Journal of High Energy Physics, Gravitation and Cosmology, 2023, 9, 455-460
https://www.scirp.org/journal/jhepgc
ISSN Online: 2380-4335
ISSN Print: 2380-4327

Matter Reactors

Rami Rom

Independent Researcher, Zikhron-Yaakov, Israel
Email: romrami@gmail.com

How to cite this paper: Rom, R. (2023) Matter Reactors. *Journal of High Energy Physics, Gravitation and Cosmology*, **9**, 455-460.
https://doi.org/10.4236/jhepgc.2023.92033

Received: December 21, 2022
Accepted: April 4, 2023
Published: April 7, 2023

Abstract

In a previous paper, we proposed that a QCD gas that may be a possible candidate for the general theory of gravity (GR) ether may be comprised of $u\tilde{d}d\tilde{u}$ exotic mesons. A method to determine the effective mass of the $u\tilde{d}d\tilde{u}$ exotic meson and the Friedmann-Robertson-Walker (FRW) metric scale factor equation of state dimensionless parameter, *w*, by measuring the pseudo-first order β decay rates expected to be inversely proportional to the QCD gas atmospheric density was given. Here, we propose to measure the β decay rate, $t_{1/2}$, and the earth distance to the milky-way galaxy super massive black hole (SMBH), h_{SMBH}, at the earth aphelion each year for several years, and fit the data with the linear curve: $-\ln t_{1/2} = ah_{SMBH} + b$. The slope parameter, *a*, and the free parameter, *b*, may be used to calculate the Kerr spin parameter and determine if the QCD gas density on the ergosphere remains constant in time, or alternatively, grows in time according to Corley and Jacobson's proposed black hole laser process.

Keywords

Compact Exotic Mesons, β Decay Rate Variability, Kerr Black Hole, Supermassive Black Hole, Black Hole Laser, Ergoregion, Ergosphere, Hawking Radiation, Superradiance, Carnot Engine, FRW Metric, Dark Energy

1. The Galactic QCD Gas Density and the BH Laser Process

The existence of super massive black hole (BH) in the center of the giant elliptical galaxy M87 was demonstrated by the Horizon Telescope Collaboration (EHT) that produced a first image of the dark shadow caused by gravitational light bending and photon capture at the event horizon [1]. The EM radio-wave observations provide powerful evidence for the presence of supermassive Kerr black holes in centers of galaxies that act as the central engines of the active galactic nuclei (AGN).

According to Corley and Jacobson [2], BHs that have ergoregions with an inner and an outer event horizon where a superluminal dispersion relation exists in their ergoregions, enhance exponentially in time the creation of boson particles in their ergoregions. The rotating BH ergoregions act like laser cavities that enhance exponentially the otherwise extremely weak Hawking radiation [3]. The Hawking process for a bosonic field becomes self-amplifying and the radiated flux grows exponentially in time, where the negative energy partner of the Hawking particle, after falling to the inner horizon, "bounces" and returns to the outer horizon ergosphere on a superluminal trajectory, where it stimulates more Hawking radiation bosons. Corley and Jacobson suggested that a bound state trapped between the ergoregion horizons is created and the particle creation increases monotonically with time, diverging as $t \to \infty$ for a discrete set of frequencies.

Radiating Kerr black hole and Hawking radiation is studied by Chou [4] that estimated the Hawking-radiation temperature of black holes with the angular momentum and the same mass of Pluto to be 9.42 K. Brito *et al.* [5] [6] studied the Superradiance instability of black holes immersed in a magnetic field. Superradiance in BH ergoregions allows for energy, charge and angular momentum extraction at the classical GR level where Hawking radiation can be interpreted as a quantum version of black-hole Superradiance. Negative energy-states are dumped in the ergoregions and amplification of outgoing waves occurs on the ergosphere boundary surface in both the classical GR equation Superradiance solution and the black hole laser process based on Hawking radiation.

Superradiant pion clouds around primordial black holes are studied by Ferraz *et al.* [7] that showed that highly spinning primordial black holes may produce clouds of pions in their vicinity via the superradiant instability with densities up to that of nuclear matter. Superradiant amplification of low-frequency wave modes results from the dissipative nature of a black hole's event horizon, combined with rotation in the Kerr case, and it is the trapping of such modes in the black hole's vicinity that leads to continuous amplification of the pion production.

