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Foundation of the Unicentric Model of the Observable Universe—UNIMOUN

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Abstract

In view of the growing difficulties of ΛCDM-cosmologies to compete with recent highly accurate cosmological observations, I propose the alternative model: the Unicentric Model of the Observable UNiverse (UNIMOUN). The model relies on employing a new time-dependent $\mathcal{H}$-metric for the GR field equations, which enables reversible phase transitions between normal compressible fluids and incompressible quantum superfluids, necessary for studying the cosmic evolution of the observable universe. The main properties of UNIMOUN read: 1) The observable universe was born in a flat spacetime environment, which is a tiny fraction of our infinitely large and flat parent universe, 2) Our big bang (BB) happened to occur in our neighbourhood, thereby endowing the universe the observed homogeneity and isotropy, 3) The energy density in the universe is upper-bounded by the universal critical density ρ_{cr}^{uni}, beyond which matter becomes purely incompressible, rendering formation of physical singulareties, and in particular black holes, impossible, 4) Big bangs are neither singular events nor invoked by external forces, but rather, they are common self-sustaining events in our parent universe, 5) The progenitors of BBs are created through the merger of cosmically dead and inactive neutron stars and/or through "supermassive black holes" that are currently observed at the centres of most massive galaxies, 6) The progenitors are made up of purely incompressible entropy-free superconducting gluon-quark superfluids with $\rho = \rho_{cr}^{uni}$ (SuSu-matter), which endows these giant objects measurable sizes, 7) Spacetimes embedding SuSu-matter are conformally flat. It is shown that UNIMOUN is capable of dealing with or providing answers to several fundamental open questions in astrophysics and cosmology without invoking inflation, dark matter or dark energy.

Keywords

General Relativity: Big Bang, Black Holes, QSOs, Neutron Stars, QCD, Condensed Matter, Incompressibility, Superfluidity, Super-Conductivity

1. Introduction

For thousands of years, the geocentric model was accepted as the unrivalled model which visibly describes the cosmos: celestial bodies and objects, including the moon, planets, the Sun, stars and etc., move across the sky, whereas the Earth residing in the centre of the cosmos. Theoretically, the model was first discussed by the famous Greek philosophers Plato and Aristotle and completed about 450 years later by the Greek astronomer Ptolemy [1] [2]. Accordingly, the Earth is a perfect sphere, stationary and located at the centre of the cosmos, whilst all other celestial objects orbit it. The first orbit was devoted to the moon and followed respectively by Mercury, Venus, the Sun, Mars, Jupiter and Saturn.

The model continued to be valid until Nicolaus Copernicus in 1543 published his new radical heliocentric model of the universe. Here the Sun, rather than the Earth, lies in the centre of the universe, whilst all other celestial objects, including the Earth, moon and planets, are orbiting the Sun. Moreover, together with Galileo Galilei, it was argued that the Earth even rotates around its axis once a day. Hence the centuries-long divine role of the Earth in the cosmos was suddenly cancelled and doomed the Earth to a normal celestial object [3] [4].

Several years later, Thomas Digges proposed replacing the heliocentric model with an alternative one, in which the universe is completely flat, static and infinite in space and time. The model was ignored due to missing support from astronomers.

Despite the modification of Johannes Kepler and Isaac Newton, the heliocentric model did not survive the early years of the nineteenth century, when observations revealed that the solar system, together with the embedding milky way galaxy, are just tiny fractions of a much larger universe. Based thereon, an alternative model was suggested by Einstein in 1917, in which the universe is spatially finite but temporally infinite [5]. Here Einstein included the cosmological constant in his field equations to relax the expansion of the spacetime at the background. However, several years later, Edwin Hubble discovered that the universe is expanding rather than static. When combining this finding with the observed homogeneity and isotropy of the universe, it was concluded that the milky way, as well as other galaxies, are uniformly distributed on the surface of an inflating ballon-like structure that lacks a central symmetric point, hence why the FLRW-metric was considered to be the correct metric for describing the expanding universe (see [6] [7] and the references therein). The current ΛCDM-cosmologies use this metric to study the universe's accelerating expansion. However, this simple model was found to still be inconsistent with various observed properties of the universe, and therefore new exotic components were invoked to solely match observations, though their physical origins continued to be a mystery [8] [9].

ΛCDM-cosmology is currently widely accepted as the standard model of cosmology, in which inflation, dark matter (DM) and dark energy are its main building blocks. DM was invoked to enable the formation of galaxies, large-scale structures and reasonable distributions of galaxies in the observable universe, whereas dark energy, generally identified as the cosmological constant Λ in the field equations, is the driver for accelerating the expansion of the universe [10] [11]. The role of inflation is to enable an abrupt expansion of the universe, through which observations of the early universe, the absence of magnetic monopoles, homogeneity and geometrical flatness of our observable universe may nicely be explained [12] [13] [14].

On the other hand, despite advanced BH theoretical research and the recent tremendous efforts by the EHT observations, which placed the existence of BHs beyond doubt, it is, however still unclear why the universe chose to adopt exponential inflation in the early universe rather than collapsing into a supermassive black hole [15] [16] [17] which is the preferable evolutionary track, when taking into account the short length and time-scales characterizing the system. Moreover, the ΛDCM-cosmologies failed to resolve other fundamental problems in astrophysics and cosmology, e.g. the coincidence and fine-tuning problems, the voids crisis, the nature of dark matter and dark energy and how to resolve the current persistent Hubble tension [8] [18].

The related fundamental question to be answered is: Do the laws of nature permit the existence of a maximum energy density in the universe? If they do, BHs become superfluous and their existence should be ruled out.

Worth noting here is that the BH-paradigm was rejected at least two times by Einstein: in 1915 and 1939 when he mentioned that "Schwarzschild singularities do not exist in physical reality."

Indeed, UNIMOUN is a self-consistent model of the universe and a promising alternative to ΛDCM-cosmologies; no exotic components are needed, and in most cases, it complies nicely with observations whilst suggesting simple and reasonable answers to still open questions is astrophysics and cosmology.

