Exact Lifetimes and Mean Mass of Stars

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Abstract: Here we consider stars from a wide range of masses that generate thermal energy through nuclear fusion of hydrogen into helium. Some boundary condition from the Scale-Symmetric Theory (SST) leads to the exact lifetime of the Sun equal to 11.95 gigayears [Gyr]. We also used the Wien's displacement law to determine the dependence of the mean mass of newly formed stars on the running radius of the Universe. We described the missing baryon problem.

1. Introduction

The lifetimes and mean mass of stars are the key properties defining evolution of stars, galaxies and the Universe.

In the mainstream cosmology, it is suggested that lifetimes do not depend inversely proportional to four powers of mass of stars but the physical justifications based on the computer models are not convincing, and there are still no clear boundary conditions that would turn proportionality into an exact relationship.

Here we present a boundary condition that results from the structure of virtual fields which are responsible for the transformation of the neutron black hole (NBH) [1] into a star that generates thermal energy by fusing hydrogen into helium or vice versa, i.e. from such a star to NBH. It allows us to formulate an exact relationship between lifetime and mass.

In paper [2], we used the Wien's displacement law to calculate the temperature of the corona of the Sun. Here we use this law to determine the dependence of the mean mass of newly formed stars on the running radius of the Universe.

The Scale-Symmetric Theory (SST) [3] shows that the missing baryon matter should have properties similar to the coronal plasma near the Sun [2], i.e. it should be the hot low-density intergalactic and interstellar plasma. According to presented here model, due to evolution of the initial big stars, abundance of the plasma with dominating nuclear strong interactions decreased while of the plasma with dominating weak interactions (it is typical for the corona plasma [2]) increased. We answered the following question: How much of the hot low-density baryonic plasma was rejected by the protogalaxies composed of the NBHs?

2. Lifetimes of stars

The virtual nuclear strong field inside NBH consists of the single gluons which are the rotational energies of the Einstein-spacetime components, i.e. of the neutrino-antineutrino pairs – such pairs communicate via the superluminal quantum entanglement – it is carried by the binary systems of closed strings (entanglons). Spin speed of the entanglons is equal to v_t =

$2.386344 \cdot 10^{97}$ **m/s** [3]. Such spin speed defines the intrinsic time of the virtual strong field (it is not the time of the strong interactions).

The evolution of NBHs was forced by their collisions with dark matter, by the inflows of dark energy, and by their mutual collisions [4]. Such processes caused the weak interactions to dominate in the scattered plasma from NBH. The virtual weak field was composed of the leptonic pairs such as the electron-positron pairs and muon-antimuon pairs. The pairs communicate via the photon loops composed of the Einstein-spacetime components so the spin speed is equal to the speed of light in "vacuum" $c = 299{,}792{,}458$ **m/s** [3]. This spin speed defines the intrinsic time of the virtual weak field (it is not the time of the weak interactions).

We can see that after the transformation of NBH into a star that generates thermal energy through nuclear fusion of hydrogen into helium, the lifetime of the star, $T_{Star\text{-}from\text{-}NBH}$, transforms as

$$T_{Star\text{-}from\text{-}NBH} \rightarrow T_{Star\text{-}from\text{-}NBH}\, c / v_t \,. \tag{1}$$

Notice that spins of the entanglons and photon loops are unitary [3].

The strong interactions inside NBHs (they are initially the cool stars) are defined by the coupling constant for the nuclear strong interactions inside baryons at low energies, i.e. $\alpha_S = 1$ [3].

The weak interactions inside the scattered plasma from NBH are defined by the coupling constant for the weak interactions of the leptonic pairs, i.e. $2\alpha_{w(electron\text{-}muon)} = 2 \cdot 0.9511084 \cdot 10^{-6}$ [3]. The factor 2 is because there are the particle-antiparticle pairs, not some single particles.

