The Theory of Fusion of Black Holes Composed of Neutron Black Holes and Neutron Stars

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Abstract: According to the Scale-Symmetric Theory (SST), in our Universe there are no interactions capable of destroying the core of baryons, so there are no black holes with a central singularity. Here, within SST, we formulated the theory of fusion of baryonic black holes. We described the signals GW190521 and GW150914.

1. Introduction

On May 21, 2019 LIGO and Virgo observed the GW190521 signal [1]. It is assumed that the signal is a result of the merger of two black holes with masses of 66^{+17}_{-18} and 85^{+21}_{-14} solar masses (90% credible intervals). The final black-hole mass is 142^{+28}_{-16} solar masses.

On September 14, 2015 LIGO and Virgo observed the GW150914 signal [2]. It is assumed that the signal is a result of the merger of two black holes with masses of 29^{+4}_{-4} and 36^{+5}_{-4} solar masses (90% credible intervals). The final black-hole mass is 62^{+4}_{-4} solar masses. The radiated energy was equivalent to $3.0^{+0.5}_{-0.5}$ solar masses.

According to the Scale-Symmetric Theory (SST), due to the very strong short-distance quantum entanglement, a destruction of the core of baryons is impossible [3] so neutron stars or stars cannot transform into black hole with a central singularity. In reality, when mass is adequate, stars and neutron stars (NSs), because of gravitational collapse(s) or collision(s), can transform into one or more neutron black holes (NBHs) and/or neutron stars (NSs). Mass of NBHs is quantized. On the basis of the internal structure of baryons described within SST [3] and the assumption that the Einstein-spacetime components (or photons) on the equator of NBHs have to have the spin speed equal to the speed of light in "vacuum" $c \approx 3 \cdot 10^8$ m/s, it is very easy to calculate the bare mass and the equatorial radius of NBH: $M_{NBH\text{-}bare} = 24.81$ [solar mass] and $R = 36.64$ km (the Schwarzschild radius is two times bigger) [4].

The NBHs and NSs in a black hole are placed on a plane. The spins/magnetic-axes of NBHs and NSs are perpendicular to the plane. Moreover, the circular flows in the Einstein spacetime on the equators of NBHs are exchanged between them so distances between the nearest NBHs in a black hole are quantized. On the assumption that the Einstein-spacetime vortices are very thin, we obtain that the distance between the nearest NBHs should be $L_o = 2\pi R \approx 2.3 \cdot 10^5$ m = 1 [L_o]. But it is not true. To explain it we must notice that according to SST, the baryons are the SST black holes due to the nuclear strong interactions, i.e. bosons that interact strongly should move at the equator of the baryon core with a spin speed equal to c [3]. The core emits the gluon loops in such a way that range of the strong interactions is $R_{Strong\text{-}field} = 2.9582094$ fm [3]. On the other hand, the equatorial radius of the core of baryons is A = 0.6974425 fm [3] so we obtain that range of the strong interactions is $F = R_{Strong\text{-}field} / A = 4.2415$ times bigger than the equatorial radius of the core of baryons which is the SST strong black hole. It leads to conclusion that the vortex created in the Einstein spacetime around NBH has a range $L_{Vortex} = F\,R = 155.4$ km.

We know from observations that the surfaces of the tornados can be in contact and do not interpenetrate, so we can assume that the distance between the nearest NBHs in baryonic black hole is $L_{NBH\text{-}NBH} = 2\,L_{Vortex} = 3.108 \cdot 10^{5}$ m $= 1$ [$L_{NBH\text{-}NBH}$].

The gravitational potential energy (it is emitted as the flows in the Einstein spacetime) emitted by two NBHs when distance between them decreases from infinity to $L_{NBH\text{-}NBH}$ is

$$\Delta E_{NBH\text{-}NBH} = G\,M_{NBH\text{-}bare}\,M_{NBH\text{-}bare} / L_{NBH\text{-}NBH} = 5.229 \cdot 10^{47}\ \text{J} = 2.925\ \text{[solar mass]}\,. \quad (1)$$

If in a black hole is NS then we neglect created vortex i.e. distance between NBH and NS is L_{Vortex}. We can see that due to a fusion of NBH and NS, is emitted following energy

$$\Delta E_{NS\text{-}NBH} = G\,M_{NBH\text{-}bare}\,M_{NS} / L_{Vortex} = 5.85\,M_{NS} / M_{NBH\text{-}bare}\ \text{[solar mass]}\,. \quad (2)$$

All NBHs in a black hole must be in the same state so they are at the vertices of a regular polyhedron, i.e. they are on the same circle.