In the present paper, we present an alternative model to the evolution of the observable universe, abbreviated UNIMOUN. In the following sections, we discuss the physical basis of the model and its mathematical foundation and briefly propose answers to selected open questions in astrophysics and cosmology. Finally, I end up with Section 5, where I summarise the model's main aspects and highlight the relevant consequences.

2. Pulsars: The Fabric of Incompressible Gluon-Quark Superfluids

The state of matter inside massive neutron stars (NSs) cannot be probed under terrestrial conditions, though multi-messenger observations may be used to limit the range of possibilities. In particular, the observed glitch phenomena in pulsars, together with the recently discovered under and over-shootings found to associate the glitch events in the Vela pulsar, confirm the predicated exchange of mass and angular momentum in the geometrically thin boundary layer between the rigid-body rotating quantum core and the differentially rotating dissipative matter in the overlying shells [19] [20] [21] [22]. Recalling that the density of degenerate matter inside the cores of massive pulsars is larger than the nuclear density ρ_0, then the cooling down of pulsars on cosmic times should transfer their contents into entropy-free superfluids. Further confirmation comes from the recently detected merger of the NS-binary in GW170817, in which the remnant is apparently not a BH but rather a NS with a hypermassive superfluid core [23]. Similar to massive stars, the luminous lifetimes of NSs correlate inversely with their masses, which, among others, may explain the missing first generation of NSs formed from the collapse of population III stars (see [24], and the references therein).

In the following, I address additional properties of NSs that are relevant to UNIMOUN:

- Had NSs radiated away their entire secondary energies[1], then their contents would settle down to the truly lowest possible quantum energy state. It is hypothesized here that this supranuclear dense matter with zero-entropy would consist of paired gluon-quarks that collectively behave as a single quantum entity. In the absence of secondary energies, internal communications between the constituents are mediated with the speed of light, which make the matter well-equipped to resist all types of external perturbations, including self-collapse.
- The glitches of the well-observed Crab and Vela pulsars are abrupt events through which considerable amounts of rotational anergies are ejected from their cores into the ambient media, where they viscously diffuse through the whole shell, thereby triggering their observed spin-up (**Figure 1**). Indeed, it was shown that pulsar cores evolve in accord with the Onsager-Feynman equation [19]:

$$\frac{\mathrm{d}(S\Omega)}{\mathrm{d}t} = \frac{h}{2m}\frac{\mathrm{d}N}{\mathrm{d}t}, \tag{1}$$

where S, Ω, N are the cross-section, angular frequency, and the number of vortices inside the core, respectively.

During the glitch event, the cross-section of the core, S, must increase, and due to incompressibility, its mass and dimension increase linearly as well. Consequently, in the limit of $t \to \infty$, the angular frequency $\Omega \to 0$, and therefore $S \to S_\infty$, which is equal to the total cross-section of the object. This implies that the dead NS is effectively metamorphosed into an invisible object that consists solely of its rest mass, as shown in **Figure 1**. These objects are termed dark energy objects (DEO).

- Observations indicate that newly born pulsars undergo glitching more frequently than older ones [25] [26]. The Crab and Vela follow these tendencies. This indicates that pulsars are born with embryonic SuSu-cores, but their effects become measurable once their relative inertias became dynamically significant (see Figure 4 in [22]).
- The spacetime embedding incompressible entropy-free SuSu-matter should be flat.

[1] e.g. $E_{thermal} = E_{kinetic} = E_{magnetic} = \cdots = 0$.

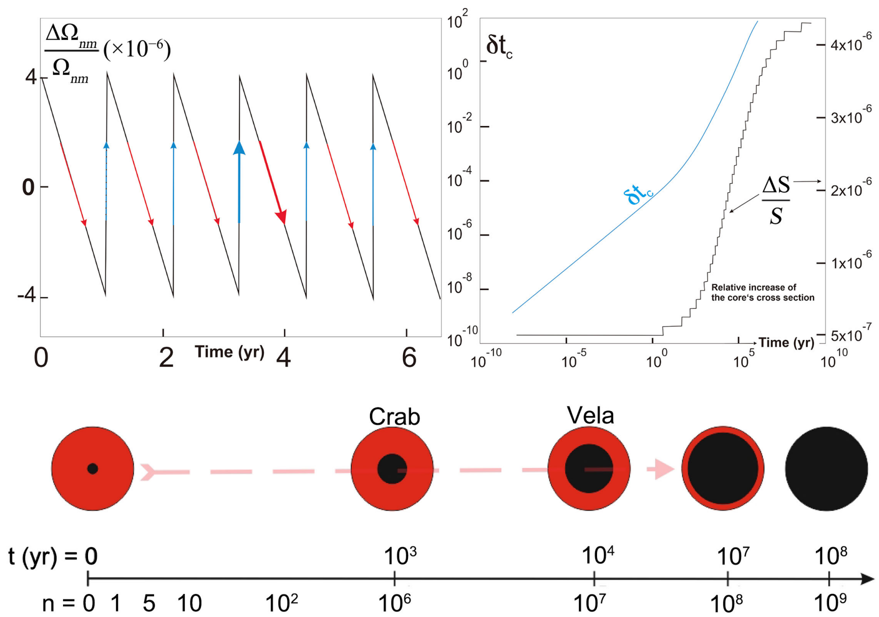

Figure 1. The time-evolution of the relative change of the angular frequency, $\Delta\Omega_{nm}/\Omega_{nm}$ of normal matter inside the boundary layer between the rigid-body rotating SuSu-core and the normal matter in the ambient shell is shown during two successive glitch events (top-left). In the top-right panel the duration between two successive glitch events, δt_c, and the corresponding increase of the relative cross-section of the DEO-core, $\Delta S/S$, versus cosmic time are shown. In the lower panel, the cosmic evolution (yr) of the size of a SuSu-core (black circle) of an arbitrary pulsar relative to the surrounding shell of normal matter and the corresponding total number of glitch-events are shown. Here, the Crab and Vela pulsars are predicated to have undergone million and ten million glitching events during their lives, respectively. They are expected to fully metamorphose into DEOs after having undergone several billion glitching events, which correspond to roughly one hundred million years.