Since the $u\tilde{d}d\tilde{u}$ exotic meson [8] is its own antimatter boson particle and assuming that superluminal dispersion relation exists in SMBH ergoregions where the QCD gas density is extremely high, we suggest here a method to determine if its density is further amplified and radiated to space by the Corley and Jacobson ergoregion laser process [2] or similarly by Superradiance [5] [6].

The following pseudo-first order β decay (Equation (1)), the β decay rate (Equation (2)), the QCD gas atmospheric density (Equation (3)), the QCD gas mass formula (Equation (4)) and the equation of state parameter, w [8], derived in a previous paper [9] proposed an alternative explanation for the observed β decay rate variability [10] [11].

$$udd\,(n) + u\tilde{d}d\tilde{u}\,(\text{exotic meson}) \rightarrow udu\left(p^{+}\right) + d\tilde{u}d\tilde{d} \tag{1}$$

$$t_{1/2} = \frac{1}{k_\beta \rho(h)} \quad (2)$$

$$\rho(h) = \rho(h_0) \mathrm{e}^{\frac{-m_{QCD\,gas} GM_{sun}(h-h_0)}{h_0^2 k_b T}} \quad (3)$$

$$m_{QCD\,gas} = \frac{-k_b T h_{perihelion}^2 \ln\left(\frac{t_{\frac{1}{2},periheilion}}{t_{\frac{1}{2},apheilion}}\right)}{GM_{sun}\left(h_{aphelion} - h_{perihelion}\right)} \quad (4)$$

$$w = \frac{GM_{sun}\left(h_{aphelion} - h_{perihelion}\right)}{-h_{perihelion}^2 \ln\left(\frac{t_{\frac{1}{2},periheilion}}{t_{\frac{1}{2},apheilion}}\right) c^2} \quad (5a)$$

$$w \sim \frac{-3.4091^{-10} t_{\frac{1}{2},apheilion}}{\Delta_t}, \Delta_t = t_{\frac{1}{2},apheilion} - t_{\frac{1}{2},periheilion} \quad (5b)$$

Here, we generalize this approach to galactic SMBH systems. The sun trajectory is not an exact ellipse; however, an eccentricity on the order of about 5% in the range of e = 0.02 - 0.08 is assumed. The perihelion and aphelion of the sun trajectory are estimated to be about 26,000 and 28,000 light years and the sun period is about 230 million years around the galaxy center SMBH, Sagittarius A. We propose performing the β decay rate measurement and the distance to Sagittarius A measurement at the earth's aphelion day every year in a sequence for several years, for 10 - 20 years for example, and fitting the measured data by a linear curve. The inputs for the fit are the β decay rate $t_{1/2}$ and the distance to Sagittarius A, h_{SMBH}.

We assume that the galactic QCD gas density drops from the SMBH ergosphere as a function of elevation according to Equation (6) below and propose to fit the data with the linear plot of the logarithm of the measured β decay rates as a function of the distance of earth at aphelion to the galaxy SMBH given by Equation (7). The linear fit parameters, a and b, are given by Equations (8) and (9).

$$\rho(h_{SMBH}) = \rho\left(h_{ergosphere}\right) \mathrm{e}^{\frac{-m_{QCD\,gas} GM_{BH}\left(h_{SMBH} - h_{ergosphere}\right)}{h_{ergosphere}^2 k_b T}} \quad (6)$$

$$-\ln t_{1/2} = a h_{SMBH} + b \quad (7)$$

$$a = -\frac{m_{QCD\,gas} GM_{BH}}{h_{ergosphere}^2 k_b T} \quad (8)$$

$$b = \frac{m_{QCD\,gas} GM_{BH}}{h_{ergosphere} k_b T} + \ln k_\beta \rho\left(h_{ergosphere}\right) \quad (9)$$

From the slope parameter, a (Equation (8)), we can calculate the SMBH ergosphere radii $h_{ergosphere}$ and from it we can calculate further the Kerr spin parameter a_{spin}, which is hard to determine experimentally [12] [13]

$$h_{ergosphere} = \frac{GM_{BH}}{c^2}\left(1+\sqrt{1-a_{spin}^2}\right) \tag{10}$$

From the free parameter, b (Equation (9)), we can determine if the QCD gas density on the ergosphere remains constant in time, or alternatively, grows in time as predicted by Corley and Jacobson Kerr BH laser cavity process [2]. In the latter case, a deviation from the linear fit will be seen since the second term in Equation (9), e.g. $\ln k_\beta \rho\left(h_{ergosphere}\right)$, will change with time.