Since coupling constants are directly proportional to internal energy so the rest energy of NBH, $\Delta E_{o,NBH} = M_{o,NBH}\, c^2$, transforms as

$$\Delta E_{o,NBH} = M_{o,NBH}\, c^2 \rightarrow M_{o,NBH}\, c^2\, 2\, \alpha_{w(electron\text{-}muon)} / \alpha_S \,, \tag{2}$$

where $M_{o,NBH} = 24.81$ **solar masses** [1].

For loops, instead the formula

$$\Delta E_{o,NBH}\, T_{Star\text{-}from\text{-}NBH} = \hbar \tag{3}$$

we have

$$(M_{o,NBH}\, c^2\, 2\, \alpha_{w(electron\text{-}muon)} / \alpha_S)\, (T_{Star\text{-}from\text{-}NBH}\, c / v_t) = \hbar \,. \tag{4}$$

By applying such boundary condition, we can calculate the lifetime of a star with a mass of $M_{o,NBH} = 24.81$ **solar masses**

$$T_{Star\text{-}from\text{-}NBH} = 31.54 \cdot 10^3 \textbf{ years [yr]} \,. \tag{5}$$

From the Stefan-Boltzmann law we have

$$j^* \sim T_{Temperature}^{\,4} \,, \tag{6}$$

where j^* is the total energy radiated per unit surface area of a black body across all wavelengths per unit time (the radiant emittance), and $T_{Temperature}$ is the black body's thermodynamic absolute temperature. The radiant emittance is the radiant flux emitted by a surface per unit area. Here we have (see formula (3))

$$j^* \sim \Delta E_o \sim 1 / T_{Lifetime} . \tag{7}$$

From theory of stars follows that temperature, $T_{Temperature}$, of them is directly proportional to their mass M_{Star}

$$T_{Temperature} \sim M_{Star} . \tag{8}$$

From (6), (7) and (8) we obtain

$$T_{Lifetime} \sim 1 / M_{Star}^4 . \tag{9}$$

Now we can calculate the exact lifetime of the Sun

$$T_{Lifetime,Sun} = T_{Star\text{-}from\text{-}NBH} (M_{o,NBH} / M_{Sun})^4 = 11.95 \textbf{ Gyr} . \tag{10}$$

If the age of the Sun is correctly estimated to be ~ 4.6 **Gyr**, it will be in its present stable stage for the next ~ 7.4 **Gyr**.

Notice also that lifetime of a red dwarf with a mass two times lower than the solar mass is ~ 191 **Gyr** – it is far longer than the Universe's age.

It is obvious also that the Solar System evolved from a group of NBHs [5] because abundance of gold in the Earth's crust is about 7 times higher than the mean value for the Universe: abundance in the Earth's crust is about $4 \cdot 10^{-9}$ per 1 [6] while in the Universe is about $6 \cdot 10^{-10}$ per 1 [7]. On the other hand, we know from observational data that amount of gold produced in collisions of neutron stars is relatively high.

3. Dependence of mean mass of newly formed stars on radius of the Universe

The Wien's displacement law looks as follows

$$T_i \lambda_i = \textbf{const.} , \tag{11}$$

where T_i is the absolute temperature, and $\lambda_i = 2\pi R_i$ is the wavelength peak.

The temperature T_i should be directly proportional to the mean mass of newly formed stars, $M_{newly\text{-}stars}$, while λ_i should be directly proportional to the running radius of the Universe, $R_{running\text{-}radius}$. Then from (11) we obtain

$$M_{newly\text{-}stars} R_{running\text{-}radius} = \textbf{const.} . \tag{12}$$

Now we need a boundary condition to obtain an exact relationship. According to SST, initially the baryonic part of the Universe was the two loops with a radius of $R = 0.1911$ **Gly** [8] composed of the protogalaxies built of the NBHs with a mass of $M = 24.81$ **solar masses** so we have

$$M_{\text{newly-stars}} R_{\text{running-radius}} = 4.741 \text{ [solar-mass} \cdot \text{Gly]} . \quad (13)$$

How should we read the formula (13)? Can we verify the SST cosmology? We will use this formula to describe the cosmological evolution of the region near the Sun.

