist of chromodynamic matter (free quarks), surrounded by an outer crust of ordinary matter. At a threshold temperature, just before the last protons and neutrons collapse into a quarks-gluons plasma, a phase transition from normal to dark matter would occur [44]. There would then be a kind of coalescence: fermion atoms, composed of two protons, two neutrons and two electrons, would then obey the same quantum statistics as photons and electron pairs (Cooper pair). The gluons linking the two baryons of a dibaryon would be reinforced by virtual gluons. (In our view, these are part of the "chromogluonic" layer that connects the material world.) Dark matter would be a kind of chromodynamic quasi-matter (non-free quarks) still subject to the principle of Confinement.

Note that a possible clue to detect the possible existence of bosons trapped inside quark stars or neutron stars that still have stability would be the frequency shift and the presence of new modes in the vibrational spectrum of the stars.

The field lines of quantum chromodynamics are abruptly ejected from their frame. This phase transition would be a kind of "**dispersion**" in reverse of the Bose-Einstein condensate [43, 55], due to the heating of quarks above the agreed temperature of asymptotic freedom. The crust of ordinary matter (neutrons especially) that would constitute the degeneracy pressure of quantum mechanics becomes a superdiffusion and overrides gravity.

And this newly formed dark matter would be superdiffused in the form of solitons. A soliton is a nonlinear, self-reinforcing, localized wave packet that is strongly stable, in that it preserves its shape while propagating freely, at constant velocity, and recovers it even after collisions with other such localized wave packets. Its stability can be traced to a balanced cancellation of nonlinear and dispersive effects in the medium [47, 76].

4.3 Boson stars

A case of astrophysical interest is the possible existence of bosonic dark matter in a star that retains its stability characteristics, after the fermionic component of the star has been transformed into a bosonic component. This type of model refers to the boson star that has attracted interest in the specialized literature in recent decades [77- 80]. A mixed fermion-boson star with a dominant bosonic component is also possible [81].

In recent years, the GAIA astrometric mission has reported the discovery of a Sun-like star in close orbit around a dark object, with a semi-major axis and period of 1.4 AU and 187.8 days respectively. If the central object were a system of compact baryonic non-luminous objects, such as neutron stars, it would probably be unstable. In contrast, the scenario of a central black hole requires an unreasonable level of fine-tuning in the usual evolutionary mechanisms. Two astronomers suggest that if the central dark object is a stable cluster of spin-0, or spin-1, bosonic particles, this black hole would in fact be a so-called “bosonic” star or dark matter cluster [82].

In fact, boson stars are configurations of stable localized solitons whose complex scalar field has coupled with gravity. In the simplest case, these stars have spherical symmetry and can appear with global U(1) symmetry, as gravitationally bound scalar condensate blocks. There are also axially symmetric boson stars in rotation with non-zero angular momentum, and various non-trivial multipole stationary configurations without continuous symmetry.

We believe that for all hyper-condensed stars, the extreme compression of baryonic matter at the core of these stars would have played a role similar to the cold in producing a Bose-Einstein condensate, which causes all particles to condense into a single giant matter wave. **Stars on the path to becoming**

black holes would change the state of ordinary matter into dark matter through quantum phase transitions. The boson star would be part of the logical continuation of the transformation of baryonic matter into bosonic matter, as was the case for the neutron star and the quark star. They could all lose their degeneracy pressure and be superdiffused into space as dark matter.

Superdiffusion means neither dispersion nor dissipation since they are solitons that would be diffused. We propose that non-topological solitons—"Q-balls"—can form in neutron stars, quark stars, and boson stars. More precisely, we suggest that Q-balls from a complex scalar field mixed with hexaquarks can naturally form dark matter and become cold dark matter by superdiffusion at cosmological scales. We would have dark matter in the form of a non-topological soliton [83, 84], with conserved global symmetry but no conserved topological charge [85].

4.3.1 False occurrences of primitive Q-balls

It has been theorized that dark matter could be made of Q-balls [86, 87] and that they could play a role in baryogenesis, that is, the origin of the matter that fills the universe [88, 89]). It is suggested in supersymmetric field theories [90] that they could have been created in the early universe. It has been hypothesized that the early universe had numerous energy masses consisting of Q-balls that burst, emitting more matter particles than antimatter particles, thus explaining why matter predominates in the visible universe [91].

Researchers have established that, within the framework of the ΛCDM model, composite Q-balls can form in the radiative epoch and carry it into the material epoch of the universe [92]. They showed that the interaction between the complex scalar field and the radiation is unimportant in the Friedmann–Robertson–Walker background. They obtained two conditions for the formation of Q-balls in the primordial universe. Then, they also showed that their formation in the radiative epoch is robust when thermal corrections are pondered. They calculated their number density in the matter-dominated epoch and its formation rate. From the matter-radiation equality, they also obtain a mass of 1 eV, much smaller than the electron mass [93–95]. The Q-ball model described in their paper suggests that they form specifically during the radiation-dominated epoch by a solitosynthesis mechanism, that their formation rate and their number density depend on the global U(1) charge Q, and that very light Q-balls can form the superfluid phase of dark matter at the galactic scale by the formation of Bose-Einstein condensates. According to them, millicharged Q-balls of mass less than 1 eV formed in the early universe during the radiation-dominated epoch would be dark matter candidates responsible for early structure on the cosmological scale.

In our view, it is unacceptable that Q-balls formed specifically during the radiative epoch by a solitosynthesis mechanism should remain stable and subsist. To start, because we don't believe in the lambda-CDM model that underpins the Standard Model of cosmology; we believe in another cosmological model of the Big Bang, as we've already said. Next, even assuming the ΛCDM model is possible, it contains a physical flaw in the gravitational domain. It is parameterized by the cosmological constant Λ associated with dark energy. The study of the luminosity distance of type Ia supernovae implies the acceleration of the expansion of the universe and the existence of dark energy.

Now, the Q-ball formed during the radiation-dominated epoch by a solitosynthesis mechanism are bosons. These black bosons have a mass-energy that is attracted by the irresistible repulsive gravitation that accelerates the expansion of the universe. If dark energy has a repulsive effect on the expansion of the universe, Q-balls can only be dragged along with it. It is therefore inconsistent for them to remain stable alongside nucleosynthesis and the production of ordinary baryonic matter.