In a previous study, it was argued that the amount of enclosed total mass of normal matter in a system should be readable from the curvature of the embedding spacetime, in accord with ADM-mass calculated from the positive energy theorem [17].

Assume we are given a cosmically dead NS, and the enclosed matter is on the verge of making a phase transition from maximally compressible into an incompressible state. In this case, there is no volume change as the separation between three quark flavours inside a baryon at ρ_{max}^{uni} and $T = 0$ is 0.85 fm (see Figure 4 in [17]) is identical to the average separation between any pair of quarks. Here it was conjectured that the energy stored in the curvature of the embedding spacetime during the phase transition goes into a macroscopic confining of the ocean of the incompressible SuSu-matter. The process here is reversible: once the SuSu-core undergoes hadronization, the macroscopic confining energy goes back into curving the embedding spacetime.

• Purely incompressible SuSu-matter is insensitive to further compression by external forces, and therefore all types of gradients of physical quantities vanish. Hence the regularity condition usually imposed at the centre of astrophysical objects is met everywhere inside SuSu-cores, therefore rendering the geometrical centre physically unimportant and endowing the constituents with the same physical conditions irrespective of their locations.

For an observer inside the sphere (save the boundary), the matter distribution is perfectly homogenous and isotropic. This implies that the probability for the hadronization front to start its runaway precisely at the centre would be inversely proportional to the number of particles inside the sphere, which is vanishingly small.

On the other hand, a runaway front that starts off-centre would be amplified during the cosmic expansion and therefore would violate the homogeneity and isotropy of the observable universe.

Moreover, a runaway front that starts inside the core would lead to local energy enhancement and therefore to over-dense sectors relative to the background energy density ρ_{max}^{uni}, which would violate the incompressibility condition, and therefore is forbidden by construction. The property of homogeneity and isotropy holds if hadronization is triggered by surface effects on a perfectly spherical symmetric object, which, under the here-discussed conditions, should be connected to an abrupt decay of the macroscopic force confining the ocean of SuSu-superfluid.

- A $10^{24} M_{\odot}$ progenitor with $\rho > \rho_0$ would not survive the collapse into a BH if the embedding spacetime were not flat.

3. UNIMOUN: Mathematical Foundation

The basic argument of UNIMOUN is that the observable universe is a perturbed local sub-domain of the infinitely large and flat parent universe, which is populated by all types of astrophysical objects, including stellar-mass DEOs and supermassive DEOs (SMDEOs). The giant perturbation was derived the hadronization of a $10^{24} M_{\odot}$ progenitor, which is deemed big bang. However, apart from mass and dimension, the structure of the progenitor is physically identical to DEOs. These are assumed to have conglomerated into clusters that subsequently merged to form SMDEOs. Due to their universal low energy states, their mergers should proceed smoothly. Alternatively, the massive black objects that are observed to reside at the centre of most massive galaxies, usually called supermassive BBs, may also function as powerful machines for converting normal matter into incompressible SuSu-matter. Accreting of matter, formation of powerful jets and merger with other objects are possible mechanisms for enhancing the mass and dimensions of SMDEOs.

Based thereon, the field equations to be solved read:

$$R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} = -\kappa T_{\mu\nu}, \tag{2}$$

where R is the Ricci tensor, $g_{\mu\nu}$ is the metric coefficients and $\kappa = 8\pi G/c^4$ [27]. $\{\mu,\nu\}$ run from 0 to 3. Following [28], the following new time-dependent $\mathcal{H}$-metric was introduced:

$$\mathrm{d}s_{\mathcal{H}}^2 = g_{\mu\nu}\mathrm{d}x^{\mu}\mathrm{d}x^{\nu} = g_{00}\,\mathrm{d}t^2 + g_{11}\,\mathrm{d}\overline{r}^2 + g_{22}\,\mathrm{d}\theta^2 + g_{33}\,\mathrm{d}\varphi^2 \tag{3}$$

where

$$g_{00} = c^2\mathrm{e}^{2\mathcal{V}(r,t)}, g_{11} = -\mathrm{e}^{2\lambda(r,t)} g_{22} = -\mathrm{e}^{2\mathcal{C}(t)}r^2, g_{33} = -\mathrm{e}^{2\mathcal{C}(t)}r^2\sin^2\theta. \tag{4}$$

Here $\mathcal{V}$ and λ are functions of the comoving radius $\overline{r}(r,t) = r\mathrm{e}^{\mathcal{C}}$, and $\mathcal{C}(t)$ is a function of time only. All physical and geometrical events are measured with respect to the preferred observer $\mathcal{H}_0$ located at $r = 0$.

Depending on the underlying physical problem, the $\mathcal{H}$-metric may reduce to the classical metrics of Minkowski, Schwarzschild and Friedmann [28].

Using the Christoffel symbol:

$$\Gamma^{\lambda}_{\mu\nu} = \frac{1}{2}g^{\lambda\kappa}\left\{g_{\kappa\nu,\mu} + g_{\kappa\mu,\nu} - g_{\mu\nu,\kappa}\right\}, \tag{5}$$

to calculate the Ricci tensor, see [28] [29]:

$$R_{\mu\nu} = \Gamma^{\alpha}_{\mu\alpha,\nu} - \Gamma^{\alpha}_{\mu\nu,\alpha} + \Gamma^{\alpha}_{\mu\beta}\Gamma^{\beta}_{\alpha\nu} - \Gamma^{\alpha}_{\mu\nu}\Gamma^{\beta}_{\alpha\beta}, \tag{6}$$

we then obtain the following Ricci components:

