Quantum Magnetodynamics’ Governance of the Cosmos

David W Gold

Torquay, Devon, England UK

Email: david.gold@scienceau.uk

Updated[1]: 14 November 2020

Abstract

Quantum Magnetodynamics is presented as the foundation for Quantum Gravity where the solution realised a perfect unity with the *magnetic* and *electrical fundamental* forces. It also advances a plausible explanation for the existence of dark matter. This conceptual foundation is used to explore the influence of magnetodynamical processes throughout the cosmos, from the conditions that were evolving during the early universe preceding the Big Bang to current compact cosmic objects that are associated with powerful magnetic fields. Magnetodynamical processes would fundamentally reconcile the extreme classical hierarchical scales of the universe, with its structural formations and in their cohesion, to a governing process that originates at the utmost quantum scale.

PACS numbers: 98.80.Qc, 95.35.+d, 97.60.-s, 98.80.Bp

1. Introduction

In the original theoretical presentation [1], assessments of *quasi*-magnetic monopoles, experimentally discovered in tetrahedral crystal structures of spin ices [2–3], show them to exhibit conformity with the theoretical particles that Paul Dirac theorised to retain duality symmetry between the electromagnetic unified fields. During deliberation into the magnetic force led to the serendipitous insight that the existence of gravitons would consist of magnetic monopole dual particles, which self-organise into theoretical ‘Gravity Strands’ – the *modus operandi* as to the *vera causa* of the gravitational force. A theoretical premise readily developed, from which evolved a solution for quantum gravity in perfect unity with *magnetic* and *electrical fundamental* forces, thereby forming a foundation for Quantum Magnetodynamics.

[1] This work, originally conceived in May 2009, has been updated based on ongoing development and enhancements to openly and transparently communicate its evolving progress.

1.1 Theoretical premise

The theoretical premise is based on the reasoning that magnetic monopoles would emanate from non-confinement in QCD (in furtherance of [4]); as cause, the by-product of quark/gluon interactions. The effect would be continuous streams of oppositely charged magnetic monopole *graviton* particles expelled from nucleons in opposite directions along the axes of spin. [1] The natural pairing of nucleons in up/down spin orientations enable their streams of gravitons to self-organise into *gravity strands* of alternating charged particles, thereby initiating a gravitational force (see figure 1.1). The force of attraction manifests due to continuous head-on attractions and annihilations of alternating pairs of oppositely charged gravitons. [2] Single/unpaired nucleons (or paired nucleons where protons' spin orientations readily invert in response to an electrical or magnetic field or magnetised state) produce gravitons with the same charge flowing in the same direction, thereby instigating a magnetic force [3] (see figure 1.2). The gravitational and magnetic forces are normally distinct in that they retain non-interaction, [4] whereas their interchangeability would formalise in unification: in Gravitomagnetic unified fields.