We think that the dark matter cluster of boson stars does not originate from dark matter formed at the very beginning of the universe – by baryogenesis, supersymmetry, popped Q-balls – and would not proceed from a paradigm with dark matter consisting of a whole "dark sector" of hidden particles. **Population III stars, around 400 million years after the Big Bang, on their way to disappearing as black holes, would have been excessive agents of dark matter creation.**

5 Two forms of matter, one deep identity: hydrogen

Before claiming that ordinary matter and dark matter have hydrogen as their deep identity, it seems essential to reject the alleged primitive dark matter that would have existed from the big bang. This idea was gratuitously forged to perfect a desired agreement between ΛCDM theory and observed galaxy structures. Today's cosmology seems to be content with a theory that is satisfied with an arbitrary multiplication of parameters cobbled together willy-nilly, as long as the whole thing “fits” just about.

As we said in Section 3, the ΛCDM theory is wrong. In the first place, because of Einstein's cosmological constant Λ, which some physicists believe they have rehabilitated by assigning it a value about 10^{120} larger. According to them, the energy density of the vacuum, deduced from quantum field theory, is worth about 10^{120} times the matter-energy density of the present universe, which corresponds to about $10^{121}\ protons/m^3$. The value of the vacuum energy density would be insensitive to the expansion of space and would maintain a constant value throughout it. It would constitute dark energy which, applied by their grand imagination to a repulsive cosmological constant in Einstein's equations, would currently possess a vacuum energy density 10^{120} greater than that indicated by astrophysical observations. This catastrophe of the vacuum is the unacceptable accepted [39, 96].

We don't believe that dark matter appeared at the Big Bang. From observations to theoretical deductions, physicists have gradually become convinced of the omnipresence of dark matter in all regions of the universe, and that it plays a crucial role in the structuring of galaxies and clusters of galaxies. But no observation or theory justifies its existence from the outset. We reject the idea that its insensitivity (within the limits of our current knowledge) to all interactions with ordinary matter and photons would have enabled it to initiate, “in a hidden way”, the structuring of the universe, long before ordinary matter had the chance to do so.

On the contrary, we believe that the structuring of the universe began with ordinary matter long before dark matter had a chance to do so.

Let's take a look at some of the situations that suggest original dark matter. Specialists' detailed study of the rotation curves of spiral galaxies suggests the possibility of a mysterious link between visible stars and dark matter [97, 98]. The fact is that the maximum of the rotation curves due to the stars reaches a peak and stabilizes on it like on a plateau. However, the level of this plateau is also a consequence of the dark matter halo. Which suggests that there is a sort of conspiracy between these two forms of matter.

There is also a close correlation between the shape of the rotation curve and the luminosity of the galaxy: the most luminous galaxies seem to have much less dark matter. For less luminous galaxies, however, the opposite is true: the contribution of the halo dominates, and the bulk of the motion appears to be due to dark matter. It is as if, in the final analysis, dark matter accumulates in places deserted by luminous matter, and vice versa.

To explain the observed balance between dark and luminous matter (since one forms at the expense of the other) and to resolve the problem of hidden mass within galaxies, a team of astronomers put forward the following scenario over three decades ago:
1) Galaxies would initially be composed essentially of hydrogen gas. This gas would condense into stars, to form very luminous galaxies, in which little gas would remain, and therefore little dark matter.
2) But in other cases, the star formation mechanism would be inefficient, the gas would be in diffuse form and the galaxy would end up with very few stars.
3) In intermediate situations, part of the gas would condense into stars, while the rest would remain in the form of a vast halo.

Here's our interpretation:
1) We agree that hydrogen gas would condense into stars, to form very luminous galaxies, in which little gas and therefore little dark matter would remain.
2) In other cases, where the gas is in diffuse form and the galaxy ends up with very few stars, **this is not because the star-formation mechanism was inefficient, but rather because it was too efficient. It would have rapidly produced the first stars, which would then have disappeared into hyper-condensed stars or black holes that would have produced and emitted dark matter.** There was no original dark matter to begin with.
3) In intermediate situations, some of the gas would condense into stars, while the rest would remain in the form of a vast halo [97]. But this dark matter would not emanate from the beginning of the universe.

If the seemingly coherent scenario proposed by physicists seems specious to us, it is essentially because it suggests an original dark matter. According to the theory of Relation [99, 100]**, if dark matter accumulates in places where there's no luminous matter, it is because this dark matter comes from the dissolution of black holes that formed from the first stars.**

The first stars have never been observed. Nevertheless, some models describe them as being far more massive and luminous than today's stars. What is more, their energy source may have been very different. Classical stars are made of ordinary matter, and their energy comes from the fusion of atomic nuclei. In contrast, the life of the first stars would have been linked to ordinary matter accompanied by magnetic fields [40]. This component of the universe, ignored by cosmology, probably played an active role in the birth of the first stars. *It allowed, through gravitational effects*, the accumulation of gigantic quantities of gas to form stars [41]. The first stars - those between 100 and 140 times the mass of the Sun, as well as those over 260 solar masses - will complete their evolution as black holes (those of intermediate mass will end in a supernova explosion). **Surprising as it may seem, the black holes of the first stars behave as intense producers of dark matter. As they dissolve, the ejected dark matter forms halos alongside the luminous matter. Only later does the accumulated dark matter condense with hydrogen gas into stars to form very luminous galaxies.**

If galaxies are composed essentially of hydrogen, and the evolutionary phases “hydrogen−star−black hole−dark matter” are part of this, there is a good chance that the dark matter state has hydrogen as its deep identity.

5.1 What form does it take?

It can't be in atomic form, because atomic hydrogen (H) emits a characteristic 21 cm wavelength, detectable with a radio telescope. Nor can it be in the form of ionized hydrogen, as this very hot gas emits X-rays that can also be detected by space telescopes. This allowed to observe that while this gas is very abundant between galaxies, there is very little within them. This hydrogen cannot be in compact form (black holes, ice balls, etc.), since the Macho and Eros programs have contradicted this hypothesis. What remains is molecular hydrogen (H_2), i.e. the association of two hydrogen atoms within a duo.

Molecular hydrogen emits little radiation at detectable wavelengths. Astronomers find it difficult to estimate its abundance.