$$\begin{aligned}
R_{00} &= \ddot{\lambda} + \dot{\lambda}^2 - \dot{\mathcal{V}}\dot{\lambda} + 2\ddot{\mathcal{C}} + 2\dot{\mathcal{C}}^2 - 2\dot{\mathcal{V}}/r + \left(-\mathcal{V}'' + \mathcal{V}'\lambda' - (\mathcal{V}')^2 - 2\mathcal{V}'/r\right)\mathrm{e}^{2(\mathcal{V}-\lambda)} \\
R_{11} &= \left(-\ddot{\lambda} - \dot{\lambda}^2 + \dot{\mathcal{V}}\dot{\lambda} - 2\dot{\lambda}\dot{\mathcal{C}}\right)\mathrm{e}^{2(\lambda-\mathcal{V})} + \mathcal{V}'' + (\mathcal{V}')^2 - \mathcal{V}'\lambda' - 2\lambda'/r \\
R_{22} &= -\left\{\ddot{\mathcal{C}} + \dot{\mathcal{C}}\dot{\lambda} + 2\dot{\mathcal{C}}^2 - \dot{\mathcal{V}}\dot{\mathcal{C}}\right\}r^2\mathrm{e}^{2(\mathcal{C}-\mathcal{V})} + (1 + r\mathcal{V}' - r\lambda')\,\mathrm{e}^{2(\mathcal{C}-\lambda)} - 1 \\
R_{33} &= -r^2\sin^2\theta\left[\ddot{\mathcal{C}} + 2\dot{\mathcal{C}}^2 - \dot{\mathcal{V}}\dot{\mathcal{C}} + \dot{\mathcal{C}}\dot{\lambda}\right]\mathrm{e}^{2(\mathcal{C}-\mathcal{V})} + \sin^2\theta\left[(1 + r' - r\lambda')\,\mathrm{e}^{2(\mathcal{C}-\lambda)} - 1\right]
\end{aligned} \tag{7}$$

where $\dot{\square}, \square'$ denote the time and spatial derivatives of the variables, respectively.

Performing detailed algebraic manipulations, re-arrangements and carrying partial integration of certain terms, we end up with the following two equations [28]:

$$\begin{aligned}
&\left[\frac{\ddot{R}}{R} - (1+\mathcal{Z}_b)\left(\frac{\dot{R}}{R}\right)^2 - \dot{F}\left(\frac{\dot{R}}{R}\right)\right]\mathrm{e}^{-2\mathcal{V}} + \frac{1}{2r}\left[\frac{\partial}{\partial t}\left(\mathrm{e}^{-2\mathcal{V}}\right) + \frac{\mathrm{e}^{-2\lambda}}{\mathrm{e}^{-2\mathcal{V}}}\frac{\partial}{\partial r}\left(\mathrm{e}^{-2\mathcal{V}}\right) + \frac{\partial}{\partial r}\mathrm{e}^{-2\lambda}\right] \\
&= -\frac{1}{2}\kappa(\mathcal{E}+p)\left[\Gamma^2\left(g_{00} - g_{11}V^2\right)\right]
\end{aligned} \tag{8}$$

$$\begin{aligned}
&\frac{1}{2}\left(\frac{1}{r} - Y\right)\frac{\partial}{\partial t}\left(\mathrm{e}^{-2\mathcal{V}}\right) - \left[(3 + 2\mathcal{Z}_b)\left(\frac{\dot{R}}{R}\right)^2 + 2\dot{F}\left(\frac{\dot{R}}{R}\right)\right]\mathrm{e}^{-2\mathcal{V}} \\
&= -\kappa(\mathcal{E}+p)V^2\mathrm{e}^{-2(\mathcal{V}-\lambda)} + \frac{1}{r^2R^2}\frac{\mathrm{d}}{\mathrm{d}r}\left(r\mathcal{X}_b\right) - \kappa\mathcal{E},
\end{aligned} \tag{9}$$

where $\mathcal{E}, p, V, \Gamma = 1\big/\sqrt{g_{00} + g_{11}V^2}, R$ are the energy density, pressure, transport velocity, Lorentz factor and scaling factor, respectively. The subscript b denotes the comoving values, and $\dot{F}$ is the flux of normal matter injected into the system through hadronization. Here $Y = \dot{R}/R$, $\mathcal{Z}_b = \mathcal{X}_b/(1-\mathcal{X}_b)$, and $\mathcal{X}(r,t) = \alpha_{bb}\left(\frac{m_n(r,t)}{r}\right)$, where $m_n(r,t)$ is the enclosed mass of normal matter and α_{bb} is the so-called compactness parameter.

In addition, the conservation of energy and momentum of matter is taken into account by requiring that the stress-energy tensor must be divergence-free, *i.e.* $\nabla_\mu T^{\mu\nu} = 0$. This yields the following set of GR hydrodynamical equations:

$$\frac{1}{\sqrt{-g}}\frac{\partial}{\partial t}\left(\sqrt{-g}\mathcal{D}\right) + \frac{1}{R}\frac{1}{\sqrt{-g}}\frac{\partial}{\partial r}\sqrt{-g}\left(\mathcal{D}V\right) = 0 \tag{10}$$

$$\begin{aligned}&\frac{1}{\sqrt{-g}}\frac{\partial}{\partial t}\left(\sqrt{-g}\mathcal{M}^r\right) + \frac{1}{R}\frac{1}{\sqrt{-g}}\frac{\partial}{\partial r}\left(\sqrt{-g}\mathcal{M}^r V\right)\\ &= -\frac{1}{R}\frac{\partial P}{\partial r} + \frac{\mathcal{M}^t}{2R}\left(g_{tt,r} + V^2 g_{rr,r}\right),\end{aligned} \tag{11}$$

where $\sqrt{-g} = r^2 R^3 \sin(\theta) \mathrm{e}^{\nu+\lambda}$, $\mathcal{D}$, and V are the determinant of the metric, the relativistic energy-density, and the transport velocity, respectively. The four-momenta is defined as $\mathcal{M}^\sigma = \mathcal{D}hu^\sigma$, where h stands for enthalpy and u^σ for the four-velocity; $\sigma = \{t, r, \theta, \varphi\}$. Here, the Lorentz factor reads:

$$u^t = \frac{1}{g_{tt} + V^2 g_{rr}}. \tag{12}$$

The continuity equation may be re-written in the following compact form:

$$\frac{\partial}{\partial t}\left(\bar{\mathcal{D}}_b\right) + \frac{1}{R}\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\bar{\mathcal{D}}_b V\right) = 0, \tag{13}$$

where $\bar{\mathcal{D}}_b = \mathcal{D}_b \mathrm{e}^{\nu+\lambda}$ and $\mathcal{D}_b = \mathcal{D}R^3$.