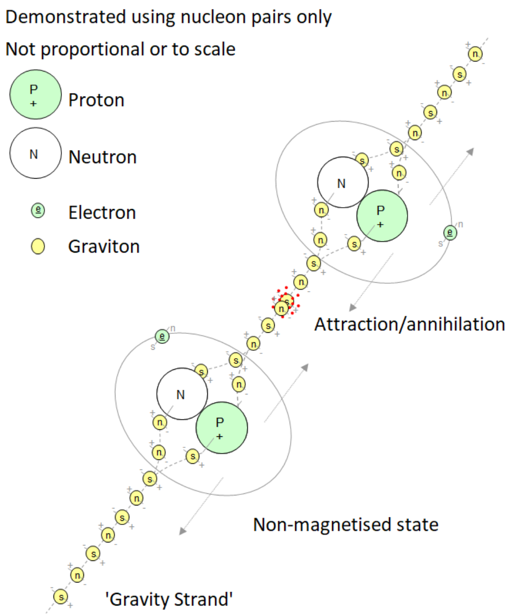


Figure 1.1: Gravitational force

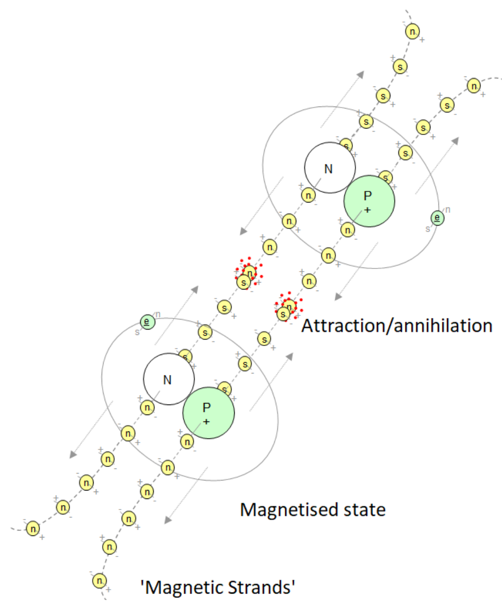


Figure 1.2: Magnetic force

[1] It defines all forms of hadronic matter as the only sources of gravitons. This would attribute the mass of black holes to extremely dense quark matter interiors. Correspondingly, neutron stars' sources of gravitons would originate from the neutron constituents of these stars. Gravitons' duality utilisation would thus explain both the very strong gravitational and magnetic fields of these compact cosmic objects. Regarding particles, only nucleons (as the only stable hadron particles) can have gravitational interactions to the exclusion of all other subatomic particles.

[2] It infers that gravitons are paired massless gauge bosons, comprising of monopoles and antimonopoles of opposite charges, which facilitates annihilation. Head-on attraction/annihilation of leading particles, in converging gravity strands, exposes the next pair of oppositely charged particles in continuation of the process. The pulling force generated by the leading particles is transferred via each opposing strand formation to the source objects.

[3] It produces plausibility that lines of magnetic flux, when made visible, are displaying monopoles with the same charge in traceable streams that curve progressively apart by their mutual repulsion (and where oppositely charged streams meet in head-on attraction/annihilation). It can be deduced that the magnetic monopole will have an electric moment, enabling interaction by the interconnection of fields between magnetic monopoles in magnetic strands and electrically charged subatomic particles. In gravity strands, the overall effects of electric moments and magnetic charges are neutralised throughout the length of each strand with only the leading particle retaining a net surplus magnetic charge.

[4] Exception arises within very powerful magnetic fields resulting in localise interference of gravity strand activity [5].

1.2 Interactions of magnetic monopoles

It is deduced that, atomically, solids are consolidated by the continuous alignment of gravity strand interactions between atomic nuclei. Gases are synthesised purely by continual intermittent interaction of gravity strands, consequential of molecular kinetic motion, and liquids are synthesised by distinguishable combinations of alignment and intermittent interaction of gravity strands. The strengths of all gravity strand interactions are concluded to be inversely proportional to molecular kinetic energy, which is dependent upon temperature [1].

The above deduction reveals an underlying dynamical phenomenon of the gravitational force, which is its dependence on temperature and, as such, is participatory in the thermodynamic properties of matter. Gravity strand interactions form part of the duality symmetry of Coulomb-Gravitational interactions, accountable for the molecular synthesis of matter, in which any asymmetry in these interactions will be the cause of expansion or contraction in matter until an equilibrium state is reinstated, or any restricted asymmetry in the gaseous states will be the cause of thermal pressure.

2. From the quantum to the classical scale

2.1 A fundamental principle of mass

Taking Einstein's famous equation in relation to the rest mass-energy of particles, and breaking down the mass element into its components of volume and density:

$$E = mc^2 = V\pi c^4 \tag{2.10}$$

where the mass element is: [1]

$$m = V\pi c^2 \tag{2.11}$$

and therefore, density is: [2]

$$\rho = \pi c^2 \tag{2.12a}$$

or alternatively:

$$\rho = \frac{\pi}{\mu_0 \varepsilon_0} \tag{2.12b}$$

It establishes that particle density is relativistically constant. Particles' volumetric size – distinct or relativistic variant – is then determined by the energy carried as verified by the Einstein-Planck formulation:

$$Vf\pi c^4 = hf \tag{2.13}$$

where h = Planck constant and f = wave frequency. The importance concerning the densities of particles is that they are identical and invariant, thereby inferring density has reached a finite universal limit: an absolute density or, to be more specific, the limit to which energy can be concentrated, where, as a consequence, energy has condensed into the manifestation of mass. [3] The significance of Eqn. 2.12b would deduce that, as energy cannot be created or destroyed and therefore must have an origin, the origin to energy is in the vacuum where vacuum energy density is potentially $1/c$ J/m^3 and, as such, must be eternal and infinite: profoundly, it will be the genesis to everything that exists.