From our standpoint, there's the other possibility described above. With the quantum phase transition, molecular hydrogen becomes more than the association of two hydrogen atoms within a duo, in the same way that oxygen atoms come together in pairs to form the oxygen we breathe. Rather, it is the analog of a Cooper pair, which is a complex of two fermions in a degenerate Fermi system. Cooper pairs differ from diatomic molecules in that they overlap strongly and are automatically Bose condensed [101].

6 How a black hole directly becomes dark matter

As mentioned earlier, the very powerful radiation sources found at the centers of some galaxies, as well as quasars, are associated with high-mass black holes. The radiation is not emitted by the hole itself, but by the surrounding regions. It is the relativistic jets of these rays that enable the creation of galaxies, and it is the lateral jets that would enable the creation of dark matter. We have seen how neutron stars and even quarks and bosons stars can transform into dark matter in some cases. We show here that, in many situations, the black hole can dissolve totally or partially into dark matter.

A black hole is a region of spacetime that cannot be seen by distant observers because light is trapped by a strong gravitational field. The boundary of this region is called the "event horizon", because it separates events (i.e. those inside the hole) that cannot be seen from events outside the hole that can. Black holes can form, for example, from the gravitational collapse of a massive star. As the star shrinks within an event horizon, it collapses without a known limit, leaving the surrounding space empty. Hence the name "hole". Spherical black holes (without electric charge) are called Schwarzschild black holes. Rotating holes are not spherical: they are called Kerr black holes [70]. For over a century, black holes remained a mere figment of the imagination, until on April 10, 2019, the Event Horizon Telescope (EHT) team unveiled for the first time a "photo" of a supermassive black hole, the one nestled at the center of galaxy M87 [102]. For a long time, it was said that, in principle, black holes cannot emit anything. According to Hawking [42], radiation can come from inside the gates of hell. Even if the dissolution of a black hole were to appear as a chimera, this should not prevent theoretical research. A good place to start would be to recall how substances inside a body subjected to high pressure from all sides can be transformed into new substances with different properties. When scientists compressed ice, they discovered that familiar ice is only one of seven varieties. Another, obtained under high pressure, even melts at negative temperatures, while a third, obtained under a pressure of 40,000 atmospheres, doesn't even melt in boiling water. Paradoxically, alongside cold ice, there is also hot ice. Researchers have long known that diamond and coal, though so dissimilar in appearance and in properties, are in fact made of the same material: carbon. Nature uses the same carbon atoms to build graphite, which is black and brittle, and diamond, which is transparent and the hardest of all materials. Two substances, one material.

A period full of surprises began when researchers discovered that, when subjected to high pressure, gray tin, a semiconductor, was transformed into white tin, a metal! And when the same phenomenon occurred with tellurium, it became clear that this transformation was not due to chance but obeyed some as yet unknown law. Subjected to high pressure, a series of metals behaved more than strangely. Some of them suddenly became as fragile as glass, or as soft as rubber, while others acquired, on the contrary, the hardness of diamond. Under a pressure of 100,000 atmospheres, potassium and rubidium, for example, were reduced, the former to a third of its original volume and the latter to half. Under ordinary conditions, cesium is hundreds of times more malleable than diamond, and a piece of this metal can undergo a volume reduction 300 times greater than a diamond of the same dimensions. But under a pressure of 30,000 atmospheres, cesium suddenly acquires such a hardness that in this respect it yields very little to diamond, while its malleability becomes thousands of times less. Under a pressure of 100,000 atmospheres, barium contracts most easily, but is not so much more malleable than diamond: at most, it contracts about ten times. The higher the pressure, the more substances contract, the more their atoms tighten, and the more unexpected phenomena are observed. How is it, the researchers wondered, that pressure brings the most dissimilar substances together, transforms semiconductors into soft metals, and gives soft metals the hardness of diamonds? While pondering the enigma of the underground explosions that produce precious stones, scientists have come to a curious conclusion:

diamonds may have formed from carbon dissolved in molten kimberlite (volcanic rock). It is quite possible that under the influence of high temperature and very high pressure, the carbon crystallized into diamonds.

To get to the bottom of things, scientists X-rayed the substances they were studying. X-rays convinced researchers that high pressure was capable of violently bringing atoms of matter closer together. Atoms could be compressed to the point where all free space between them disappeared. Such results have not been achieved on Earth. Such conditions exist only in hyper-condensed stars: white dwarfs and neutron stars. To which are added the hypothetical quark and boson stars, as well as hyperon stars (baryons other than proton and neutron), if they exist. A white dwarf (or electron star) has about the mass of the Sun and a radius the size of Earth. The radius of a neutron star is a few kilometers, while its mass per unit volume is of the order of magnitude of the density of a proton. While for white dwarfs the speeds between electrons are increasingly greater, they are only a fraction of the speed of light, in the case of neutron stars this speed is of the same order of magnitude as that of light. As the star contracts, trying to maintain the balance between the repulsive force of neutrons and the attractive forces, the forces of quantum origin increase: neutrons acquire greater kinetic energy. But energy of motion also means mass, so the additional kinetic energy, intended to stop the contraction, will instead accelerate it, since it weighs more. With nothing able to stop the movement that has begun, the star collapses towards the singularity of the black hole where the usual concepts of space, time and matter are no longer valid [103, 53].

What is the nature of a black hole's interior before it reaches the singularity? *A priori*, the orders of magnitude of the Planck scale should determine the singularity appearing at the edges of space-time. At the fundamental length of $\simeq 10^{-36}\, m$, quantum effects must be considered in the gravitational interaction (quantum gravity). Many studies have attempted to reconcile Einstein's theory with quantum theory, including those of superstring theory, which establish at this distance a structure of space-time which would have 10 and 11 dimensions (if not more) and not 4. But long before reaching this Planck length, quantum phase transitions much “bigger” than the Planck limit cannot be ruled out. They would act as “shock absorbers” in the relativistic fall. Each of them could form a "pre-Planck" barrier and correspond to the cosmic censorship of the black hole conjectured by Penrose [104].