To close the system, an equation of state (EOS) should be included, e.g. $P = P(\mathcal{E}) = P\left(\mathcal{D}/u^t\right)$.

In the present model, the evolutions of matter and spacetime's topology are followed with respect to a fixed observer at the centre. In this case $R = const.$ and therefore $\dot{R} = Y = 0$.

Equations (8) and (9) are then integrated with time to follow the time-evolution of the topology of spacetime, which is in turn dictated by the spatial distribution of mass-energy obtained by time-integrating the hydrodynamical Equations (10) and (11).

The initial configuration is a progenitor of $10^{24} M_\odot$, which set to levitate at the background of the infinitely large and flat spacetime of the parent universe. The progenitor is made of purely incompressible SuSu-matter, whose matter-density is set to be equal to universal critical density $\rho = \rho_{cr} = 3\times\rho_0$. At $t = 0$, the membrane confining SuSu-matter is removed and a hadronization front starts propagating from the surface inward, converting thereby SuSu-matter into normal compressible and dissipative matter. The created pressure of normal matter generates extraordinary strong pressure-gradients that jettisons the newly created normal matter into the ambient space with ultra-relativistic speeds, as shown in Figure 2. Here the gradual increase of both the modified Lorentz factor $\bar{u}^t$ and the kinetic energy E_{kin} with radius is due to the inward-increasing gravitational redshift of the fireball. The shock front follows the traces of the expansion front separating the enclosed curved spacetime from the unperturbed ambient flat one.

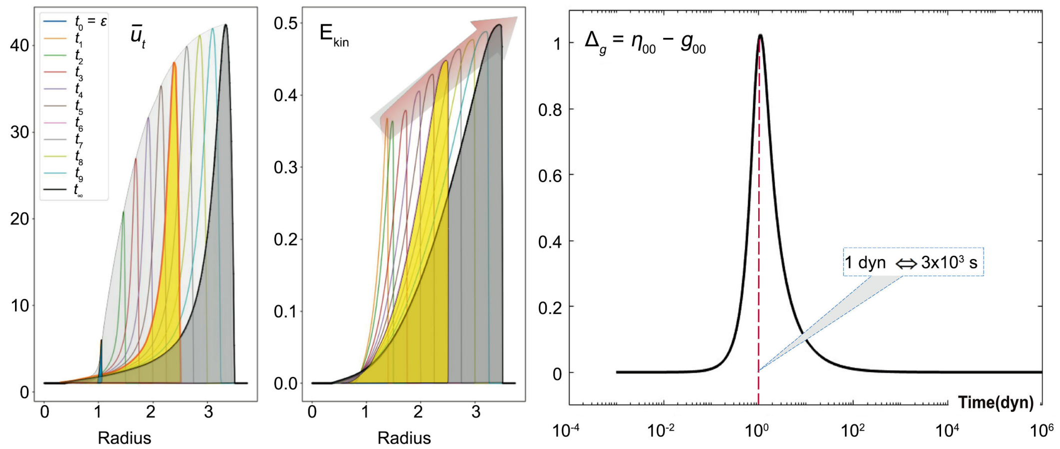

Figure 2. Different snapshots of the radial distributions of the modified Lorentz factor $\bar{\mathbf{u}}_t$ and the kinetic energy E_{kin} during hardonization and thereafter are displayed. The radii and time here are in r_p and dynamical time scale units. The time-sequence of the snapshots is marked with different colours, starting with blue and ending with black. In the right panel the deviation of the topology of the dynamical spacetime from the flat spacetime, Δ_g, during hadronization and at much later times is shown.

4. Viability of UNIMOUN as a Cosmological Model

In this section, we intend to discuss selected problems in observational astronomy and the possible answers that can be provided by the current models.

- **The SMBH in M87: Is the existence of BHs a proven hypothesis?**

Distant BHs still may not exist, even if currently, both theory and resolution-limited observations allude to their existence. Directly observing event horizons of BH is forbidden by construction, and their vicinities are far beyond the resolution sensitivities of today's telescopes, including the event horizon telescopes (EHT). The object residing inside the central dark region of the famous figures published by the EHT must not be a BH, but a highly compact supermassive dark object that is hiding an entropy-free incompressible SuSu-matter at its centre with a radius r_{core}, and surrounded by a shell of weakly compressible and dissipative normal matter. As the spacetime inside the SuSu-core is flat, but curved in the surrounding space, the configuration is immune to collapse into a true BH. To clarify the idea: consider the supergiant galaxy M87. The mass of the supermassive black hole (SMBH) is predicated to be $M_{BH}^{obs} = [6.0 \pm 0.4] \times 10^9 M_\odot$, yielding $r_{\mathcal{H}}^{obs} \approx 1.92 \times 10^{15}$ cm for the event horizon. On the other hand, UNIMOUN suggests that these values correspond solely to the content of normal matter. Hence the true radius of the black object in M87 and the corresponding compactness parameter α_{M87}, read:

$$r_{true} = r_{\mathcal{H}}^{obs} + r_{core} \Rightarrow \alpha_{M87} = \frac{1}{1 + \frac{r_{core}}{r_{\mathcal{H}}^{obs}}}, \qquad (14)$$

which is upper-bounded by unity for any non-vanishing SuSu-core.

This implies that measuring the trajectories of orbiting stars around the central object does not necessarily infer the true radius of the event horizon $r_{\mathcal{H}}^{true}$.