[1] Used to ascertain electron radius = 9.166 x 10^{-17} m and proton radius = 1.122 x 10^{-15} m.
[2] πc^2 = 2.82352 x 10^{17} kg/m^3, which equates to 282 trillion t/m^3.
[3] The distinction between massive and massless particles will, therefore, be in the completeness of energy condensing at absolute density.

2.2 Black holes

When a dying star collapses in a supernova, and the mass density of the remnant core exceeds the Tolman-Oppenheimer-Volkoff limit for neutron degeneracy pressure, the object left is a stellar black hole. It is defined in relation to the premise that hadronic matter is the only source of gravitons. It can be reasoned that, for black holes to emit gravitons, the consistency of their interiors must allow quark/gluon interaction; therefore, the most plausible explanation for their interiors would be the existence of an extremely dense quark-gluon plasma or, in this context, as superfluid quark matter [6]. Accepting the assumption of absolute density, the density of this quark matter, together with its established mass, can be used to determine the volume and surface radius of a black hole. The event horizon of a black hole is determined by the Schwarzschild radius:

$$r_s = (2Gm)/c^2 \tag{2.20}$$

If the mass of a stellar black hole is less than 8.0786 solar masses, the event horizon will then be below the surface, and the black hole and its surface will therefore be observable. It is postulated that all black holes are ultimate composite particles (i.e. quark matter at absolute density). Technically, they are then deemed as quark stars.

Regarding the assumption that a black hole forms a singularity, an infinitesimal dense volume, presents an implausible entity, whereby the fundamental physical laws break down, and all known forces in their current form would be negated, which includes gravity (as, without quarks and gluons, there can be no gravity).

2.3 Gravitational radiation

The external gravitational field of a hadronic object will consist of high concentrations of unconfined free radiating gravity strands in outward gravitational radiation. [1] Including the gravitational radiation from all hadronic matter within the universe, would make gravitons among the most numerous of any particle. Their substantial non-annihilated accumulative surplus would advance an explanation as to the unexplained existence and amount of Dark Matter; the explanation becomes resolved by the continuing existence of a Cumulative Gravitational force (clarification is given later). The explanation would further advance a deduction that magnetic monopole *graviton* massless gauge-bosons do not couple with massless photon gauge-bosons, which means that only subatomic particles processing distinct units of electrical charge can couple with the quanta of light. [2]

It is plausible that, when light traverses a gravitational field of radiating gravity strands, the light is refracted in proportion to the density of the gravity strands and the angle to perpendicular of the radiation. Furthermore, the recognised frame-dragging effect can, potentially, be attributed to a rotating field of gravity strands.

[1] The density of gravity strands in gravitational radiation, which decreases inversely proportional to the square of the distance from a hadronic object, arises proportional to the mass of that object and will fluctuate in degree from any variability in mass densities within the mass. This last facet is in agreement with data collected by the ESA GOCE geoid project [7]. A consequence of gravitational radiation (relativistic) has been observed with binary pulsar PSR 1913+16 [8]. (General relativity predicts that accelerating masses should emit gravitational radiation in the same way that accelerating charged particles emit electromagnetic radiation.) Radiation is conveyed by particles.

[2] Similar to neutrinos, it would explain why magnetic monopoles remain undetected due to their apparent ‘invisibility’, whereas, unlike neutrinos, magnetic monopoles are not free radical particles but have precise functionality.

2.4 Compact cosmic objects associated with powerful magnetic fields

The duality utilisation of gravitons that culminate in gravitomagnetic unified fields will realise a correlation between gravitational field strengths and the powerful magnetic fields of compact cosmic objects. This can be understood based on the fact that, when these objects are in a highly energised state (e.g. during formation), the ability for gravitons to self-organise into gravity strands is reduced, which inversely increases the formation of magnetic strands responsible for the magnetic force. Thereby, this process can be used to elucidate the origin of such strong magnetic fields.