Cosmic censorship is the assumption that naked singularities never occur; essentially, the singularity itself cannot be seen from the outside. It would be a kind of trapped surface between the event horizon and the singularity. Probably at the Planck length $L_P = \simeq 10^{-36}\ m$. **We assume that there are one or more other censorships between the event horizon and the cosmic censorship.** Reaching, for example, $10^{-19}\ m$. **The trapped surface of this pre-Planck censorship would lead to a quantum phase transition and the Confinement principle.** According to the latter, quarks (or antiquarks) do not exist as individual particles. Only meson (quark-antiquark) and baryon (three-quark) body plans are allowed.

The quantum phase transition would mark a change of state towards dark matter. This pre-Planck wall would trigger a spatial extension of the black hole into space in the form of a “dark bubble of soft matter” or a “macroscopic dark matter wave”. But how to explain this breach when, seen from the inside, a black hole is surrounded by an insurmountable energy barrier? In quantum mechanics, there is a process - a consequence of Heisenberg's uncertainty relations - that allows the probability density of a quantum object beyond the barrier to be non-zero. This provides a way of explaining the diffusion of dark matter from the black hole into space. This phenomenon of superdiffusion occurs in some black holes at very low temperatures, when quarks and gluons tend to separate but are unable to do so because of the principle of Confinement, when the gravity of the hexaquarks drops to almost zero and the black hole dissolves into space.

In theory, when the hadrons of a Schwarzschild black hole are subjected to pressure and cold temperature (cold contributes to compression) caused by the enormous gravity, they reach a critical temperature at which a continuous phase transition occurs. This temperature is called the degeneracy temperature because, for a given system of discernible particles, it is the characteristic temperature at which they become indistinguishable, below which the effects of the Fermi or Bose statistics they obey become apparent. At temperatures well above the degeneracy temperature, indistinguishability has little effect [70].

The hadrons of a Kerr black hole have accumulated kinetic energy in their "fall". They are very close to each other. There is coalescence. When they collide with the pre-Planck wall, they brutally lose the kinetic energy acquired during their fall, for example, by emitting a gamma ray. Having no energy left to separate, they remain bound. The cohesion of two bound baryons is expressed by their binding energy [105]. The energy lost when they were assembled has not prevented the energy of motion from increasing to that critical level where a quantum transition phase can occur: a switching takes place from a fermions system to a bosons system. Assemblies of fermions, in which the combined spin is an integer, behave like bosons, as in the case of the Cooper pair.

The strong force (interaction) is the dominant force acting between hadrons, but the inter-hadron force is a vestige of the more powerful force acting between the quarks that make up hadrons. This force is transmitted by the exchange of gluons. According to the theory of quantum chromodynamics (QCD), quarks have an electric charge that is a fraction of the electron and a small mass. Gluons have zero mass. They move very fast and carry the energy that accumulates. Mass is $m = E/c^2$ as a product of pure energy. The tensions caused by the collision with the wall stretch the space between the quarks, releasing energy, increasing the colored charge. At the same time, the shock causes oscillations and distortions within the hadron, resulting in spontaneous symmetry breaking. The symmetrical state and underlying symmetries of dynamics that may exist become unstable, and the system then exchanges precarious stability for an asymmetry that would ultimately be a change of state. Baryonic matter becomes dark matter. Superdiffusion ensues.

We could also put it in more radical terms: in some cases, the dark matter spreading through space comes from a spontaneously broken black hole. It is neither a smashing against a censorial barrier, nor a radiation across the event horizon (outwards), nor properly an explosion: but a dissolution. A counter-intuitive spectacle akin to quantum madness. For black holes are incapable of surviving unless bound by degenerative pressure, gravity, and symmetry. So they dissolve, all the more easily because they have been so compressed.

7 Summary and conclusion

In this article, we have explored a few aspects of how dark matter could originate indirectly or directly from black holes. In Section 2, we conjectured that massive black holes act as catalysts in the process of dark matter formation. Our scenario follows on from Silk's paper [1], which suggests that energetic jets from an AGN can produce galaxies. This is called active positive feedback. We believe that the enormous amount of light from the regions surrounding AGN can also influence the creation and evolution of dark matter. We refer to the term "lateral feedback" as the flow of energy from the photon sphere (between the event horizon and the accretion zone) that is deflected sideways toward the accretion zone. A new phase transition that triggers the birth of dark matter would be caused by an effective mechanical coupling between the clouds of energy and charged particles that cross the outer line of the photon sphere, and the dust and gas with which they collide in the accretion zone. We have added tested formulas for AGN feedback that can be applied to lateral feedback. In Section 3, it seems inevitable that we will have to turn to quantum physics to discover the nature of dark matter in relation to black holes. Hawking's calculations [42] show that a black hole has a temperature and emits electromagnetic radiation. Why should it not be the same for dark matter? Quantum physics also allows us to imagine the existence of superpositions of states: if a system has several possible quantum states, it can not only be in one of them, but it can also be in a hybrid state from these basic states, a "coherent superposition" of these states [44]. Superconductors and superfluids are systems that, although macroscopic, exhibit quantum behavior. Our trail leads us to particles made of ordinary matter, but which would not be visible (quarks). The suggested relationship between baryonic and dark matter resembles a phase transition. **When the macroscopic wave is constituted at a certain excessive threshold temperature (point λ), all the particles of the matter under consideration come into coherent phase on the same wave. It is akin to a soliton,** which is a solitary wave that propagates without deforming in a nonlinear and dispersive medium. In Section 4, we discussed hyper-condensed stars on the verge of becoming black holes: the neutron star, the hypothetical quark stars, and the boson stars. The compression of baryonic matter at the core of these stars **would have changed the state of ordinary matter into dark matter through quantum phase transitions. Coalescence would occur at a threshold temperature, before collapse into the black hole,** and fermion pairs would begin to obey the same quantum statistics as photons. Dark matter would be composed of quasi-free quarks, still subject to the principle of Confinement, which would form dibaryons. The transformation from the baryonic state to the bosonic state under high pressure and temperature conditions would have made the system of these stars unstable. The degeneracy pressure of quantum mechanics would prevail over gravity. There would be **superdiffusion**: the **macroscopic** wave of newly formed dark matter would spread out into space. One could also say that dibaryons would pilot solitons. In Section 5, we argued that dark matter appeared after the big bang, not as soon as the big bang. We argued that the production of the first lumps of the universe would have been started with ordinary matter long before dark matter had a chance to do so. We refuted the ΛCDM theory with its cosmological constant carrying a dark vacuum energy 120 orders of magnitude greater than the observed value. We have deduced that the dark matter state has hydrogen as its deep identity. With the quantum phase transition, molecular hydrogen, which is the association of two hydrogen atoms in a duo, becomes analogous to a Cooper pair whose fermions behave like bosons. In Section 6, we discussed how a black hole directly becomes dark matter. We showed that in many cases, the black hole can dissolve completely or partially into dark matter. **We formulated another censorship between the event horizon and the cosmic censorship. Supposedly at $\mathbf{10^{-19}}\ \boldsymbol{m}$.. The trapped surface of this pre-Planck censorship would result in a quantum phase transition marking a change of state towards dark matter.** This pre-Planck wall would trigger a spatial extension of the black hole into space in the form of a "dark bubble of soft matter" or a "macroscopic dark matter wave". Superdiffusion would complete the transition.