When we neglect the initial protuberances on the surface of the baryonic matter in the expanding Universe then the today spatial distance to the baryonic surface is $R_{\text{Spatial}} = 13.866$ **Gly** [8]. But radial velocity of such a surface was (and still is) $v_{\text{Radial,BM-surface}} = 0.6415c$ [8]. This means that such a surface needed $T_{\text{Time}} = 21.614$ **Gyr** to reach the spatial distance 13.866 **Gly**

$$T_{\text{Time}} = R_{\text{Spatial}}\, c / v_{\text{Radial,BM-surface}} = 21.614 \text{ Gyr} . \quad (14)$$

We can see that we can define two different Hubble constants, i.e. the spatial Hubble constant, $H_{o,\text{spatial}}$

$$H_{o,\text{spatial}} = c / R_{\text{Spatial}} = 70.52 \text{ (km/s)/Mpc} \quad (15)$$

and the time Hubble constant, $H_{o,\text{time}}$

$$H_{o,\text{time}} = c / T_{\text{Time}} = 45.24 \text{ (km/s)/Mpc} . \quad (16)$$

Consider the age of the Sun ~4.6 **Gyr** – it is the time distance so the Sun was formed when the Universe was 21.6 – 4.6 = 17 **Gyr** old. It relates to the spatial distance 17 · 0.6415 = 10.9 **Gly**. From formula (13) follows that the mean mass of the stars formed at that time was 0.435 **solar mass**.

The observed mean mass of 16 stars within 5 **parsec** from the Sun is ~0.58 **solar mass**, while of 27 stars that have passed or will pass within 5 **ly** of the Sun within ±3 **million years** is ~0.55 **solar mass** [9]. We assume that the mean mass of the group of the stars near the Sun was ~0.57 **solar mass** and that some decreases in mass of stars via radiation are compensated by capture of the interstellar plasma – the geological facts confirm such a scenario. Just temperature of the Sun in its stable stage practically does not change. From (13) we obtain that the mean mass ~0.57 **solar mass** relates to the spatial distance equal to 8.3 **Gly** so the time distance was 8.3 / 0.6415 = 13.0 **Gly**, i.e. the mean age of such a group is 21.6 – 13.0 = 8.6 **Gyr**. This means that the mean age of such a group is 8.6 – 4.6 = 4 **Gyr** longer than that of the Sun.

Can we explain it?

Due to the specific evolution of the Solar System [5], inside it should be matter from wide range of ages. The oldest parts should be in centres of the planets and in not numerous meteorites. The ages of 40 large silicon carbide grains extracted from the Murchison CM2 meteorite range from 3.9 ± 1.6 **Myr** to ~3 ± 2 **Gyr** before the start of the Solar System ~4.6 **Gyr** ago [10]. So some of the grains are at least ~1 **Gyr** older than the other parts of the Solar System but some of the grains can be ~9.6 **Gyr** old as well. So one of the many explosions of the precursor of the Sun could take place about ~9.6 **Gyr** ago or so. We can assume that formation of the red dwarfs in some distance from the central explosion (i.e. from the precursor) took much less time than for the Sun to form. This assumption is logical because the distant gas was much colder. It means that the Sun is ~4.6 **Gyr** old but the mean age of the near stars is ~8.6 **Gyr**.

4. The missing baryon problem

The theoretical density of baryons in the Universe results from the CMB. But from observational data follows that abundance of visible baryonic matter is much lower [11]. So where is hidden most of the baryonic matter?

Due to the weak interactions of the dark-matter (DM) loops with baryonic vortex or stars in spiral galaxies via the virtual leptonic pairs, there appears the advection, i.e. the baryonic vortex or stars outside the central stellar bulge of a spiral galaxy acquire their unusual orbital speeds (we will call them the advection orbital speeds).