Magnetars with extremely powerful magnetic fields of between 10^8–10^{11} tesla are up to 1000 times more powerful than the magnetic fields of neutron stars. The magnetic field of a magnetar rapidly decays over approximately 10,000 years [9–10] to the equivalence of a regular neutron star. A hydrodynamic dynamo process from the rapid rotation of a magnetar, which is postulated as the source of the magnetic field, cannot explain the decay in the strength of the magnetic field, because the rotation increases in rate over the decay period from 5–12 seconds for most magnetars [10] to less than one second for regular neutron stars [11].

It is further reasoned that, as the energised state of the magnetar decreases, the gravitational field increases in strength as gravitons, manifested in magnetic strands, progressively self-organise into gravity strands, which explains the cause of the magnetic field's decay. Increasing gravitational strength proportionally increases the mass density of the magnetar, which is evidenced in starquakes brought about by the internal structure of the star contracting. Therefore, it also explains magnetars' increasing rate of rotation, which is due to the conservation of angular momentum. It predicts that a magnetar, initially formed at an upper limit in mass, will transmute into a black hole during its period of magnetic field decay, where contracting volume and increasing mass density eventually overcome the Tolman-Oppenheimer-Volkoff limit for neutron degeneracy pressure; as potentially occurred proceeding the initial supernova of DES14X3taz [12] and in the disappearance of N6946-BH1 [13].

The above is also considered for super-Chandrasekhar mass supernovae, where the mass of white dwarf stars can reach up to 2.8 solar masses before exploding into a supernova, thereby breaking the Chandrasekhar limit of 1.44 solar masses maximum for a white dwarf star. It has been identified in a paper by Upasana Das and Banibrata Mukhopadhyay, *Violation of Chandrasekhar Mass Limit: The Exciting Potential of Strongly Magnetized White Dwarfs* [14], as a plausible connection to this phenomenon. As presented in their paper, would again associate compact cosmic objects with initially powerful magnetic fields. A highly energised white dwarf star can form a surface magnetic field of up to 10^5 tesla [14] and, based on the previous realisation of correlation between gravitational and magnetic field strengths, an inversely weaker gravitational field. The reduction in strength of the internal gravitational force is offset by an equivalent reduction in the electron degeneracy pressure, causing an increase in volume with a correspondingly lower mass density for the star. This allows a white dwarf star, during this highly energised period, to grow by means of mass transfer from a binary companion before its mass density exceeds a critical density of 2×10^{12} kg/m^3, which triggers a supernova, thereby, providing an explanation as to how the mass of the white dwarf star can grow beyond the Chandrasekhar limit.

The above explanations form predictions to test for quantum gravity. With regard to compact cosmic objects associated with powerful magnetic fields, any deviation in an object's expected gravitational field strength being inversely proportional to its magnetic field strength, and detectable in unexpected larger object volume and lower mass density, would be an epitomization of quantum magnetodynamical processes.