Physicists have speculated that the space inside a black hole, rather than being crushed indefinitely towards a "singularity", could instead sprout into an entire new universe, expanding almost from nothing into a space of its own, quite distinct and inaccessible from our own universe. According to "inflationary" cosmology, our own universe could in fact have formed in a similar way [52]. The conjecture of Relation Theory is more measured: the space inside a black hole would crash into a "pre-Planck" wall. Spontaneous symmetry breaking would transform the substance into a dark matter wave. The latter could emerge in our own universe, extending into a bubble of its own space, quite distinct from and coexisting with the baryonic sector of our universe. “Corpuswaves” occupying a valley of the energy scale would gravitationally connect to the regular sector of the universe. According to our interpretation, much of the dark matter in our universe may in fact have formed within black holes.

Our view on the nature of dark matter in our world can be in substance as follows:
Black holes produce dark matter indirectly and directly.
Hyper-condensed stars also produce it.
Dark matter appeared after the big bang, and production of the universe's first lumps would have begun with ordinary matter.
The disproportionate cosmological constant of the ΛCDM theory leads to the “vacuum catastrophe”.
Dark matter and ordinary matter have hydrogen as their core identity. Molecular hydrogen, in a quantum phase transition, would become analogous to a Cooper pair whose dibaryons behave like bosons.
Matter particles under high pressure and at a certain threshold temperature come into phase to form a coherent macroscopic wave of dark matter which has the characteristics of a soliton.
When the ordinary matter crust of hyper-condensed stars, which constitutes the degeneracy pressure of quantum mechanics, overcomes gravity, the soliton is repelled into space by superdiffusion. In many cases, the black hole dissolves in whole or in part into dark matter. A pre-Planck censorship would exist between the event horizon and the Planck cosmic censorship at $\simeq 10^{-36}\, m$.
This pre-Planck wall would trigger a spatial extension of the black hole into space in the form of a “macroscopic dark matter wave”.
Superdiffusion would continue to gradually invade the universe.

All this goes against the ΛCDM theory which we refute for the following reasons:
As mentioned in sections 3 and 5, it is an unfounded premise to believe that all dark matter was present from the beginnings of the universe, as advocated by the ΛCDM scenario. It did not participate in the reactions that led to the production of primordial elements and 10,000 years after the Big Bang, it was not at the origin of large structures. Black holes from the first stars would have generated dark matter which, subsequently, would have participated in the

formation of galaxies. As far as Lambda is concerned, let's just say that specialists know, thanks to the analysis of fossil cosmological radiation, that the universe has a flat geometry overall. This means that it contains a critical energy density, i.e. just enough for it to be infinite and not collapse on itself. About 5% of this critical density would be matter in a baryonic form and 25% in a non-baryonic form. The study of supernovae by two different teams revealed that the remaining 70% of the critical density would be in a form of dark energy which would have the effect of accelerating the expansion of the universe. However, the study of supernovae that led to the discovery of acceleration is based on the analysis of galaxies with individual and collective motions that are as yet unknown, but which have nothing to do with those describing expansion from the equations of general relativity within the framework of the homogeneous theoretical model [106]. For more than one reason [107, 39], it has been inconsistent to establish a definite link between the acceleration of expansion and the analysis of observations. Not to mention the discord surrounding Hubble's cosmic expansion for decades. Several teams of cosmologists against several others do not agree on the value of H_0 which represents the current expansion rate of the universe. These days, two clans with distinct experimental methods face off. The first announces a value of $\boldsymbol{67.4\ km/s/Mpc}$ - meaning that every second, a cube of space 1 megaparsec on a side grows by 67.4 km. - suggests a slower expansion, or even deceleration. The second exhibits a result of $\boldsymbol{74.0\ km/s/Mpc}$, which urges acceleration [108].

We conclude that a different cosmology is needed, with a new cosmic narrative and, if possible, a new equation involving the electromagnetic field [99, 100]. Let's not forget that general relativity, which describes a universe populated by matter, which, by its presence, creates gravitation, ignores energy altogether. What this article is essentially saying is that quantum mechanics can intervene, during the collapse of a star towards the singularity predicted by relativity, to transform classical matter into dark matter and propagate it through space.

References

[1] Silk, J., et al. (2024) Which Came First: Supermassive Black Holes or Galaxies? Insights from JWST, The Astrophysical Journal Letters, Vol. 961, No 2, L39. DOI 10.3847/2041-8213/ad1bf0.

