Is there an upper limit on how big a black hole can be?

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Abstract

There is a limit on the mass and size of the black hole. I calculate the mass and size of a black hole based on two assumptions 1) There is a maximal density possible in the universe, and 2) There is a limit on the acceleration in the universe. The result is that the maximal mass of a black hole is ~1.2 x 10^54kg.

Yes, I think there must be an upper limit to the mass and size of a black hole. A black hole is a physical entity and therefore must have physical limits.

First, I would like to relate to the structure of a black hole. My conjuncture is that in the center of a black hole, there is a massive neutron star rather than a singularity point with an infinite density as suggested by others. In this sense, a black hole and a neutron star are the same. A neutron star has a mass and size. The same applies to the neutron star at the center of the black hole, it has mass and a physical radius. The question now is how come that black holes are not directly observed in the universe, while neutron stars are seen. My answer is: **The visibility depends on the relation between the physical radius of the nucleus and its Schwarzschild radius**. A celestial body will be observed if its physical radius is bigger than its Schwarzschild radius. On the other hand, a celestial body that has a physical radius that is smaller than its Schwarzschild radius will be hidden. More details in Is a black hole a neutron star?

In the following paragraph, I calculate the maximal mass and physical of a black hole. To this end, I make two hypotheses.

1) There is a maximum density of matter in the universe.

This maximum density occurs when nucleons of matter are packed so densely that they cannot be squeezed anymore. It is known that neutron stars, atom nuclei, and neutrons have approximately the same maximum density. This density is:

$$\rho_{\max} \cong \rho_{neutron} = \frac{m_{neutron}}{\frac{4}{3} \cdot \pi \cdot R_{neutron}{}^{3}} = 7.81 \cdot 10^{17} \cdot kg / \mathrm{m}^{3} \qquad (1)$$

Where:

$m_{neutron} = 1.674927471 \cdot 10^{-27} kg$ …is the mass of a neutron.

$R_{neutron} = 0.8 \cdot 10^{-13} cm$ …is the radius of the neutron

2) There is a maximal acceleration in the universe.

The hypothesis that there is a maximum acceleration possible in the universe is known. Experiments were conducted to find this acceleration. For example, Potzel

describes such an experiment. https://arxiv.org/abs/1403.2412 . He calculated that the maximal acceleration possible in the universe is $a_{\max} \approx 1.5 \cdot 10^{21} \cdot \frac{m}{\sec^2}$. In his paper, he mentions another experiment done by Friedman, who found an acceleration: $a_{\max} = 1 \cdot 10^{19} \cdot \frac{m}{\sec^2}$. The experiments are quite sensitive and more refined experiments are needed. In this paper, I estimate: $a_{\max} = 1.6 \cdot 10^{20} \cdot \frac{m}{\sec^2}$

Solution:

My claim is that the maximal acceleration on the surface of a spherical body having mass M and radius R can be calculated by Newton's theory of gravity:

$$a_{\max} = \frac{G \cdot M}{R^2} \qquad (2)$$

The physical radius of the neutron star is based on the formula used for calculating the radius of the atom's nucleus.

$$R = R_{neutron} \cdot \left(\frac{M}{m_{neutron}}\right)^{\frac{1}{3}} \qquad (3)$$

The reasoning for using this equation is that the structure of the neutron star is similar to the structure of the atom nucleus. See Atomic nucleus. The radius of the atom's nucleus is calculated by $R = r_0 \cdot A^{1/3}$ where R – radius of the atom's nucleus and A- number of nucleons.

The mass of a spherical neutron star is:

$$M = \frac{4}{3} \cdot \pi \cdot R^3 \cdot \rho_{\max} \qquad (4)$$

From equations (1), (2), (3), and (4) the maximal mass and the radius of a neutron star can be calculated:

$$M = \left(\frac{a_{\max} \cdot R_{neutron}^{2}}{G \cdot m_{neutron}^{\frac{2}{3}}}\right)^{3} = 1.24 \cdot 10^{54} \cdot kg \quad (5)$$

And its radius:

$$R = R_{neutron} \cdot \left(\frac{M}{m_{neutron}}\right)^{\frac{1}{3}} = 7.24 \cdot 10^{8} \cdot km \quad (6)$$

Conclusion

There is the mass and radius of a neutron star at the center of a black hole above which it cannot hold its content and must explode.

Question: Does the mass of 1.24 x 10^54kg ring a bell?