The Main Equation in Theory of Gamma-Ray Bursts

Sylwester Kornowski

Abstract: Here, using the Scale-Symmetric Theory (SST), we derived the main equation in theory of Gamma-Ray Bursts (GRBs) and used it to describe the GRB 080916C. Such theory is closely related to the theory of neutron "black holes" (NBHs) which is similar to the theory of baryons.

1. Introduction

SST shows that the gravitational interactions around the NBHs and the nuclear strong interactions around the core of baryons are similar. In both areas acts the Titius-Bode law i.e. there are orbits which radii defines following formula [1], [2]

$$R_i = A_i + d\, B_i\ , \tag{1}$$

where $A_i / B_i \approx 1.3898$ for both objects, $d = 0, 1, 2, 4$ (for baryons, NBHs and black holes), $8, 16, 32, 64, 128$ (only for NBHs and black holes).

The equatorial radius of NBH is $A_{i(NBH)} = 3.664 \cdot 10^4$ **m** [3].

A star is captured by NBH in its orbit $R_{i(NBH)} = A_{i(NBH)} + B_{i(NBH)}$. Then, the nuclear plasma radially passes to the equator of NBH.

Mass of NBHs is quantized: $M_{NBH} = 24.81$ **solar masses** [3].

Within SST we derived following formula that we can apply also to stars [1]

$$\tau_{Lifetime} \sim 1 / m^4\ , \tag{2}$$

where m is mass of star.

We can assume that the time of a burst, t_{Burst}, is directly proportional to the lifetime $\tau_{Lifetime}$

$$t_{Burst} \sim \tau_{Lifetime}\ . \tag{3}$$

2. The main equation in theory of GRBs

During the creation of new NBH there is the radial transition from distance ($A_{i(NBH)}$ + $B_{i(NBH)}$) to distance $A_{i(NBH)}$ i.e. the baryons on surface of an collapsing object cover the distance $B_{i(NBH)}$.

Emission during creation of a ball/condensate is due to the weak interactions so we can assume that the nuclear weak interactions define the time t_{Burst}. In SST, the weak mass is defined as follows

$$M_{Weak} = \alpha_{W(proton)} M_{NBH} , \tag{4}$$

where $\alpha_{W(proton)} = 0.0187229$ [1].

Emphasize that the speed of light in "vacuum" c is characteristic for the nuclear strong interactions

$$t_S = B_{i(NBH)} / c , \tag{5}$$

so for the weak interactions, which is weaker, the speed of transition is slowed down.

From formulae (2) – (5) we obtain the time duration of burst for star with a mass equal to M_{NBH}

$$t_{Burst,NBH} = t_S (M_{NBH} / M_{Weak})^4 =$$

$$= (B_{i(NBH)} / c) / \alpha_{W(proton)}{}^4 = 716 \text{ s} . \tag{6}$$

From (2), (3) and (6) we have

$$t_{Burst} = 716 (m / M_{NBH})^4 \text{ [s]} , \tag{7}$$

where m [**solar masses**] is mass of captured star by NBH and $M_{NBH} = 24.81$ [**solar masses**].

Equation (7) is the main equation in the theory of Gamma-Ray Bursts.

Some baryonic analog to formula (7) looks as follows

$$t_{Burst} = 716 (m_{Particle} / n)^4 \text{ [s]} , \tag{8}$$

where $n = 939.565413(6)$ **MeV** is the mass of neutron [4], and $m_{Particle}$ denotes mass of a particle.

3. The GRB 080916C

Consider a star or binary system of stars with total mass which relates to mass of the hyperon $\Lambda = 1115.683(6)$ **MeV** [4]. From formulae (7) and (8) we obtain that some stellar analog to the hyperon Λ has mass equal to $M_\Lambda = 24.81 \cdot 1115.683/939.5654 = 29.46$ **solar masses** i.e. such star is more massive than NBH. From (7) we obtain that the burst should last

$$t_{Burst,GRB080916C} = 716 (M_\Lambda / M_{NBH})^4 = 1420 \text{ s} = 23.7 \text{ min}. \tag{9}$$

In the final stage there should appear new NBH while the mass equal to $29.46 – 24.81 = 4.65$ **[solar masses]** should be emitted as the gamma rays. Since total energy of the Sun is about $1.8 \cdot 10^{54}$ **erg** so emitted isotropic energy should be about $4.65 \cdot 1.8 \cdot 10^{54} = 8.4 \cdot 10^{54}$ **erg**.

We can compare these results with data obtained by the Fermi LAT and Fermi GBM Collaborations [5]. They obtained ~1400 **s** and $\sim 8.8 \cdot 10^{54}$ **erg** respectively.

4. Summary

Here, using the Scale-Symmetric Theory, we derived the main equation in the theory of Gamma-Ray Bursts, we described properties of the GRB 080916C, and showed that initial star captured by NBH had mass which relates to mass of hyperon Λ.

References

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