[2] Ruelle, D. (1991) Hasard et chaos, Odile Jacob Points, 163, 168-170. ISBN 2-02-020933-0.
[3] Detruy, M. (2020) Trous noirs, Ciel & Espace, no 570, p. 44, 45. Jets relativistes.
[4] NASA Webb Mission Team (2024) Webb Unlocks Secrets of One of the Most Distant Galaxies Ever Seen, March 04. https://science.nasa.gov/missions/webb/webb-unlocks-secrets-of-one-of-the-most-distant-galaxies-ever-seen/
[5] Cooper, K. (2024) Space.com, The James Webb Space Telescope may have found some of the very 1st stars, March 5. https://www.space.com/james-webb-space-telescope-universe-first-stars-black-hole-population-3
[6] Fabian, A. C. (2012) Observational Evidence of Active Galactic Nuclei Feedback. Annu. Rev. Astron. Astrophys. 50, 455–489.
[7] Magorrian, J., et al. (1998) The Demography of Massive Dark Objects in Galaxy Centers. Astron. J. 115, 2285–2305.
[8] Gebhardt, K., et al. (2000) A Relationship between Nuclear Black Hole Mass and Galaxy Velocity Dispersion. Astrophys. J. Lett. 539, L13–L16.
[9] Ferrarese, L.,Merritt, D. A (2000) Fundamental Relation between Supermassive Black Holes and Their Host Galaxies. Astrophys. J. Lett. 539, L9–L12.
[10] Silk, J., Rees, M. J. (1998) Quasars and galaxy formation. Astron. Astrophys. 331, L1–L4.
[11] Haehnelt, M. G., Natarajan, P., Rees, M. J. (1998) High-redshift galaxies, their active nuclei and central black holes. Mon. Not. R. Astron. Soc. 300, 817–827.
[12] King, A. (2003) Black Holes, Galaxy Formation, and the MBH -σ Relation. Astrophys. J. Lett. 596, L27–L29.
[13] Peng, C. Y. (2007) How Mergers May Affect the Mass Scaling Relation between Gravitationally Bound Systems. Astrophys. J. 671, 1098–1107.
[14] Anglés-Alcázar, D., Davé, R., Faucher-Giguère, C.-A., Özel, F., Hopkins, P. F. (2017) Gravitational torque-driven black hole growth and feedback in cosmological simulations. Mon. Not. R. Astron. Soc. 464, 2840–2853.
[15] Veilleux, S., et al. (2017) Quasar Feedback in the Ultraluminous Infrared Galaxy F11119+3257: Connecting the Accretion Disk Wind

with the Large-scale Molecular Outflow. Astrophys. J. 843, 18.
[16] Harrison, C.M., et al. (2018) (ESO) (2018) AGN outflows and feedback twenty years on, Nature Astronomy, 2, 198-205. arXiv:1802.10306v1
[17] Baade, W., Minkowski, R. (1954) Identification of the Radio Sources in Cassiopeia, Cygnus A, and Puppis A. Astrophys. J. 119, 206– 214.
[18] Burbidge, G. R. (1958) Nuclear Energy Generation and Dissipation in Galaxies. PASP 70, 83–89.
[19] Matthews, T. A., Sandage, A. R. (1963) Optical Identification of 3C 48, 3C 196, and 3C 286 with Stellar Objects. Astrophys. J. 138, 30–56.
[20] Rees, M. J. (1984) Black Hole Models for Active Galactic Nuclei. Annu. Rev. Astron. Astrophys. 22, 471–506.
[21] Soltan, A. (1982) Masses of quasars. Mon. Not. R. Astron. Soc. 200, 115–122.
[22] Yu, Q., Tremaine, S. (2002) Observational constraints on growth of massive black holes. Mon. Not. R. Astron. Soc. 335, 965–976.
[23] Binney, J., Tabor, G. (1995) Evolving Cooling Flows. Mon. Not. R. Astron. Soc. 276, 663–678.
[24] Ciotti, L., Ostriker, J. P. (1997) Cooling Flows and Quasars: Different Aspects of the Same Phenomenon? I. Concepts. Astrophys. J. Lett. 487, L105–L108.
[25] Rodríguez Zaurín, J., Tadhunter, C. N., Rose, M., Holt, J. (2013) The importance of warm, AGN-driven outflows in the nuclear regions of nearby ULIRGs. Mon. Not. R. Astron. Soc. 432, 138–166.
[26] González-Alfonso, E., et al. (2017) Molecular Outflows in Local ULIRGs: Energetics from Multitransition OH Analysis. Astrophys. J. 836, 11.
[27] Harrison, C. M., Alexander, D. M., Mullaney, J. R., Swinbank, A. M. (2014) Kiloparsec-scale outflows are prevalent among luminous AGN: outflows and feedback in the context of the overall AGN population. Mon. Not. R. Astron. Soc. 441, 3306–3347.
[28] Liu, G., Zakamska, N. L., Greene, J. E., Nesvadba, N. P. H., Liu, X. (2013) Observations of feedback from radio-quiet quasars - II. Kinematics of ionized gas nebulae. Mon. Not. R. Astron. Soc. 436, 2576–2597.
[29] Sun, A.-L., Greene, J. E., Zakamska, N. L. (2017) Sizes and Kinematics of Extended Narrow-line Regions in Luminous Obscured AGN Selected by Broadband Images. Astrophys. J. 835, 222.

[30] Fiore, F., et al. (2017) AGN wind scaling relations and the co-evolution of black holes and galaxies. Astron. Astrophys. 601, A143.
[31] Osterbrock, D. E., Ferland, G. J. (2006) Astrophysics of gaseous nebulae and active galactic nuclei.
[32] Cano-Diaz, M., et al. (2012) Observational evidence of quasar feedback quenching star formation at high redshift. Astron. Astrophys. 537, L8.
[33] Brusa, M., et al. (2015) X-shooter reveals powerful outflows in z∼1.5 X-ray selected obscured quasi-stellar objects. Mon. Not. R. Astron. Soc. 446, 2394–2417.
[34] Rose, M., et al. (2018) Quantifying the AGN-driven outflows in ULIRGs (QUADROS) - I: VLT/Xshooter observations of nine nearby objects. Mon. Not. R. Astron. Soc. 474, 128–156.
[35] Di Matteo, T., Springel, V., Hernquist, L. (2005) Energy input from quasars regulates the growth and activity of black holes and their host galaxies. Nature 433, 604–607.
[36] King, A., Pounds, K. (2015) Powerful Outflows and Feedback from Active Galactic Nuclei. Annu. Rev. Astron. Astrophys. 53, 115– 154
[37] Roth, N., Kasen, D., Hopkins, P. F., Quataert, E. (2012) Threedimensional Radiative Transfer Calculations of Radiation Feedback from Massive Black Holes: Outflow of Mass from the Dusty "Torus". Astrophys. J. 759, 36.
[38] Gilli, R., et al. (2022) Supermassive black holes at high redshift are expected to be obscured by their massive host galaxies' interstellar medium, Astronomy&Astrophysics, Vol. 666, A17, 21 pages. DOI https://doi.org/10.1051/0004-6361/202243708
[39] Bagdoo, R. (2023) Cosmological Inconstant, Supernovae 1a and Decelerating Expansion. Journal of Modern Physics, 14, 692-721. https://doi.org/10.4236/jmp.2023.145040
[40] Bagdoo, R. (2024) ARCADE 2 Spatial Roar, What Theory of Relation Reveals. Journal of Modern Physics, 15, 690-719. https://doi.org/10.4236/jmp.2024.155032
[41] Bertone, G. (2014) Le mystère de la matière noire, Dunod, Paris, p. 100, 160, 161, 166. ISBN 978-2-10-071020-1
[42] Hawking, S. (1988) A brief history of time, Bantam Books, 99-113. ISBN 0-553-05340-X
[43] Aspect, A., et al. (2004) Demain, la physique, Odile Jacob, 67, 128-129, 123-170. ISBN 2-7381-1458-X