Here multi-messenger observations may be used to detect the behaviour of M87 during mergers with other astrophysical objects, carrying precise measurements of the dynamics of the proton-dominated jet in the vicinity of the predicted event horizon [30], as well as the dynamics of the plasma in the boundary layer between the optically this accretion disk, and the central object may enable observers to infer the difference $\Delta_H = r_{\mathcal{H}}^{obs} - r_{\mathcal{H}}^{true}$.

Currently, the observational data of M87 are unable to accurately determine the dynamics of plasmas inside [$r_{\mathcal{H}} < r \le 4r_{\mathcal{H}}$].

This leave us with a gross uncertainty, as setting a SMDEO with a mass $6.5\times10^9 M_\odot$ and constant density $\rho = 3\times\rho_0 = const.$ at the centre of the dark region in M87 would merely increase $r_{\mathcal{H}}^{obs}$ by a factor of 10^{-6}, which far below the measurement sensitivities of today's telescopes, including the VLBI and EHT.

- **The life cycle of BBs in the parent universe**

The progenitors of BBs are reproducible giant objects in the parent universe. There are several clues that indirectly support this conjecture:

1) Almost all massive NSs that should have formed from the collapse of the first generation of stars are observationally missing. According to standard cosmologies, the first generation of stars should have formed within the first several hundred million years after the BB. These stars must have been relatively very massive and metal-free and therefore their lifetimes must have been significantly shorter than those in the local universe. If Pop III stars did really form, then a significant number should have collapsed to form massive pulsars and NSs, that by now, should be metamorphosed into invisible DEOs. These in turn, may conglomerate into tight clusters and/or merge with other objects from the observable universe or from the parent universe to form the progenitors for the next generations of BBs.

2) The multi-messenger observations of the merger event in GW170817 didn't exclude the possibility that the remnant may be a massive NS [31] [32]. Here, due to the low energy states of both incompressible SuSu-cores, the merger of these cores is expected to proceed smoothly toward forming a massive incompressible SuSu-core. For a sufficiently long cosmic time, the remnant would undergo repeated mergers to end up as a SMDEO which and serve as a progenitor for the next BB.

3) The supermassive black objects observed to reside the centres of most massive galaxies are ultracompact and massive objects that harbour SMDEOs that evolving toward forming the progenitors of the next generation of BBs.

- **What is the origin of the SMBHs in high redshift galaxies?**

Irrespective of the counter arguments against BHs, observations indicate that most high redshift galaxies host supermassive BHs at their cenres with masses beyond $10^8 M_\odot$. The currently suggested growth mechanisms, such as merger and accretion, are not sufficiently effective to enable their formation and rapid growth during the first 400 Myr after the big bang.

According to UNIMOUN, these host galaxies are relics of old and inactive ones that were levitating in the infinitely large and flat parent universe that happened to be surrounding the progenitor prior big bang. Matter and the associated enormous momentum from the fireball tuned these galaxies into active modes and set them into outward-oriented accelerating motions.

- **What is the origin of the dark matter and dark energy in our cosmos?**

Supermassive BHs in UNIMOUN correspond to evolving supermassive DEOs. Similar to massive pulsars and NSs, whose cores are set to grow in mass and size as they evolve on cosmic times, the central regions of SMBHs should be occupied by cores that are made incompressible SuSu-matter surrounded by compressible and dissipative matter. As the latter cools down on cosmic times, then the matter in the geometrically thin boundary layer between these two fluids is set to convert into SuSu-matter and to subsequently integrate into the core, thereby increasing its mass and size in a discrete quantum manner. Consequently, the spacetime embedding the matter in the boundary layer (BL) is ought to change topology from a curved into a flat one, thereby weakening the central gravitational attraction of the orbiting objects. In UNIMOUN, the changes of spacetime's topologies resulting from the discrete growth of SMDEOs should be observed through the radial motion of the objects orbiting the central supermassive object. Here the prompt reduction of the gravitational mass of the central object should lead to an excess of kinetic energy that would force these orbiting objects to migrate outwardly, thereby giving rise to a total velocity that grows with distance from the central object, *i.e.* $V \sim r^{\alpha}$, where $\alpha \geq 1/2$.

Moreover, as UNIMOUN predicts the infinitely large and flat parent universe to be populated by all type of astrophysical objects, the possibility that invisible old, cold, inactive matter and/or objects maybe involved or effecting the formation of galaxies should not be excluded.

UNIMOUN doesn't require dark energy to accelerate the universe. Recalling that the observable universe is a perturbed sub-domain of our infinitely large and flat parent universe, which would diffuse out and return to the initial state, then invoking dark energy is neither a conformal process with the parent universe nor needed. According to UNIMOUN, the mechanisms underlying the acceleration of high redshift galaxies are a consequence of matter and momentum transfer from the powerfully expanding fireball into the old and inactive galaxies that surrounded the progenitor prior to its explosion. The bombardment of these galaxies with matter associated with tremendous momentum from the fireball may easily set quiet galaxies into outward accelerating motions (see **Figure 3** as well as [33] [34] for further details).

- **Why is the observable universe incredibly flat?**

During the hadronization phase of the progenitor, incompressible SuSu-matter was converted into normal compressible and dissipative matter, which in turn dictated how the embedding spacetime should curve. At the end of this epoch, which lasted for roughly 46 minutes, the created total mass of normal matter attained its maximum value, at which the embedding spacetime was maximally curved (see Δ_g/**Figure 2**).

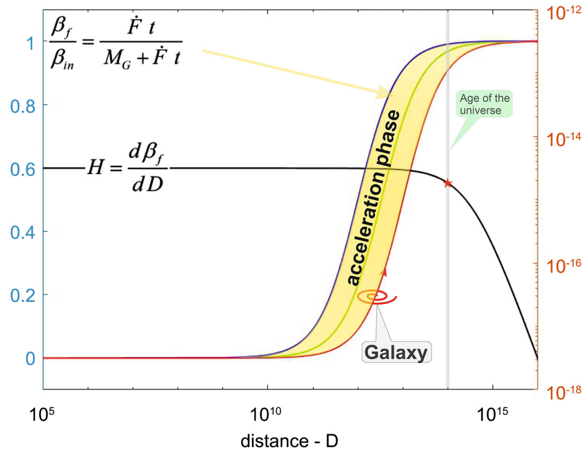

Figure 3. The time development of the receding velocity, β_f of galaxies for different incident fluxes $\dot{F}_{in} = 10^{-11}, 5\times10^{-12}, 10^{-12}$ denoted respectively by blue, green and red lines. The depicted yellow region denotes the domain of galaxy accelerations, where the galaxies are assumed to have a fixed mass of $M_G = 10$. Also, the cosmic evolution of the Hubble parameter, $H = \mathrm{d}V/\mathrm{d}D$ is displayed in black-colored line. Here H decreases slowly with the cosmic time from relatively high values in the early universe to low ones on later times.

