# The Hot Subdwarfs in Omega Centauri Cluster as Untypical Supernovae

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**Abstract:** Using the Scale-Symmetric Theory (SST), we argue for the tower of the Chandrasekhar limits as the origin of the helium-rich hot subdwarfs in omega Centauri cluster. The structure of bare muons described within SST leads to the hot blue stars with a mass of 0.465 solar masses. Previously we showed that stars with masses of 1.395, 11.20 and 0.891 solar masses should behave as the Type Ia supernovae i.e. after the explosion of such stars there should not be created a neutron star as a remnant. Stars with a mass of 0.465 solar masses are the untypical supernovae. They are the remnants of the exploding stars with a mass of 0.891 solar masses which lose their outer hydrogen layers. Their mass is too small to cause a collapse and next explosion as it is for higher Chandrasekhar limits. But the 3-component weak mass (a ball/condensate composed of the confined Einstein-spacetime components that is entangled with two rotating neutrinos) in muons (for mass equal to 0.465 solar masses there appears a maximum for number density of such 3-component systems and each component carries energy equal to 17.61 MeV) is a catalyst for fusions of three alpha particles into carbon-12 (the last experimental data show that any nonzero amount of coherence in a system can be converted into an equal amount of entanglement between that system and another initially incoherent one). Due to such fusions, surfaces of the untypical supernovae are very hot (a narrow temperature range from 35,000 K to 40,000 K). They are the extreme horizontal branch (EHB) stars.

## 1. Introduction and substantiation

According to the Scale-Symmetric Theory (SST), there is the duality of relativity i.e. the speed of light in "vacuum", $c$, is the speed in relation to the source of radiation (it follows from the fact that the radiation is entangled with the source) or in relation to the last-interaction object (then, the radiation is entangled with such object and sometimes it is a detector). Such interpretation is in accordance with the Michelson-Morley experiment.

The extended General Relativity (GR) leads to the superluminal non-gravitating Higgs field which is the starting point in SST [1A]. The three new symmetries lead to the succeeding phase transitions of such Higgs field and one of the five appearing scales is the cosmological scale. Evolution of the cosmological object, which appears in the cosmological scale, leads to the dark matter, dark energy and to the very early Universe composed of protogalaxies built of the neutron black holes (NBHs) with a mass of $m_{NBH} = 24.81$ solar masses each [2]. This upper limit for mass of neutron stars (mainstream theories lead to much smaller mass about $2 - 3$ solar masses) follows from the facts that inside nucleons are very dense gluon fields, [3], and there is the smallest-distance entanglement between gluons which protect the cores of nucleons against their collapse [1A]. Due to the inflows of the dark energy and dark matter into the protogalaxies, the NBHs transformed into the first-generation stars but due to the properties of the cosmological object and due to the duality of relativity, we cannot see the initial period 7.75 Gyr of evolution of the protogalaxies so of the NBHs as well (our universe is about 21.614 Gyr old so most distant galaxies are in the time distance about 13.866 Gyr [1A]).

Here we show that the He-rich hot subdwarfs in $\omega$ Centauri cluster with a mass of 0.465 solar masses each, [4], [5], must be the third-generation of stars.

Stability of a star follows from the equivalence of the produced nuclear energy and the emitted energy. When produced nuclear energy too quickly leaks from a star then we should observe a collapse of the star whereas when the produced nuclear energy starts to interact with baryons, i.e. when the energy is confined inside a star, then the star must violently explode. We seek the threshold masses of stars/white-dwarfs for which there appears at first sudden collapse and next violent explosion. This means that we should look for carriers of energy interacting weakly with baryonic matter. Weakly interacting carriers of nuclear energy cause that temperature of a star suddenly drops and the star suddenly collapses. It causes that there appears very hot and dense nuclear plasma. Such plasma becomes non-transparent even for the weakly interacting carriers. The number density of the weakly interacting carriers suddenly increases so the star violently explodes.

Here, [2], we can find the formula for the Chandrasekhar limits (1.395, 11.20 and 0.891 solar masses) i.e. the formula for masses of stars that should behave as the Type Ia supernovae i.e. after the explosion of such stars there should not be created a neutron star as a remnant

$$M_{Chandrasekhar\text{-}limits} = M_{CL} = m_{NBH}\, M_X / m_{neutron}. \qquad (1)$$

For $M_X$ = 52.83 MeV (it is mass/energy of the weak condensate and two rotating neutrinos in centre of each resting muon; it is the black hole in respect of the weak interactions) is $M_{CL}$ = 1.395 solar masses – it is the Chandrasekhar limit for the Type Ia supernova, for $M_X$ = 424.12 MeV (it is mass of the weak condensate in centre of each resting nucleon; it is the black hole in respect of the weak interactions as well) is $M_{CL}$ = 11.20 solar masses – it is the Chandrasekhar limit for the SN 1987A supernova, and for $M_X$ = 33.743 MeV (it is typical energy of neutrinos) is $M_{CL}$ = 0.891 solar masses.

The SST shows that a resting muon consists of torus/electric-charge and a 3-component weak condensate composed of a ball built of the luminal Einstein-spacetime components (i.e. built of the confined neutrino-antineutrino pairs) and two rotating neutrinos (both torus and the 3-component weak condensate have mass equal to 52.828 MeV each) [1]. Each of the parts of the 3-component weak condensate has energy equal to $M_{X,EHB}$ = 52.828/3 = 17.61 MeV. Mass of a star with a maximum for number density of systems composed of three entangled objects with energy equal to 17.61 MeV each, should be (we apply formula (1))

$$M_{CL,EHB} = m_{NBH}\, M_{X,EHB} / m_{neutron} = 0.465 \text{ solar masses}. \qquad (2)$$

The hot subdwarfs with a mass of 0.465 solar masses are the untypical supernovae. The untypical supernovae are the remnants of the exploding stars with a mass of 0.891 solar masses which lose their outer hydrogen layers. Their mass is too small to cause a collapse and next explosion as it is for the higher Chandrasekhar limits.

But the 3-component weak systems in muons are a catalyst for production of carbon-12 from three helium-4 nuclei. Just any nonzero amount of coherence in a system can be converted into an equal amount of entanglement between that system and another incoherent one [6]. The last results show that coherence and entanglement are operationally equivalent but conceptually different ideas. Here the 3-component weak systems are the coherent systems whereas the associations of the three alpha particles are the initially incoherent systems. Due to the fusions of helium-4 into carbon-12, surfaces of the untypical supernovae are very hot (a narrow temperature range from 35,000 K to 40,000 K). They are the extreme horizontal branch (EHB) stars. Such is the origin of the helium-rich hot subdwarfs in $\omega$ Centauri cluster.

From formula (1) follows that for the tower of the Chandrasekhar limits, the ratio $M_{CL}/M_X$ is invariant so the limits $M_{CL}$ are not quantized but the internal structures of bare particles quantize the $M_X$ so the $M_{CL}$ as well. Within theories that neglect the internal structures of bare particles or start from incomplete set of initial conditions (for example, within the Standard Model or General Relativity) we cannot formulate a coherent model for the tower of the Chandrasekhar limits – it is possible within the SST because of the succeeding phase transitions of the superluminal non-gravitating Higgs field.

Notice that existence of the Type Ia supernovae with a mass of 1.395 solar masses (in theory of such stars appears a half of the muon mass) and existence of the He-rich hot subdwarfs with a mass of 0.465 solar masses (in theory of such stars appears one sixth of the muon mass) suggests that the structure of muon described within the SST is correct.

## References

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