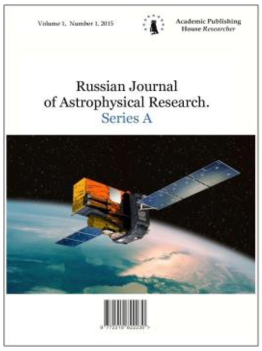
Published in the Slovak Republic
Russian Journal of Astrophysical Research. Series A
Has been issued since 2015.
E-ISSN: 2413-7499
2020, 6(1): 3-6

DOI: 10.13187/rjar.2020.1.3
www.ejournal28.com



Articles

Black Hole and Large Number Hypothesis

Takaaki Musha [a, *]

[a] Advanced Science-Technology Research Organization, Yokohama, Japan

Abstract

Large Number Hypothesis (LNH) was proposed by Paul Dirac. This coincidence of number was also recognized by Arthur Eddington who related the above ratios to N, which the estimated number of charged particles in the universe. This hypothesis shows some physical parameters depends on the age of the universe. For example, it shows the strength of gravity as represented by the gravitational constant is inversely proportional to the age of the universe. By applying this hypothesis to a black hole, it can be shown that the entropy of the black hole depends on the age of the universe and the thermal radiation from the black hole increases with time.

Keywords: black hole, large number hypothesis, entropy, thermal radiation.

1. Introduction

The Dirac large numbers hypothesis (LNH) is an observation made by Paul Dirac in 1937 relating ratios of size scales in the Universe to that of force scales. The ratios constitute very large, dimensionless numbers: some 40 orders of magnitude in the present cosmological epoch. According to Dirac's hypothesis, the apparent similarity of these ratios might not be a mere coincidence but instead could imply a cosmology with these unusual features:

From this hypotheses, the following features were obtained.

The strength of gravity as represented by the gravitational constant is inversely proportional to the age of the universe. The mass of the universe is proportional to the square of the universe's age, and physical constants are actually not constant. Their value depends on the age of the universe.

This coincidence was primary found by Arthur Eddington who related the above ratios to N, which the estimated number of charged particles in the universe (Eddington, 1931):

This can be shown as $t/(r_e/c) \approx 10^{40}$, where t is the age of the universe, c is the light speed and r_e is the classical electron radius.

By applying LNH to the entropy of the black hole, some features of the black hole can be obtained.

We abbreviate the Large Number Hypothesis as LNH hereafter;

[*] Corresponding author
E-mail addresses: takaaki.mushya@gmail.com (T. Musha)

2 LNH and the black hole

The ratio of the Coulomb force and the gravity, we have

$f_C / f_g \approx 10^{40}$, (1)

where f_C is a Coulomb force and f_g is a gravity given by

$f_C = \frac{e^2}{4\pi\varepsilon_0 r^2}$, and $f_g = \frac{Gm_p m_e}{r^2}$, (2)

In these equations, e is a charge of an electron, G is a gravitational constant, m_p is a mass of a proton and m_e is a mass of an electron.

If we let $t/(r_e/c) = \tau$, which is a time scale of the universe, we have a following equation from LNH as

$$\tau \approx \frac{e^2}{4\pi\varepsilon_0 G m_p m_e}, \quad (3)$$

Then we can write

$$G \approx \frac{e^2}{4\pi\varepsilon_o m_p m_0 \tau}. \quad (4)$$

From which, it is seen that G varies with time.

A black hole is a region of spacetime exhibiting gravitational acceleration so strong that nothing—no particles or even electromagnetic radiation such as light—can escape from it. The theory of general relativity predicts that a sufficiently compact mass can deform spacetime to form a black hole.

The area of its event horizon, A, can be described as (Imaeda, Imaeda, 1982)

$$A = \frac{8\pi G^2 M^2}{c^4}\left[1 + \sqrt{1 - \frac{cJ}{GM^2}}\right], \quad (5)$$

where M is a mass of the black hole and J is its angular momentum.

From Eq.(3), we have the following equation for non-rotating black hole;

$$A = \frac{M^2 e^4}{2\pi c^4 m_p^2 m_e^2}\frac{1}{\tau^2}, \quad (6)$$

Starting from theorems proved by Stephen Hawking, Bekenstein conjectured that the black hole entropy was proportional to the area of its event horizon divided by the Planck constant (Majumdar, 1999). Then the formula for the Bekenstein entropy of the black hole can be shown as

$$S_{bh} = \frac{k_B}{4\hbar}\left(\frac{Ac^3}{G}\right) \approx \frac{k_B M^2 e^2}{2\hbar c \varepsilon_0 m_p m_e}\frac{1}{\tau}. \quad (7)$$

The radiation temperature from the black hole can be also obtained as (Imaeda, Imaeda, 1982)

$$T = \frac{h}{16\pi^2 k_B}\left(\frac{c}{GM}\right) \approx \frac{hc}{4\pi k_B M}\frac{\varepsilon_0 m_p m_e}{e^2}\tau, \quad (8)$$

Some features derived from LNH for a black hole

From equations described above, we obtain the following results.

