The Origin of Masses of Globular Clusters

Sylwester Kornowski

Abstract: It is not true that we can calculate correctly the Chandrasekhar limit assuming that a neutron star is a Fermi gas that obeys Fermi-Dirac statistics. Due to the atom-like structure of baryons, the binding energy for all neutrons has the same value so the factors which appear in the Chandrasekhar limit are incorrect. There are at least two Chandrasekhar limits i.e. about 11.2 solar masses and 1.394 solar masses which is the mass of the Type Ia supernovae. The clouds, that later transform into the globular clusters, are produced on Schwarzschild surface of the quasars and are carried by the relativistic jets. Calculated here the upper limit for the initial mass of the globular clusters in the Milky-Way Galaxy is 155,200 solar masses. Quasars with greater mass produce more massive globular clusters. The obtained theoretical upper limit for the mass is consistent with observational facts.

1. Introduction

The Scale-Symmetric Everlasting Theory (S-SET), [1], shows that the very early Universe was the cosmic loop composed of protogalaxies grouped in larger cosmic structures. Each protogalaxy was built from the neutron black holes (NBH). Mass of NBH is 24.8 solar masses and its radius is $R_{NBH} = 3.664 \cdot 10^4$ m – it is inconsistent with the mainstream theory of neutron stars. It is not true that we can calculate correctly the Chandrasekhar limit assuming that a neutron star is a Fermi gas that obeys Fermi-Dirac statistics. This statistics determines the energy distribution of fermions in a Fermi gas in thermal equilibrium. In reality, the S-SET leads to the atom-like structure of baryons. There appears the shells and radius of the last shell is $R_S = 2.7048$ fm. The distances between the nucleons in atomic nuclei are mostly equal to R_S/sqrt(2) and R_S. Such model leads to perfect results for nuclear binding energies [2]. In a neutron star there is a lattice with the side equal to R_S/sqrt(2), i.e. the diagonal of a net mesh is R_S. It is true that the neutrons in a neutron star behave as a non-interacting Fermi gas but due to the shells which result from the strong interactions, the neutrons are in strictly determined mean distance for which the nuclear binding energy is not equal to zero but this energy is confined in the strong fields. The binding energy for all neutrons has the same value so the factors which appear in the Chandrasekhar limit are incorrect. It concerns the term ω_3^osqrt(3)/($2\mu_e^2$), where $\omega_3^o \approx 2.018236$ is a constant connected with the solution of the

Lane-Emden equation whereas μ_e is the average molecular weight/mass per electron. The same concerns the relativistic many-particle Schrödinger equation.

Knowing the side of the lattice and knowing that neutrons behave as ‘non-interacting’ fermions, it is very easy to calculate the maximum mass of neutron star (of NBH) and its radius ([1]: formulae (99) – (101)).

There is not only one Chandrasekhar limit but a few threshold masses for stars which explode as the supernovae without a neutron-star remnant. The transport of energy from interior to exterior of the NBH is due to the neutrons, i.e. the mass of neutron (mass = 939.565 MeV) leads to star with mass equal to 24.8 solar masses. When energy is carried by less massive objects then mass of supernova is lower. For example, if energy is carried by the condensates in centre of the core of baryons ([1]: mass = 424.124 MeV) then mass of supernova is 24.8·424.124/939.565 = 11.2 solar masses – such mass had the supernova SN 1987A so we should not observe a neutron-star remnant. If energy is carried by the condensates in the centre of muons ([1]: mass = 105.656/2 = 52.828 MeV) then mass of supernova is 24.8·52.828/939.565 = 1.394 solar masses and it is the mass of the Type Ia supernovae. The condensates in centre of the baryons and muons are the black holes in respect of the weak interactions [1].

Within S-SET, we can as well correctly calculate the mass density of the NBH: $2.394 \cdot 10^{17}$ kg/m^3.

Due to the succeeding inflows of dark energy (the additional Einstein-spacetime components), there was the exit of the cosmic loop from its black-hole state. The protogalaxies transformed into quasars whereas most of the neutron black holes transformed into the big stars.