2.5 Dark matter

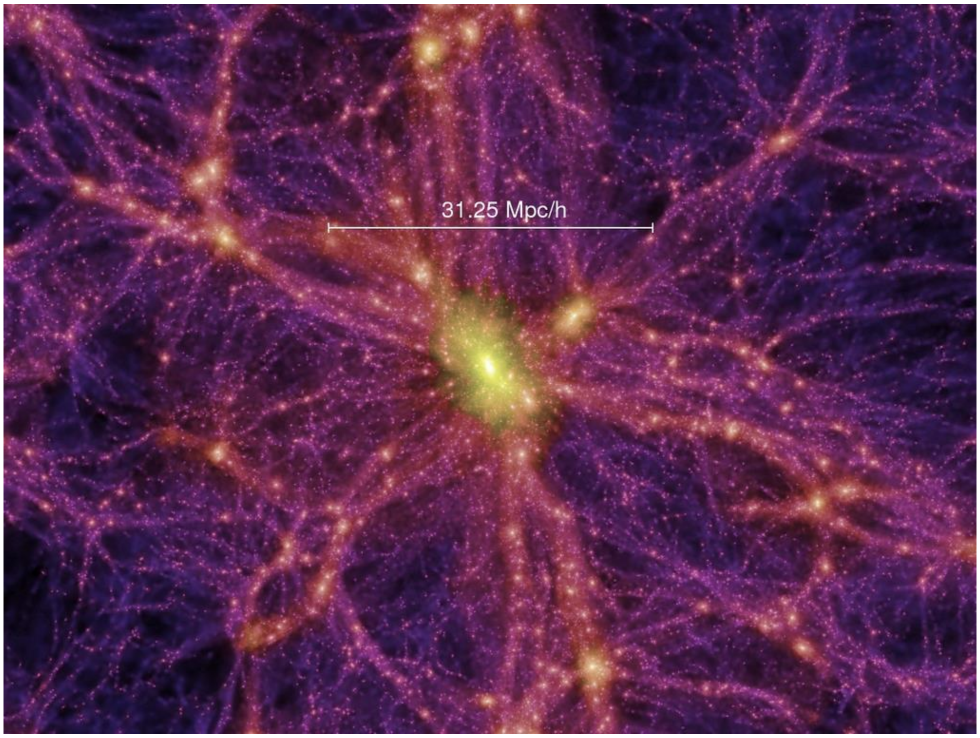


Image 1: Galaxies, galactic clusters and superclusters

The cumulative mass of the galactic supercluster at the centre of image 1 should cause curvature in space-time, which would cause the surrounding structural material to manifest to some degree in a spiral or orbital motion around the supercluster; however, this curvature is non-evident. The conglomeration of the overall megastructure is fibrous and emphasises its heterogeneous nature, as illustrated in the way filaments form between galactic structures and in which their formation is explained by a cumulative gravitational force.[1] Formerly known as dark matter, is the substantial non-annihilated accumulative surplus of the *self-interacting* mediatory gravity strands radiating from all cosmic hadronic matter. The accumulative surplus of gravity strands in halos that engulf galaxies will constitute and act as a massless *graviton gas*, and is more diffused in larger halos that surround galactic clusters. The density of gravity strands forming these halos will proportionally cause light that passes through to be refracted in a gravitational lensing effect. Gas-like consistency of these halos are explanatory to their observed displacement or distortion when two galaxies or galactic clusters collide.

The image produces an analogy that reflects, as a manifestation at the macroscopic scale, the multi-vectorial interactions of gravity strands occurring at the microscopic scale.

[1] The effect of the cumulative gravitational force over a large scale is heterogeneous in that propagation is non-uniform, while the gravitational force in a local region is homogeneous and propagates uniformly. Both are coactive at the same time over different scales. The transition from a gravitational force to a cumulative gravitational force will be realised, over a large scale, when there is a change from homogeneous to heterogeneous in interactivity; this is a consequence of the differentiation in scale that gives rise to two different aspects of the same force. (Magnetic monopole gravitons, intrinsic to all discrete scales of the gravitational force, would eliminate the need for any other non-evidential hypothetical exotic particles proposed as constituting dark matter, which, to enable interaction with gravity, would need to be hadronic (i.e. matter/particles comprising of quarks).

3. The early quantum universe

The conceptual foundation for quantum gravity is applied to the early universe preceding the Big Bang event to ascertain the conditions arising from magnetodynamical processes. The period to be considered is from after the universe was one second old – the juncture at which quark-gluon plasma condensed into protons and neutrons – to the universe at 400 million years old when the first stars formed, leading to the formation of the first galaxies at approximately one billion years.

Within the first few minutes after the Big Bang, there was a limited period when helium and traces of lithium were formed in a nucleosynthetic process. With regard to the helium nuclei, the opposite spin orientations of the two pairs of nucleons outwardly emit four monopole strands that combined by self-organising into two directionally opposite radiating gravity strands. On the other hand, in the close confinement of the inwardly emitted monopole strands, as four individual magnetic strands, interacted as attracting magnetic pairs and assisted, to some degree, nuclear binding (which is produced by the strong nuclear force by exchanging pions between nucleons). The assistance from the magnetic binding forms an explanation to the pronounced stability of helium nuclei. [1] This primordial element accounted for 25% of all baryonic matter and would have been the only source effectuating a gravitational force, and this remained the case until the recombination epoch.