2. Continuous Matter Creation by AGN SMBH Engines?

We proposed in the previous paper [9] that the $u\tilde{d}d\tilde{u}$ exotic mesons condense into a new strongly bound peculiar positronium/quarkonium state introduced by Crater and Wong's Two Body Dirac Equation (TBDE) approximate solution [14] [15]. We further assume here that in SMBH ergoregions the pressure is extremely high such that 2 $u\tilde{d}d\tilde{u}$ exotic mesons may combine and form the following short-lived octaquark and a 16-quark exotic mesons:

$$2u\tilde{d}d\tilde{u}\left(\text{exotic meson}\right) \rightarrow u\tilde{d}d\tilde{u}d\tilde{d}\tilde{u}u\left(\text{octaquark meson}\right) \tag{11}$$

$$2u\tilde{d}d\tilde{u}d\tilde{d}\tilde{u}u\left(\text{octaquark meson}\right) \rightarrow u\tilde{d}d\tilde{u}d\tilde{d}\tilde{u}uu\tilde{d}d\tilde{u}d\tilde{d}\tilde{u}u\left(\text{16-quark meson}\right) \tag{12}$$

Octaquarks exotic mesons may decay to neutrons, protons, and short-lived pions where the antimatter particles, antineutrons $\tilde{d}\tilde{u}\tilde{d}\left(\tilde{n}\right)$ (Equation (16)) and antiprotons $\tilde{d}\tilde{u}\tilde{u}\left(\tilde{p}\right)$ (Equation (18)), are trapped in the BH ergoregions and the matter particles are emitted to space by Hawking radiation as described by Equations (13)-(16) below.

$$u\tilde{d}d\tilde{u}d\tilde{d}\tilde{u}u\left(\text{octaquark meson}\right) \rightarrow udd\tilde{u}u\left(n^*\right) + \tilde{d}\tilde{u}\tilde{d}\left(\tilde{n}\right) \tag{13}$$

$$udd\tilde{u}u\left(n^*\right) \rightarrow udu\left(p^+\right) + d\tilde{u}\left(\pi^-\right) \rightarrow udu\left(p^+\right) + e^- + \tilde{\nu}_e \tag{14}$$

$$u\tilde{d}d\tilde{u}d\tilde{d}\tilde{u}u\left(\text{octaquark mesom}\right) \rightarrow udu\tilde{d}d\left(p^{+*}\right) + \tilde{d}\tilde{u}\tilde{u}\left(\tilde{p}\right) \tag{15}$$

$$udu\tilde{d}d\left(p^{+*}\right) \rightarrow udd\left(n\right) + u\tilde{d}\left(\pi^+\right) \rightarrow udd\left(n\right) + e^+ + \nu_e \tag{16}$$

Note that in Equations (16) and (18) the excited neutron n^* and proton p^{+*} are exotic pentaquarks that include a $\tilde{u}u$ and $\tilde{d}d$ mesons that may trigger the quark and antiquark pair exchanges inside the nucleons.

16-quark exotic mesons may decay into deuterons and compact tetraquark $u\tilde{d}d\tilde{u}\left(\text{bosons}\right)$ where the antideuterons $\tilde{d}\tilde{u}\tilde{d}\tilde{u}\tilde{d}\tilde{u}\left(\tilde{n}+\tilde{p}^-\right)$ (Equation (20)) are trapped in the BH ergoregions and the deuterons and $u\tilde{d}d\tilde{u}\left(\text{exotic meson}\right)$ are emitted to space by Hawking radiation.

$$\begin{aligned} &u\tilde{d}d\tilde{u}d\tilde{d}\tilde{u}uu\tilde{d}d\tilde{u}d\tilde{d}\tilde{u}u\left(\text{16-quark meson}\right) \\ &\rightarrow udduud\left(\text{deuteron}\right) + \tilde{d}\tilde{u}\tilde{d}\tilde{u}\tilde{d}\tilde{u}\left(\text{antideutron}\right) + u\tilde{d}d\tilde{u}\left(\text{boson}\right) \end{aligned} \tag{17}$$

Thus, if the QCD gas density is extremely high in the AGN SMBHs' ergoregion, octaquark and 16-quark short-lived exotic mesons may be produced and decay into protons, electrons, neutrons and deuterons on the ergospheres and emitted to space by Hawking radiation. The BH laser amplification process of the proposed QCD gas exotic mesons in BH ergoregions suggests that matter and antimatter symmetry may be broken by the Hawking processes (note Equations (13)-(16)), where the antimatter particles remain trapped in the BHs' ergoregions.

