Nuclear mass density based high temperature stable black holes

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Introduction

During the collapse a massive star, at the moment of formation of black holes, a large quantity of heat is generated and thereby its internal temperature increases. At increasing mass density and increasing internal temperature nuclear interactions like fusion of quarks, will take place and generate more heat causing the black hole internal temperature to increase further. At one particular temperature, its thermal energy density approaches its mass-energy density and thus the black hoe starts maintaining its structural stability against further collapse. In this new direction and with reference to the Compton wavelength of nucleon and electron, existence of two stable massive black holes can be predicted.

Basic ideas

A) With reference to the Compton wave length of nucleon , there may exist a massive black hole with mass density in the following way.

$$\left[M_B\left(\frac{4\pi}{3}R_B^3\right)^{-1}\right] \cong m_n\left(\frac{4\pi}{3}\left(\frac{\hbar}{m_n c}\right)^3\right)^{-1} \quad (1)$$

Here, (M_B, R_B) represent the mass and radius of black hole respectively and m_n is the mass of nucleon. On simplification,

$$M_B \cong \sqrt{\frac{\hbar^3 c^3}{8G^3 m_n^4}} \cong \frac{M_P^3}{\sqrt{8}m_n^2} \cong 1.3\times 10^{30} \text{ kg.} \quad (2)$$

where $M_P \cong \sqrt{\frac{\hbar c}{G}}$ is the Planck mass. This obtained black hole mass is 2.2154 times less than the Chandrasekhar mass limit.

B) With reference to the Compton wave length of electron, there may exist a massive black hole with mass density in the following way.

$$\left[M_B\left(\frac{4\pi}{3}R_B^3\right)^{-1}\right] \cong m_e\left(\frac{4\pi}{3}\left(\frac{\hbar}{m_e c}\right)^3\right)^{-1} \quad (3)$$

Here m_e is the mass of electron. On simplification,

$$M_B \cong \sqrt{\frac{\hbar^3 c^3}{8G^3 m_e^4}} \cong \frac{M_P^3}{\sqrt{8}m_e^2} \cong 4.38\times 10^{36} \text{ kg .} \quad (4)$$

This can be compared with the Milky way central black hole of mass 4.3 million solar masses.

Thermal energy density of black holes

According to Abhas Mitra - the so-called black holes observed by astronomers are actually radiation pressure supported Eternally Collapsing Objects (ECOs). These balls of fire are so hot that even neutrons and protons melt there and whose outward radiation pressure balances the inward pull of gravity to arrest a catastrophic collapse before any Black Hole or 'singularity' would actually form.

Following the notion of hot ECOs and black holes, to stop further collapse, for any black hole to maintain its black hole radius or its structure, its thermal energy density must be equal to its mass-energy density. Clearly speaking,

$$aT_B^4 \cong \left[M_B c^2 \left(\frac{4\pi}{3} R_B^3 \right)^{-1} \right] \tag{5}$$

With reference to the compound radiation constant and the Planck mass, above relation can be simplified into the following form.

$$T_B \cong 0.4615 \cdot \frac{\hbar c^3}{G k_B \sqrt{M_B M_P}} \tag{6}$$

This is similar to the Hawking's black hole temperature formula. According Hawking, temperature of a black hole is given by the following famous relation.

$$T_B = \frac{\hbar c^3}{8\pi k_B G M_B} \tag{7}$$

Here, (M_B, T_B) represent the mass and temperature of the black hole respectively. Note that, so far Hawking's proposal is not verified and not confirmed by any of the advanced astrophysical observations or Large Hadron Collider experiments. It is being believed based on the advanced quantum mechanical theoretical and mathematical formulations.

Similar to the Hawking's black hole temperature formula, now above relation (6) can be re-expressed as follows.

$$T_B = 0.4651 \sqrt{\frac{M_B}{M_P}} \cdot \left(\frac{\hbar c^3}{k_B G M_B} \right) \tag{8}$$

Now above assumptions A and B can be expressed in the following way.

A) With reference to the Compton wave length of nucleon , there may exist a stable massive black hole with thermal energy density in the following way.

$$\begin{aligned} aT_B^4 &\cong M_B c^2 \left(\frac{4\pi}{3} R_B^3 \right)^{-1} \\ &\cong m_n c^2 \left(\frac{4\pi}{3} \left(\frac{\hbar}{m_n c} \right)^3 \right)^{-1} \end{aligned} \tag{9}$$

where T_B represents temperature required to maintain the black hole's further collapse.

$$T_B \cong \left[\frac{m_n c^2}{a} \left(\frac{4\pi}{3} \left(\frac{\hbar}{m_n c} \right)^3 \right)^{-1} \right]^{\frac{1}{4}} \tag{10}$$

$$\cong 8.46 \times 10^{12} \text{ K}$$

B) With reference to the Compton wave length of electron, there may exist a stable massive black hole with thermal energy density in the following way.

$$\begin{aligned} aT_B^4 &\cong M_B c^2 \left(\frac{4\pi}{3} R_B^3 \right)^{-1} \\ &\cong m_e c^2 \left(\frac{4\pi}{3} \left(\frac{\hbar}{m_e c} \right)^3 \right)^{-1} \end{aligned} \tag{11}$$

To have stability against the gravitational collapse, black hole of mass 4.38×10^{36} kg requires a temperature,

$$T_B \cong \left[\frac{m_e c^2}{a} \left(\frac{4\pi}{3} \left(\frac{\hbar}{m_e c} \right)^3 \right)^{-1} \right]^{\frac{1}{4}} \tag{12}$$

$$\cong 4.6 \times 10^9 \text{ K}$$

Conclusion

With reference to Hawking's view and Abhas Mitra's view in a unified picture it can be suggested that, when the black hole mass density approaches the nuclear mass density, black hole's internal temperature increases and imitates quark fusion which in turn generates more heat resulting in a high temperature stable massive black holes with mass close to the 10^{30} kg.

References

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