The prevailing 75% of baryonic matter consisted of ionized atomic hydrogen each producing same charged magnetic monopoles in corresponding opposite radiating magnetic strands (see Figure 1.2 with consideration to a single proton's radiation of magnetic strands). The accumulative effect of the predominant atomic hydrogen magnetic strand radiation resulted in the magnetic force being the dominant force during the first 379,000-year period (between the nucleosynthesis and recombination epochs), which was a period when the early universe was still in a highly energised state. The dominance of magnetism would have produced very strong turbulent magnetic forces, which would have changed the homogeneous and isotropic distribution of matter, resulting in localised perturbation in densities. It is predicted that this period of magnetic turbulence will eventually become evident in the cosmic microwave background (CMB) when higher resolution in detail is achieved – in resembling the surface of the Sun but at a vastly greater scale.

At the recombination epoch, when the energised state of the early universe decreased substantially, matter decoupled from energy (photon radiation), which allowed electrons to combine with atomic nuclei to form atoms. From this moment on, vicinal atomic hydrogen will naturally bond by covalence to form molecular hydrogen H_2. Magnetic field moments within H_2 molecules will align the two protons' spins in opposite up/down orientations (in accordance with the Pauli exclusion principle whereby two identical adjoining fermions cannot simultaneously be in the same quantum state). Although the two protons remain repelled apart, their continuous streams of magnetic monopole gravitons will still self-organise into two directionally opposite radiating gravity strands. Once bonded, stability as H_2 molecules is dependent on energy levels. The formation of molecular hydrogen would have increasingly contributed to the overall gravitational potential. Over the next 400 million years, the dominant magnetic force significantly diminished to its present level (still evident in the cosmic web; in the filaments between galactic structures [15], as radiation of magnetic strands emanating from energetic ionise hydrogen). During this period, gravitational strength conversely increased to become the predominant governing force.

[1] Furthermore, viscosity can be explained by the degree of magnetic strand interactions between neighbouring atoms. The non-existent external radiation of magnetic strands from helium nuclei will forward an explanation to the superfluidity of liquid helium at near zero in absolute temperature.

At this early stage in the universe's development, where there were no significant structures for the gravitational force to interact with, the substantial non-annihilated surplus of gravity strands rapidly accumulated into effectuating a cumulative gravitational force (formerly referred to as dark matter).

(Conceptualism of Modified Newtonian Dynamics – MOND – or in some other modified form is considered as, potentially, a necessary approach when dealing with the presence of dark matter, or referred to as the cumulative gravitational force, which must also take into account the complexity of such a force, as over large scales, its propagation is heterogeneous.)

The manifestation of a cumulative gravitational force within large scale regions would have initiate the process of drawing matter together, causing localised perturbation in densities to grow. At first, the process will be slow but will proceed to accelerate, eventually leading to an abrupt eruption of star formation at an unprecedented rate. (This is supported by an analysis of Hubble Space Telescope deep-sky images; that is, the first stars in the universe appeared abruptly, rather than at a gradual pace. It is also evident that localised regions were in the midst of rapidly accelerating gravitational contraction.) It is expected that those regions experiencing accelerating gravitational contraction would have continued to contract and develop into a localised runaway process, where all available regional matter would finalise in a supermassive black hole. Therefore, for this not to have happen, indicates the existence of a counterbalancing mechanism that prevented total collapse.

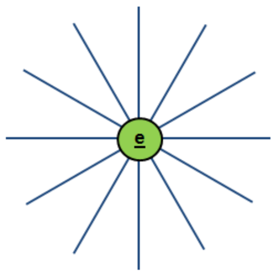
In my subsequent paper, *Formulation of a Principle Model of Forces* [16], I methodologically use extrapolations, from a recursive pattern relating to unified fields and previously unrealised recurring structures, to deduce that an additional fundamental *inflationary* force existed in unity with the weak nuclear force. The major sources of this inflationary force emanate from a by-product of nucleosynthetic processes within active stars. The repulsive aspect of this force only interacts with other nucleosynthetic active stars, which explains why these stars within galaxies naturally stay or move apart and do not collide or merge. (Only non-nucleosynthetic remnants, i.e. white dwarf stars, neutron stars or black holes, readily cause mergers.) The current accelerating expansion of the universe is also attributed to this inflationary force (formerly known as Dark Energy).