[44] Ortoli, S., Pharabod, J_P. (1984) Le cantique des quantiques, La Découverte, 79. ISBN 2-253-04389-3
[45] Greene, B. (1999) The Elegant Universe, Vintage Books, 350-352. ISBN o-375-70811-1
[46] Cohen-Tannoudji, G., Spiro, M. (1986) La matière-espace-temps, Fayard Folio Essais, 76, 147-149, 230, 244.
[47] Soliton, Wikipedia. https://en.wikipedia.org/wiki/Soliton
[48] Zabusky, N.J., Porter, M.A. (2010) Soliton, Scholarpedia, 5(8):2068. Doi:10.4249/scholarpedia.2068, revision #186585
[49] Lochak, G., Diner, S., Fargue, D. (1989) L'objet quantique, Flammarion, 67-79. ISBN 2-08-211178-4.
[50] Davies, P. (1987) Superforce, Payot, 152-160.
[51] Wilczek, F. (2008) The Lightness of Being, Basic Books, 47-56 ISBN : 978-0-465-01895-6
[52] Begelman, M., Rees, M. (1998) Gravity's fatal attraction, Scientific American Library, 30, 43, 228.
[53] Magnan, C. (1988) La Nature sans foi ni loi, Belfond/sciences, 182, 183, 186-191. ISBN 2.7144.2122.9
[54] Hexaquark, Wikipedia, https://en.wikipedia.org/wiki/Hexaquark.
[55] Condensat de Bose-Einstein, Wikipédia, https://fr.wikipedia.org/wiki/Condensat_de_Bose-Einstein
[56] Sutter, P. (2020) Oddball sexaquark particles could be immortal, if they exist at all [archive], LiveScience, February 4th.
[57] Gohd, C. (2020) Did this newfound particle form the universe's dark matter? [archive], Space.com, March 20.
[58] Vijande, J. Valcarce, A., Richard, J.-M. (2011) Stability of hexaquarks In the string limit of confinement, Physical Review D, vol. 85, no 1, p. 014019. DOI 10.1103/PhysRevD.85.014019, Bibcode 2012PhRvD.. 85a4019V, arXiv 1111.5921.
[59] (2014) Exotic Particle Confirmed [archive], Forschungszentrum Jülich Ppress releaseJuly 23.
[60] Chirgwin, R. (2014) Massive news in the micro-world: a hexaquark particle [archive], The Register, June 10.
[61] Adlarson, P., et al. (2014) Evidence for a New Resonance from Polarized Neutron-Proton Scattering, Physical Review Letters, vol. 112, no 2, p. 202301 (DOI 10.1103/PhysRevLett.112.202301, Bibcode 2014PhRvL.112t2301A. arXiv 1402.6844)

[62] Bashkanov, M., Watts, D. P. (2020) A new possibility for light-quark dark matter, Journal of Physics G: Nuclear and Particle Physics, vol.47, no 3, 03LT01. DOI 10.1088/1361-6471/ab67e8; arXiv:2001.08654v1
[63] Starr, M. 2020) Physicists Think We Might Have a New, Exciting Dark Matter Candidate [archive] », Science Alert, March 4.
[64] Adlarson, P., et al. (2014) Neutron-proton scattering in the context of the (2380) resonance, Phys. Rev. C 90, 035204.
[65] Jaffe, R.L. (1977) Perhaps a Stable Dihyperon (PDF), Physical Review Letters, 38 (5): 195–198. Bibcode:1977PhRvL..38..195J. DOI:10.1103/PhysRevLett.38.195. OSTI 1446298.
[66] Ambartsumyan, V. A., Saakyan, G. S. (1960) The Degenerate Superdense Gas of Elementary Particles », Soviet Astronomy, vol. 37, p. 193. Bibcode 1960SvA.....4..187A, [archive].
[67] Stotzer, R. W., et al. (1997) Search for H dibaryon in He-3 (K-, k+) Hn, Physical Review Letters, vol. 78, no 19, p. 3646–36490. DOI 10.1103/PhysRevLett.78.3646, Bibcode 1997PhRvL..78.3646S.
[68] Alavi-Harati, A., et al. (2000) Search for the weak decay of a lightly bound H0 dibaryon », Physical Review Letters, vol. 84, no 12, p. 2593–2597 (PMID 11017277, DOI 10.1103/PhysRevLett.84.2593, Bibcode 2000PhRvL..84.2593A, arXiv hep-ex/9910030)
[69] Kagiyama, S., Nakamura, A., Omodaka, T. (1992) Compressible bag model and dibaryon stars », Zeitschrift für Physik C, vol. 56, no 4, p. 557–560. DOI 10.1007/BF01474728, Bibcode 1992ZPhyC..56..557K.
[70] Davies, P. (1989) The New Physics, Cambridge University Press, 494-502. ISBN 0 521 43831 4
[71] Ivanenko,D.D., Kurdgelaidze, D.F. (1970) Quark Stars, Soviet Physics Journal 13, 1015-1019. https://doi.org/10.1007/BF00818558.
[72] Boisson, T. (2018) Qu'est-ce qu'une « étoile étrange » ? Trust my science, 20 mai. https://trustmyscience.com/qu-est-ce-qu-une-etoile-etrange/
[73] Bodmer, A. R. (1971). "Collapsed Nuclei". Physical Review D. 4 (6): 1601–1606. Bibcode:1971PhRvD...4.1601B. doi:10.1103/PhysRevD.4.1601.
[74] Witten, E. (1984). "Cosmic separation of phases". Physical Review D. 30 (2): 272–285. Bibcode:1984PhRvD..30..272W. doi:10.1103/PhysRevD.30.272.
[75] Weber, F., Kettner, C., Glendenning, N. K (July 1994) Properties of

