The Lower Limit for Mass and Radius of Neutron Stars

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Abstract: Here we calculated radius (12.1 km) and the lower limit for mass (0.891 solar masses) of neutron stars. Such a limit is defined by the characteristic energy of neutrinos in hot nuclear plasma that forces a shower of beta decays.

Introduction and motivation

Within the Scale-Symmetric Theory (SST) [1], [2], we calculated the upper limit for mass of neutron stars ($M_{NBH} = 24.81$ **solar masses**) – it is for the neutron black holes (NBHs) with a radius of $R_{NBH} = 36.64$ **km** [2]. We showed also that the TOV limit is an illusion – just the interactions of neutron stars (NSs) with the dark-matter (DM) loops with quantized spins cause that the NSs with a mass of 2.44 solar masses and slightly higher and with a mass of 19.53 solar masses and slightly higher are electromagnetically much darker so their detection is difficult [3].

Here we described phenomena that lead to the lower limit for mass of NSs.

According to SST, the characteristic energy of neutrinos in hot nuclear plasma is the one fourth of the mass of neutral pion: $E_{Neutrinos} = 33.74$ MeV [1]. On the other hand, there appears the tower of the Chandrasekhar limits for supernovae – masses of such stars are defined by characteristic energies emitted smoothly by collapsing stars [4]. In such collapses are not created NSs as some remnants. It concerns the $E_{Neutrinos}$ as well which is the lowest energy which leads to the explosion of a star without the creation of a neutron star as the remnant of the explosion. Thus, the energy $E_{Neutrinos}$ should define the lower limit for mass of NSs. At this energy, the β decays of neutrons in neutron star are common across the entire volume, so with a "peaceful" transformation such a star transforms into iron ball. When the transformation is violent, the explosion resembles a Type Ia supernova.

The lower limit for mass of NSs, $M_{Lower\text{-}limit}$, we can calculate from following formula [4]

$$M_{Lower\text{-}limit} = M_{NBH} E_{Neutrinos} / M_{Neutron} = 0.891 \textbf{ solar masses}, \quad (1)$$

where $M_{Neutron} = 939.565$ MeV is the mass of neutron calculated in SST [1].

Radius of neutron star with a mass equal to the lower limit of mass is

$$R_{Lower\text{-}limit} = R_{NBH} (M_{Lower\text{-}limit} / M_{NBH})^{1/3} = 12.1 \textbf{ km}. \quad (2)$$

SST shows that we must totally change the theory of neutron stars and black holes so the foundations of cosmology as well. Moreover, the SST theory of neutron stars is based on the

atom-like structure of baryons so the quark model must be totally reformulated. It is high time to put cosmology and particle physics on the right track.

The results obtained in the SST for neutron stars are in full agreement with the observational data [5].

References

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