Virtual mass m^* that is the mediator of the weak interactions of the DM loops with the actual mass m_{actual} of baryonic vortex is defined by the product of the actual baryonic mass m_{actual} and the coupling constant that defines type of weak interactions $2\alpha_{w(....)}$, i.e. $m^* = 2\alpha_{w(....)} m_{actual}$. The factor 2 follows from the fact that inside the virtual weak field there are the virtual pairs, not single particles. The spin speed of the DM loops in the rest is c and the spin speed of the initial baryonic mass, $m_{o,initial}$, on the equators of the black holes composed of the NBHs, was very close to c. Denote by $v_{advection,orbital}$ the acquired advection speed by the actual baryonic mass interacting weakly with the DM loops. For the baryonic vortices we have $v_{orbital}{}^2 = GM_{Baryon}/R$ so for $R =$ **const.** we have [12]

$$(v_{advection,orbital} / c)^2 = (2\alpha_{w(....)} m_{actual} / m_{o,initial}) \, . \qquad (17)$$

In formula (17), the m_{actual} is the actual baryonic mass of a massive spiral galaxy whereas the interactions of the DM loops with the baryonic matter are via the virtual lepton pairs (the virtual electron-positron (e^-e^+) and muon-antimuon ($\mu^-\mu^+$) pairs).

Now we can write the formula for the orbital speeds of stars outside the central bulge that follow from the DM loops-baryonic matter advection

$$v_{orbital\text{-}speed,advection} = c \, (2\alpha_{w(electron\text{-}muon)} m_{galaxy,actual} / m_{o,BH})^{1/2} \, , \qquad (18)$$

where $m_{o,BH}$ is mass of the black hole (BH) from which the massive spiral galaxy evolved because of the inflows of dark matter and dark energy.

Initial mass of each protogalaxy was $M_{Protogalaxy} = 1.0656 \cdot 10^{11}$ **solar masses** [12]. But due to the four-object symmetry [8], initially, the mean mass of massive spiral galaxies (the mean initial mass of bared massive galaxies was two times higher) was $m_{o,BH} = 4M_{Protogalaxy} = 4.26 \cdot 10^{11}$ **solar masses**.

The virtual $\pi^-\pi^+$ pairs are characteristic for the strong fields – their mass represents the whole initial baryonic matter, $M_{Baryon,total}$. On the other hand, the virtual $\mu^-\mu^+$ pairs are characteristic for the weak fields and they represent the mean rejected baryonic mass, $M_{Baryon,rejected}$. Thus the relative total rejected baryon mass, $P_{Baryon,rejected/total} = M_{Baryon,rejected} / M_{Baryon,total}$, by the protogalaxies was

$$P_{Baryon,rejected/total} = M_{Baryon,rejected} / M_{Baryon,total} = (\mu^- + \mu^+) / (\pi^- + \pi^+) = 0.757 \, . \qquad (19)$$

Emphasize once more that we are of course talking about the average value for the entire Universe. Such transition we will call the strong-weak transition.

We can see that only following amount of baryonic matter, $P_{Baryon,visible}$, was visible via the radiation of stars (we neglect the baryonic mass of the black holes)

$$P_{Baryon,visible} = 1 - P_{Baryon,rejected/total} = 0.243 \,, \tag{20}$$

i.e. about 24**%**. The rest about 76**%** is the interstellar baryon plasma and intergalactic baryon plasma.

Consider a massive spiral galaxy. From observational data follows that a maximum mean orbital speed of baryon matter interacting with DM loops for selected galaxies is $\log(v\ [\mathbf{km/s}]) = 2.5$ (see Figure 1 in [13]) i.e. $v_{orbital\text{-}speed,advection,max} = 316$ **km/s**. From (18) we obtain $m_{galaxy,actual} / m_{o,BH} = 0.584$ so only 100**%** · 0.243 / 0.584 = 41.6**%** of baryon matter in the galaxy is in stars.