As predicted by the minimum energy theorem, the equivalence of energy and curvature implies that the amount of energy stored in the spacetime should be readable from the curvature of the embedding spacetime. However, when the fireball expands, the embedding spacetime should flatten, and therefore the corresponding compactness parameter must decrease with cosmic time. In this case, the evolution of the deviation of the spacetime's topology from the flat spacetime may be measured as follows:

$$\Delta_g = \eta_{00} - g_{00} = \mathcal{X}(r,t) = \alpha_{bb}\left(\frac{m_n(r,t)}{r}\right) = \begin{cases} 0 & t \le 0 \\ \alpha_{bb}/2 & t = \tau_{dyn} \\ \alpha_{bb}/t & t > \tau_{dyn} \\ \mathcal{O}\left(10^{-17}\right) & t = \tau_{age}^{uni} \approx \text{universe's age}, \end{cases} \tag{15}$$

where $m_n(r,t)$ is the enclosed total mass of normal matter and α_{bb} is the compactness parameter, which, under normal astrophysical conditions, must be smaller than or equal to unity.

Hence, as the progenitor is made up of incompressible SuSu-matter, then the spacetime at the background was flat. During the hadronization of the progenitor, the spacetime was continuously enhancing its curvature. Once the hadronization process is completed, the fireball starts expanding and the embedding spacetime should flatten to become today almost indistinguishable from flat spacetime (**Figure 4**).

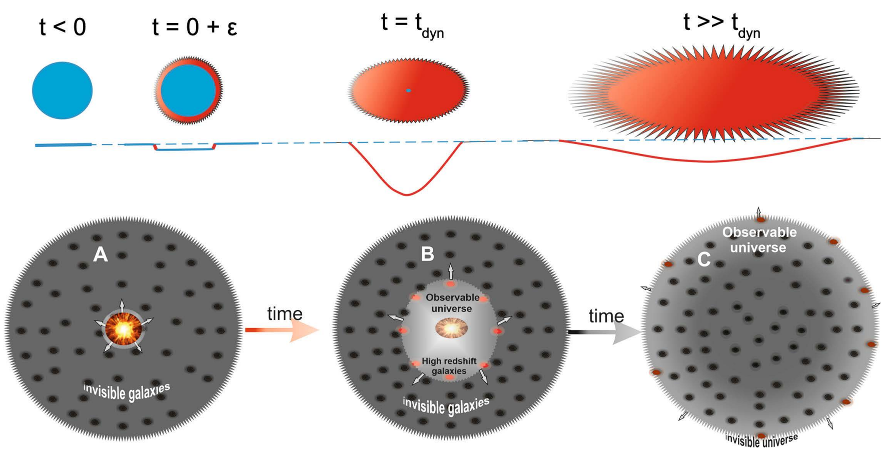

Figure 4. A schematic description of the progenitor's spacetime (upper panel): prior to hadronization $t < 0$, the progenitor is made up of incompressible SuSu-matter embedded in flat spacetime. During the hadronization phase: *i.e.* $0 \le t \le \tau_{dyn}$, the creation of normal matter enhances the curvature of the embedding spacetime and reaches its maximum possible value at $t = \tau_{dyn}$, at which the progenitor is entirely hadronized, and the total mass of normal matter has attained its maximum value. At later times, $t > \tau_{dyn}$, the total mass of normal matter remains constant, whereas the expanding spacetime becomes increasingly flatter. In the lower panel, the spacetime embedding the fireball continues to expand and diffuse into the flat parent universe, whose innermost shells are populated with quiet and inactive galaxies, though they may turn active once the expansion front marches through them.

- **Hubble parameter and the local universe**

The motions of galaxies in the local universe display relatively low redshift compared to their remote counterparts. This behaviour is a logical consequence of the measurable duration of the progenitor's hadronization process, which may be explained as follows: During the hadronization phase, which lasted for roughly 46 minutes, the embedding spacetime, which was initially flat, started to enhance its curvature almost in a continuous manner and to finally become maximally curved when the hadronization phase was completed. This implies that the early and lately created normal normal matter fluids evolve under different gravitational redshift conditions. The created normal matter near the geometrical centre is relatively deeply trapped in the potential-well and therefore, a significant kinetic energy is lost while climbing up the well, which slows its motion and delays its escape into the ambient space. This enables the normal matter in the central region to cool down and possibly to form the observed galaxies of our local universe (see Figure 3 in [34]).

- **Entropy of DEOs versus black holes**

According to BH-thermodynamics, the entropy of a star collapsing into a BH should increase roughly by a factor of 10^{19} [35]. To avoid loss of quantum information that may result from the collapse of massive stars into BHs, the event horizon my serve as a 2D complex construct, where the information are stored in accordance with the holographic principle [36]. In our scenario, however, BHs are replaced by DEOs that are made up of incompressible SuSu-superfluid occupying just one single quantum state, and therefore they have zero entropy. These cores are surrounded by normal compressible and dissipative matter, whose compactness parameter is close to but still smaller than unity. Similar to glitching pulsars, when the normal matter liberates its secondary energies entirely and cools down on cosmic time, the mass and dimensions of the cores should grow discretely in accord with Onsager-Feynman's analysis of superfluidity. In this respect, the jet in M87 serves as a mechanism, not only to transfer angular momentum out of the system but also to expel the other types of energy as well as entropy from the central SMDEO into the intergalactic medium (see [30], and the references therein).