(1) The area of the event horizon of the black hole decreases with time, contrary to the black hole area theorem states that surface area of a black hole does not decrease with time.

(2) The entropy of the black hole decreases with time.

(3) The temperature of the black hole increases with time given by

$T \approx 6.024 \times 10^{-34} \times \tau / M$

Quantum field theory in curved spacetime predicts that event horizons emit Hawking radiation, with the same spectrum as a different from the Hawking radiation black body of a temperature inversely proportional to its mass (Hawking, 1988). Then black holes are expected to shrink and evaporate over time as they lose mass by the emission of photons and other particles. LNH also predicts that the black hole radiates energy and shrinks with time, which is the same as the Hawking radiation, but the amount of radiation increases with time.

This means that the black hole radiates energy from the vacuum because the mass of the black hole maintains constant, which contradicts the second law of thermodynamics.

On 10 April 2019 an image was released of a black hole, which is seen in magnified fashion because the light paths near the event horizon are highly bent. The dark shadow in the middle results from light paths absorbed by the black hole (Lutz, 2019). The image is in false color, as the detected light halo in this image is not in the visible spectrum, but radio waves as shown in Figure 1. The black hole is 500 million trillion km away and was photographed by a network of eight telescopes across the world.

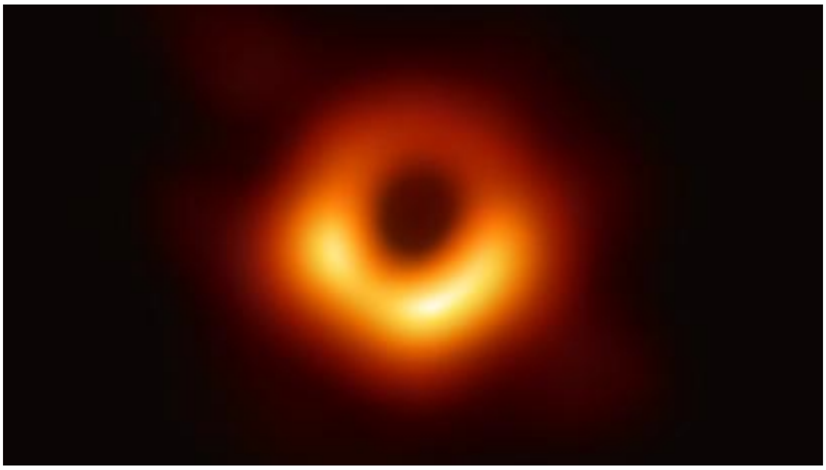


Fig. 1. The photo of a black hole

There is an idea of elementary particles being tiny black holes, yet even within the canonical model of particle physics elementary particles like electrons and quarks are taken to have mass yet occupy zero-dimension. In fact, because of the self-energy of a point-particle, leptons have infinite bare mass and infinite bare charge – vacuum fluctuations are needed to shield these infinite values. Such a point-particle is a singularity, or in more common parlance a black hole (Holzhey, 1991). However, if elementary particles are black holes, they evaporate and the universe is filled with thermal radiation at the present time according to the equation $T \approx 6.024 \times 10^{6} / M$ obtained from the LNH.

If a black hole does exist in the universe as observed, LNH, which was suggested by Paul Dirac in 193 7, is considered to be false.

3. Conclusion

LNH predicts that black hole radiates energy by shrinking its area of the event horizon.

The black hole does not lose its mass, but it emits thermal radiation with time. However, this result contradicts to the second law of thermo dynamics. If LNH is true, we can create a thermal engine with perpetual motion by using the micro black hole. But this result leads to the conclusion that there is no black holes in the universe.

References

Eddington, 1931 – *Eddington, A.* (1931). Preliminary Note on the Masses of the Electron, the Proton, and the Universe. *Proceedings of the Cambridge Philosophical Society*. 27(1): 15-19.

Hawking, 1988 – *Hawking, S.* (1988). A Brief History of Time. Bantam Books.

Holzhey, 1991 – *Holzhey, C.F.E.* (1991). Black holes as elementary particles. [Electronic resource]. URL: https://arXiv:hep-th/9202014

Imaeda, Imaeda, 1982 – *Imaeda, K., Imaeda, M.* (1982). Physics of black hole, Kodansha. Ltd. Tokyo (Japanese edition).

Lutz, 2019 – *Lutz, O.* (2019). How Scientists Captured the First Image of a Black Hole. [Electronic resource]. URL: https://www.jpl.nasa.gov/edu/news/2019/4/19/how-scientists-captured-the-first-image-of-a-black-hole/

Majumdar, 1999 – *Majumdar, P.* (1999). Black Hole Entropy and Quantum Gravity. *Indian J. Phys.* 73.21 (2): 147.