We claim that the GW190521 signal is a result of fusion of two black holes composed of 3 and 4 neutron black holes i.e. it is not a merger understood as a transformation into one singularity. Just black holes are granular.

We claim that the GW150914 signal is a result of fusion of two black holes one of which is neutron black hole and the other is a binary system composed of neutron black hole and neutron star with a mass of ~18 [solar mass].

2. Calculations

2.1 The GW190521 signal

Consider the distribution of NBHs in black holes containing 3, 4 and 7 NBHs.

The 3 NBHs are at the vertices of the equilateral triangle so we have three distances each with a length of 1 [$L_{NBH\text{-}NBH}$] so the binding energy is $\Delta E_3 = (3 / 1)\,\Delta E_{NBH\text{-}NBH} = 8.78$ [solar mass] and the total mass of the black hole is $M_3 = 3\,M_{NBH\text{-}bare} - \Delta E_3 = 65.65$ [solar mass].

The 4 NBHs are at the vertices of the square so we have six distances with an average length of 1.138 [$L_{NBH\text{-}NBH}$] so the binding energy is $\Delta E_4 = (6 / 1.138)\,\Delta E_{NBH\text{-}NBH} = 15.42$ [solar mass] and the total mass of the black hole is $M_4 = 4\,M_{NBH\text{-}bare} - \Delta E_4 = 83.82$ [solar mass].

The 3 NBHs in the first initial black hole are placed on the same circle. The same concerns the 4 NBHs in the second initial black hole. It suggests that all the 7 NBHs in the final black hole also should be on the same circle. Then calculated radius of such circle is $R_7 = 1.1524$ [$L_{NBH\text{-}NBH}$] and we have twenty one distances with an average length of 1.683 [$L_{NBH\text{-}NBH}$] so the binding energy is $\Delta E_7 = (21 / 1.683)\,\Delta E_{NBH\text{-}NBH} = 36.50$ [solar mass]. The total mass of the final black hole is $M_7 = 7\,M_{NBH\text{-}bare} - \Delta E_7 = 137.17$ [solar mass].

Obtained here results are consistent with [1].

2.2 The GW150914 signal

Consider a black hole containing one NBH and NS with a mass of $M_{NS} = 18$ solar masses.

The binding energy we can calculate from formula (2) – it is $\Delta E_{NS\text{-}NBH} = 4.24$ solar masses so such black hole has mass

$$M_1 = M_{NBH\text{-}bare} + M_{NS} - \Delta E_{NS\text{-}NBH} = 38.57 \text{ [solar mass].}$$

In the final black hole, the NS should be on the line going through centres of the two NBHs but outside them so we can neglect the gravitational interaction of the NS with the more distant NBH. It causes that mass of the final black hole is

$$M_{Final} = M_{NBH\text{-}bare} + M_1 - \Delta E_{NBH\text{-}NBH} = 60.45 \text{ [solar mass].}$$

The emitted energy is

$$\Delta E = \Delta E_{NBH\text{-}NBH} = 2.93 \text{ [solar mass].}$$

Obtained here results are consistent with [2].

3. Summary

There is no experimental evidence that cores of baryons can be destroyed, so the transformation of stars into black holes with a central singularity is speculation.

There is the lower limit for baryon black hole – it is 24.81 [solar mass]. We claim that future more detailed observations will show that neutron stars have mass up to 24.8 solar masses – they may be silent stars which mimic the behaviour of black holes.

The SST cosmology presents many fruitful calculations concerning black holes and their associations that suggest that galactic black holes are made up of neutron black holes, so there is sure to be a revolution in the future regarding their internal structure and stellar evolution.

Obtained here results for the GW190521 and GW150914 signals are consistent with results presented in [1] and [2].

References

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