It would take the presence of this inflationary force to stop the potential for regional gravitational collapse. As regional stars form, their activation contributes to the repulsive aspect of a localised inflationary force. This activation is counterbalanced in a self-regulatory process with the regional cumulative gravitational force and thus initiates the preconditions to allow the formation of galaxies. Within galaxies, this self-regulatory counterbalancing process is dependent upon the ratio of matter densities to star densities. At the onset of star formation, the formation of black holes was still at the infancy stage. As a consequence, the first galaxies to form were dwarf galaxies and, in many cases, their matter to star density ratio was insufficient to overcome the dominance of the local cumulative gravitational force. In such cases, they finalised in total collapse, which accounts for the large deficit in dwarf galaxies expected to currently exist. This also explains the mechanism that, over a relative short timescale, caused a significant leap from the infancy stage in the formation of black holes to the existence of supermassive black holes, which are the seeds in the same early abrupt evolution of large galaxies.

The conclusion is that the gravitational force gradually developed over the first 400 million years of the universe's existence. Within approximately the first 400,000 years, the total gravitation potential was just 25% of its present potential. During this same period, the magnetic force prevailed as the dominant force that effectuated disturbances in the distribution of matter. The introduction of the inflationary force, while speculative, is conceptually an essential precondition for the formation of galaxies.

Appendix A: Loop quantum gravity

Carlo Rovelli's informative account of the development and meaning of loop quantum gravity, also referred to as loop theory, is presented in his book *Reality Is Not What It Seems: The Journey to Quantum Gravity*. At the quantum level, the gravitational field is described by Faraday's field lines. These imaginary lines represent the field emanating from a source where the separation between the lines reflects the magnitude of the field. They are usually presented two-dimensionally but should be envisaged in three-dimensions. Illustrated below are the negatively charged electrical field of an electron and the magnetic field surrounding a magnet:



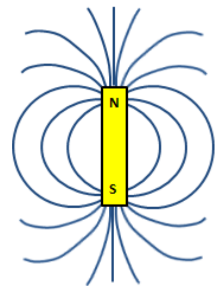


Figure A1: (a) Electron's field lines (b) Magnetic field lines

The following quote by Carlo Rovelli on an early stage in the development of loop quantum gravity is extracted from his aforementioned book:

> *...I remember a period of intense discussions and burning intellectual fervour.* [Abhay] *Ashtekar had rewritten the Wheeler–De Witt equation in a simpler form; and* [Lee] *Smolin, together with Ted Jacobson of the University of Maryland in Washington, had been the first to find some of the strange solutions of the equation. The solutions had a curious peculiarity: they depended on closed lines in space. A closed line is a 'loop'...*
>
> *...Remember Faraday's* [field] *lines – the lines which carry the electric force and which, in Faraday's vision, fill space? Well, the closed lines that appear in the solutions of the Wheeler–De Witt equation are Faraday lines of the gravitational field.* [17]

Interpretation of the loops, as presented in loop theory, concluded in quantum foam of space-time. An alternative interpretation is that for Faraday's field lines to loop on themselves is illustrated by the example of the magnetic field in (b) of figure A1. The field lines of an individual magnetic monopole will be identical to the field lines of an electron as illustrated by (a) in figure A1, but, with consideration, the size of a magnetic monopole is anticipated to be extremely small in comparison to the size of an electron. In the case of gravity strands, the field lines that are produced in an individual strand by alternating charged magnetic monopoles will be loops and where the centres of each loop are at discrete distances apart:

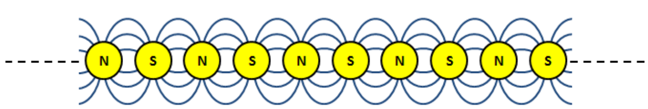


Figure A2: Gravity strand (section of) field lines

Acknowledgement

Image 1 is used with the permission and courtesy of Prof. Volker Springel et al. and Virgo Consortium in association with the Millennium Simulation Project at the Max Planck Institute for Astrophysics: https://wwwmpa.mpa-garching.mpg.de/galform/virgo/millennium/

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