2. Calculations

For radiation energy density, ρ_r, we obtain

$$p = \rho_r = E / V = h \nu / V = h c / (\lambda V), \qquad (1)$$

where p is the negative pressure created in the Einstein spacetime by virtual or real loop which circumference is equal to the length of wave λ, h is the Planck constant, c is the speed of light in ‘vacuum’ whereas V is volume. We can see that negative pressure is inversely proportional to radius of loop.

The black holes in centre of quasars are built of neutron black holes. The NBH produce jets. The mechanism is as follows. On their equators are produced loops. They are moving to poles of NBH so their radius decreases whereas energy increases – it follows from the conservation of their angular momentum (E r / c = const). On the poles their radius is the reduced Compton wave of bare electron $r_e = \lambdabar_{C,\text{bare-electron}} = 3.8661 \cdot 10^{-13}$ m [1].

Applying formula (1), we obtain

$$p_{flow} = (R_{NBH} / r_e)\, p_{dyn,E}, \qquad (2)$$

where $p_{dyn,E} = \rho_E c^2/2$ is the mean dynamic pressure of the Einstein spacetime whereas $\rho_E = 1.10220 \cdot 10^{28}$ kg/m^3 is the density of the Einstein spacetime.

Due to the four-particle symmetry, the maximum number of entangled electron loops that appear on a pole of a NBH is $N = 2 \cdot 4^{32} = 3.7 \cdot 10^{19}$, [1], so the maximum initial energy of an electron in the jets produced by the neutron black holes a quasar consists of is about $1.9 \cdot 10^{19}$ MeV.

Due to the negative pressure in the jets which follows from the flows of the Einstein spacetime along the jets, on the electrons is exerted force opposite to the gravitational attraction

$$F_{flow,electron} / (\pi r_e^2) = (R_{NBH} / r_e) p_{dyn,E}, \tag{3}$$

$$F_{flow,electron} = \pi R_{NBH} r_e \rho_E c^2 / 2. \tag{4}$$

The clouds, which later transform into globular clusters, are produced on Schwarzschild surface of a quasar. The initial gravitational force acting on a cloud, which, due to advection, is carried by the jets, is

$$F_{gr,cloud} = G M_{quasar} m_{cloud} / R_{Sch,quasar}^2 = c^4 m_{cloud} / (4 G M_{quasar}). \tag{5}$$

From following condition we can calculate the upper limit for initial mass of a cloud

$$F_{flow,electron} = F_{gr,cloud}. \tag{6}$$

From formulae (4) – (6), we obtain

$$m_{cloud} \leq \pi R_{NBH} r_e \rho_E 2 G M_{quasar} / c^2 = 155{,}200 \text{ solar masses}, \tag{7}$$

where $M_{quasar} = 2.13 \cdot 10^{11}$ solar masses is the typical mass of quasars which transform into the massive spiral galaxies (the merger of two protogalaxies) [3]. The next typical mass of quasars is $8M_{quasar}$ – they transformed into the massive elliptical galaxies [3]. There as well were the barred quasars and quasars with non-typical masses. The mass $m_{cloud} \leq 155{,}200$ solar masses, is for the Milky-Way Galaxy.

From formula (7) follows that quasars with greater mass produce more massive globular clusters.

The today masses of the globular clusters in the Milky Way are, roughly, from about 10^4 to 10^5 solar masses so the obtained theoretical upper limit for the mass is consistent with observational facts.

3. Summary

It is not true that we can calculate correctly the Chandrasekhar limit assuming that a neutron star is a Fermi gas that obeys Fermi-Dirac statistics. Due to the atom-like structure of baryons, the binding energy for all neutrons has the same value so the factors which appear in the Chandrasekhar limit are incorrect.

There are at least two Chandrasekhar limits i.e. about 11.2 solar masses and 1.394 solar masses which is the mass of the Type Ia supernovae.

The clouds, that later transform into the globular clusters, are produced on Schwarzschild surface of the quasars and are carried by the relativistic jets. Calculated here the upper limit for the initial mass of the globular clusters in the Milky-Way Galaxy is 155,200 solar masses. Quasars with greater mass produce more massive globular clusters.

The obtained theoretical upper limit for the mass is consistent with observational facts.

References

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