Both the glitch phenomena of pulsars and their metamorphosis into entropy-free objects suggest that there might be a hidden connection between entropy and gravity: isolated entropy-free DEOs appear to be incapable of communicating with the outside world and therefore cease to affect the topology of the embedding spacetimes. While the present approach differs from the emerging gravity scenario [37], investigating the gravity-entropy connection might turn out to be a rewarding effort.

Assuming these communications to be mediated by a certain elementary particle, say via entropytons, then these particles appear to be trapped inside the object once the state of matter making up the object undergoes a phase transition into incompressible entropy-free SuSu-superfluid.

5. Summary

UNIMOUN is a mathematically founded and physically viable model for the observable universe: it has the capability of competing with modern astronomical observations as well as with experimental data. It is based on thorough theoretical and numerical calculations for modeling glitching pulsars, namely of the Crab and Vela, as well as on the merger of the binary NSs in GW170817, but also on the recently observed perfect fluidity of gluon-quark plasma at the LHC and RHIC (see [38], and the references therein). The main outcome of these investigations is that massive pulsars and NSs are capable of creating the exotic and extraordinarily stable state of matter inside their cores: incompressible gluon-quark superfluid. This, however, suggests the following two possibilities:

- The laws of nature may have placed an upper limit on the maximum energy density in the universe, which, among others, forbid the formation of physical singularities, and in particular black holes.
- The cosmic time required for pulsars to evolve, starting from their births, then going through NS and DEO-phases to finally conglomerate into tight clusters, that subsequently merge to form hypermassive progenitors, is predicated to be much longer than the current age of the universe. This open the possibility that objects originating from the parent universe could, in principle, be involved in the merger process. In this case the ultimate deaths of massive neutron stars and the formation of big bang's progenitors may be strongly interconnected more than current research could suggest.

When these theoretical possibilities are put together, it becomes inevitable to conclude that our observable universe must be a tiny fraction of an infinitely large, homogeneous and isotropic flat parent universe. And as the parent universe is populated by all types of astrophysical objects, e.g. planets, stars, galaxies and galaxy clusters, etc. then the origin of the SMBH-candidates hosted by high redshift galaxies become straightforward: The black objects so far classified as SMBH should have been there already before the big bang, but they started growing, once the hosting galaxies have been hit by the fireball-matter and the expansion front of the spacetime.

Based thereon, our big bang is just one of countless big bangs that occur in a sequence or in parallel manner at the same time or in different locations of the parent universe. These BBs may be classified as local and power-limited perturbations that are doomed to decay and diffuse out in the ambient parent universe (Figure 5).

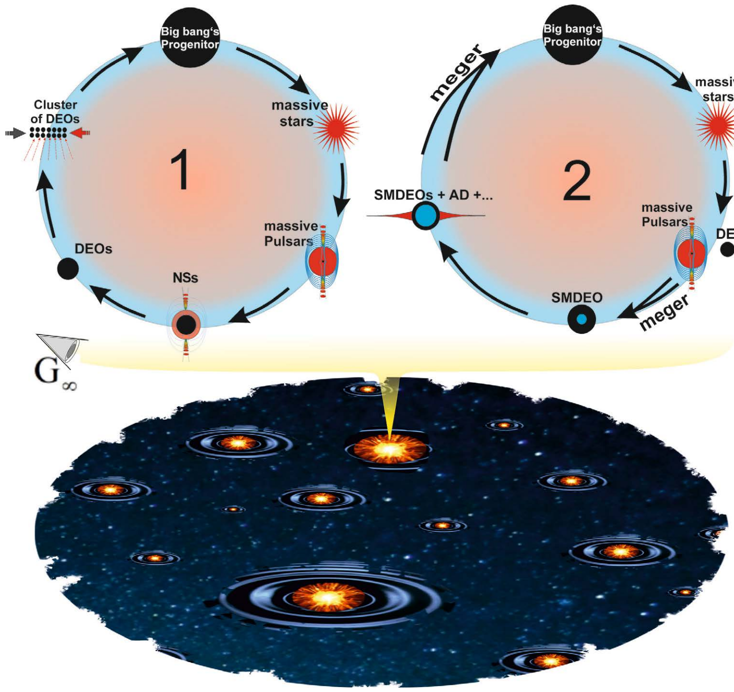

Figure 5. A schematic description of two possible life cycles of BBs in the parent universe, as seen by the supra-observer $\mathbf{G}_\infty$. Cycle "1": The trapped cold matter from the BB collapse to form massive stars, which subsequently collapse to form pulsars. These pulsars are born with embryonic incompressible SuSu-cores, whose masses grow with cosmic time to finally turn into DEOs. These objects may conglomerate into tight clusters to subsequently merge and BB-progenitors. In cycle "2": during mergers of NSs-NSs, BHs-BHs and NSs-BHs the SuSu-cores merge smoothly to form SMDEOs surrounded by shells of normal matter that is sufficiently compact to enable conversion of the normal matter in the BL into incompressible SuSu-matter. This, in turn, adopts the same quantum numbers of the core's matter and subsequently joins the core, thereby increasing its mass and size. This is currently the operating process in the supermassive BH-candidates that are observed to reside in the centres of massive galaxies. In our infinitely large and flat parent universe, BBs may occur sequentially and/or in parallel at the same or different locations.

The evolution of these perturbations is similar to water droplets falling into large water containers: the strongest spatial and temporal variations occur immediately after the droplet splash but start decaying once the generated waves set in their expansion, they diffuse out and disappear finally.

Finally, there is an additional fundamental outcome of UNIMOUN:

As the parent universe is populated with all types of astrophysical objects, then the possibility that part of these objects may have been involved in the formation of the progenitor of our big bang should not be excluded. On the other hand, this raises the possibility that the governing laws of nature and the underlying physical constants and therefore the type of matter are unalterable throughout the infinite parent universe. In this case, the probability of finding habitable planets in the parent universe is certain.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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