Strange-Matter Stars, Presented at the International Conference Nuclei in the Cosmos, Gran Sasso.
[76] Zabusky, N.J., Kruskal, M.D. (1965) Interaction of "Solitons" in a Collisionless Plasma and the Recurrence of Initial States, Phys. Rev. Lett.15, 240.
[77] Liebling, S. L., Palenzuela, C (2012) Living Reviews in Relativity 15. http://www.livingreviews.org/lrr-2012-6.
[78] Bernal, A., Barranco, J., Alic, D., Palenzuela, C. (2010) Multi-state Boson Stars, Phys. Rev. D81, 044031, 0908.2435.
[79] Matos, T., Urena-Lopez, L. A. (2000) Quintessence and Scalar Dark Matter in the Universe, Class.Quant.Grav. 17, L75. astro-ph/0004332.
[80] Arbey, A., Lesgourgues, J., Salati, P. (2001) Quintessential halos around Galaxies, Phys. Rev. D 64, 123528,
URL http://link.aps.org/doi/10.1103/PhysRevD.64.123528
[81] Valdez-Alvarado, S., et al. (2013) Dynamical evolution of fermion-boson stars, Phys. Rev. D 87, 084040.
https://doi.org/10.1103/PhysRevD.87.084040. arXiv:1210.2299v2
[82] Pombo, A. M., Saltas, I. D. (2023) A Sun-like star orbiting a boson star, arXiv:2304.09140v1. DOI: https://doi.org/10.1093/mnras/stad2151
[83] Manton N. S., Sutcliffe, P. (2004) Topological solitons, Cambridge University Press. DOI: 10.1017/CBO9780511617034
[84] Shnir, Y. M. (2018) Topological and Non-Topological Solitons in Scalar Field Theories. Cambridge University Press.
https://doi.org/10.1017/9781108555623
[85] Shnir, Y. (2022) Boson Stars, Lect.Notes Phys. 1017 (2023) 347-362. DOI: 10.1007/978-3-031-31520-6_10. arXiv:2204.06374.
[86] Frieman, J. Gelmini, G., Gleiser, M. Kolb, E. (1988) Solitogenesis: Primordial Origin Of Nontopological Solitons, Physical Review Letters, 60 (21): 2101–2104. Bibcode:1988PhRvL..60.2101F.
[87] Kusenko, A., Shaposhnikov, M. (1998) Supersymmetric Q balls as dark matter, Physics Letters B. 418 (1–2): 46–54. arXiv:hep-ph/9709492.
[88] Dodelson, S., Widrow, L. (1990) Baryon Symmetric Baryogenesis, Physical Review Letters. 64 (4): 340–343. PMID 10041955.
[89] Enqvist, K., McDonald, J. (1998) Q-Balls and Baryogenesis in the MSSM, Physics Letters B. 425 (3–4): 309–321. arXiv:hep-ph/9711514
[90] Kusenko, A. (1997) Solitons in the supersymmetric extensions of the Standard Model, Physics Letters B. 405 (1–2): 108–113.

arXiv:hep-ph/9704273.
[91] Ashley, H. (2021) Weird quantum objects known as Q balls could explain why we exist, livescience.com.
[92] Mandal, S., Shankaranarayanan, S. (2025) Can Q-balls describe cosmological and galactic dark matter? https://doi.org/10.48550/arXiv.2502.00821
[93] Dolgov, A. D., Dubovsky, S. L., Rubtsov, G. I., Tkachev, I. I. (2013) Constraints on millicharged particles from Planck data, Phys. Rev. D 88, 117701.
[94] Badertscher, A., et al. (2007) Improved limit on invisible decays of Positronium, Phys. Rev. D 75, 032004.
[95] Gninenko, S. N., Krasnikov, N. V., Rubbia, A. (2007) Phys. Rev. D 75, 075014
[96] Gunzig, E. (2008) *QUE FAISIEZ-VOUS AVANT LE BIG-BANG ?* Odile Jacob, 163, 281-2. ISBN : 978-2-7381-2057-1
[97] Bouquet, A., Monnier, E. (2003) Matière sombre et énergie noire, Dunod, 123-127. ISBN 978-2-10-0506658-3
[98] Bagdoo, R. (2022). Galaxies Rotation Curves Traced Out by the Theory of Relation. European Journal of Applied Sciences, Vol. 10, No. 2, 1-14. DOI:10.14738/aivp.102.11906.
[99] Bagdoo, R. (2019) The Equation of the Universe (According to the Theory of Relation). Journal of Modern Physics, 10, 310-343. https://doi.org/10.4236/jmp.2019.103022
[100] Bagdoo, R. (2019) The World in an Equation: A Reappraisal of the Lemaitre's Primeval Cosmic Rays. Journal of Modern Physics, 10, 922-952. https://doi.org/10.4236/jmp.2019.108061
[101] Leggett, A. J. (1980) Diatomic Molecules and Cooper Pairs, Lecture Notes in Physics, LNP, volume 115, DOI:10.1007/BFB0120125Corpus ID: 120032336
[102] Black hole, Wikipedia, https://en.wikipedia.org/wiki/Black_hole
[103] Radounskaïa, I. (1972) Idées folles, Édition MIR, Moscou, 183-185, 188-192.
[104] Hawking, S., Penrose, R. (1996) The nature of space and time, Princeton University Press, 20-22. ISBN 0-691-03791-4
[105] Chelet, Y. (1961) *L'énergie Nucléaire,* Édition du Seuil, 83, 84, 124.
[106] Magnan, C. (2011) Le théorème du jardin, AMDS Édition, 267. ISBN 979-10-90238-02-2.

[107] Bagdoo, R. (2020) *The Pioneer Effect: A New Physics with a New Principle.* Journal of Modern Physics, 11, 616-647. https://doi.org/10.4236/jmp.2020.115041
[108] Langin, G. (2020) Zizanie autour de l'expansion cosmique, Ciel & Espace, Hors-série, sept/nov., HS 37, p. 45.