Notice that my paper [12] appeared 2-3 years earlier than [13]. From my paper results that, on the assumption that the surface density of the baryonic discs of the massive spiral galaxies is invariant (then masses of the discs are directly proportional to squared radii), the periods of spinning of the massive spiral galaxies must be the same.

5. Summary

The exact lifetimes and mean mass of stars are very important in cosmology because they regulate evolution of stars, galaxies and the Universe.

The internal structure of virtual fields described within the Scale-Symmetric Theory leads to a boundary condition that defines the exact relationship between lifetimes of stars and their masses. The exact relationship looks as follows

$$T_{Lifetime}\ [\mathbf{Gyr}] = a / (M\ [\mathbf{solar\ mass}])^4 \,, \tag{21}$$

where $a = 11.95$ **[Gyr · solar-mass⁴]**.

The calculated here exact lifetime of the Sun is 11.95 **gigayears**.

The computer models for stellar evolution are wrong because our formula acts correctly for the solar mass related to a star with a mass 24.81 times higher.

In paper [2], we used the Wien's displacement law to calculate the temperature of the corona of the Sun. Here we use the Wien's displacement law to determine the dependence of the mean mass of newly formed stars on the running radius of the Universe. We used such a formula to described the cosmological evolution of the region near the Sun. Mass of the stable stars (so their temperatures as well) practically does not change with time because the decreases in mass via radiation are compensated by capture of the interstellar plasma – the geological facts confirm such a scenario.

We calculated that about 75.7**%** of the baryonic matter is invisible – it is in the form of the hot low-density intergalactic and interstellar plasma.

In the framework of the SST, we have repeatedly shown that mechanisms on a cosmic scale must have counterparts in mechanisms specific to nucleons. This is due to the fact that counterparts of the virtual processes in the nuclear strong field of baryons are, on the cosmic scale, the virtual processes in the weak field composed of lepton pairs.

References

[1] Sylwester Kornowski (18 November 2020). “The Internal Structure of Neutron Stars from a New Perspective”
http://vixra.org/abs/2011.0067
[2] Sylwester Kornowski (17 December 2020). “Magnetic Activity of Solar-Type Stars”
http://vixra.org/abs/2012.0118v2
[3] Sylwester Kornowski (25 September 2020). “Foundations of the Scale-Symmetric Physics (Main Article No 1: Particle Physics)”
http://vixra.org/abs/1511.0188
[4] Sylwester Kornowski (10 October 2020). “Transformation of Neutron Black Holes into Expanding Hot Plasma”
http://vixra.org/abs/2010.0065
[5] Sylwester Kornowski (6 December 2020). “A New Theory of the Solar System”
http://vixra.org/abs/2012.0024
[6] en.wikipedia.org/wiki/Abundances_of_the_elements_(data_page)
[7] periodictable.com/Properties/A/UniverseAbundance.v.log.html
[8] Sylwester Kornowski (14 February 2019). “Foundations of the Scale-Symmetric Physics (Main Article No 2: Cosmology)”
http://vixra.org/abs/1511.0223
[9] en.wikipedia.org/wiki/List_of_nearest_stars_and_brown_dwarfs
[10] Philipp R. Heck, *et al.* (13 January 2020). “Lifetimes of interstellar dust from cosmic ray exposure ages of presolar silicon carbide”
PNAS, https://doi.org/10.1073/pnas.1904573117
[11] Anna de Graaff, *et al.* (29 September 2017). “Probing the missing baryons with the Sunyaev-Zel’dovich effect from filaments”
A&A 624, A48 (2019)
arXiv:1709.10378v3 [astro-ph.CO]
[12] Sylwester Kornowski (18 June 2016). “The Dark-Matter Mechanism and Orbital Speeds of Stars in Galaxies”
http://vixra.org/abs/1410.0031
[13] Gerhardt R Meurer, *et al.* (9 March 2018). “Cosmic clocks: a tight radius-velocity relationship for HI-selected galaxies”
MNRAS, Volume 476, Issue 2, May 2018, Pages 1624-1636
arXiv:1803,04716 [astro-ph.GA]