3. Summary

We propose to measure the β decay rate, $t_{1/2}$, and the earth distances to Sagittarius A, h_{SMBH}, at the earth aphelion for several years and fit the data with a linear curve: $-\ln t_{1/2} = ah_{SMBH} + b$. The slope parameter, *a*, and the free parameter, *b*, may be used to calculate the Kerr spin parameter and determine if the QCD gas density on the ergosphere remains constant in time or alternatively grows in time.

Corley and Jacobson showed that boson particle creation may be amplified exponentially in time in rotating BH ergoregions and ergospheres [2]. Brito *et al.* showed that a BH immersed in a magnetic field has classical Superradiance instability [5] [6]. Ferraz *et al.* showed that highly spinning primordial black holes may produce clouds of pions via their superradiant instability [7]. Romero *et al.* showed that AGNs' SMBHs may act under certain conditions as matter creator engines emitted to space by relativistic jets [13]. Kaburaki *et al.* showed that rotating black holes in strong magnetic fields may act as Carnot engines, where work is extracted from the BH in the form of electric current that flows along the poloidal field [16]. If the proposed linear fit of the β decay rate measurements [10] will indicate that the QCD gas density on the Sagittarius A ergosphere grows in time, SMBH ergoregions act as matter reactors that break matter and antimatter symmetry by trapping the antimatter particles in their ergoregions and may act as matter sources for a Quasi-Steady State Cosmology (QSSC) model [17] [18].

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

[1] The Event Horizon Telescope Collaboration (2019) First M87 Event Horizon Telescope Results. I. The Shadow of the Supermassive Black Hole. *The Astrophysical Journal Letters*, **875**, Article 17. https://iopscience.iop.org/article/10.3847/2041-8213/ab0ec7/pdf

[2] Corley, S. and Jacobson, T. (1999) Black Hole Lasers. *Physical Review D*, **59**, Article 124011.https://doi.org/10.1103/PhysRevD.59.124011 https://arxiv.org/pdf/hep-th/9806203.pdf

[3] Hawking, S. (1975) Particle Creation by Black Holes. *Communications in Mathematical Physics*, **43**, 199-220. https://doi.org/10.1007/BF02345020 https://www.brainmaster.com/software/pubs/physics/Hawking%20Particle%20Crea

tion.pdf

[4] Chou, Y. (2020) A Radiating Kerr Black Hole and Hawking Radiation. *Heliyon*, **6**, e03336. https://www.sciencedirect.com/science/article/pii/S240584402030181X

[5] Brito, R., Cardoso, V. and Pani, P. (2014) Superradiant Instability of Black Holes Immersed in a Magnetic Field. *Physical Review D*, **89**, Article 104045. https://arxiv.org/pdf/1405.2098.pdf https://doi.org/10.1103/PhysRevD.89.104045

[6] Brito, R., Cardoso, V. and Pani, P. (2020) Superradiance. Springer Cham, New York. https://arxiv.org/abs/1501.06570 https://doi.org/10.1007/978-3-030-46622-0

[7] Ferraz, P.B., Kephart, T.W. and Rosa, J.G. (2020) Superradiant Pion Clouds Around Primordial Black Holes. *Journal of Cosmology and Astroparticle Physics*, **2022**. https://arxiv.org/pdf/2004.11303.pdf

[8] Frieman, J.A., Turner, M.S. and Huterer, D. (2008) Dark Energy and the Accelerating Universe. *Annual Review of Astronomy and Astrophysics*, **46**, 385-432. https://arxiv.org/pdf/0803.0982.pdf

[9] Rom, R. (2022) The Quantum Chromodynamics Gas Density Drop and the General Theory of Relativity Ether. *Journal of High Energy Physics, Gravitation and Cosmology*, **9**, No. 2.

[10] Sturrock, P.A. (2022) Neutrino-Flux Variability, Nuclear-Decay Variability, and Their Apparent Relationship. *Space Science Reviews*, **218**, Article No. 23. https://doi.org/10.1007/s11214-022-00878-3

[11] Pomee, S. (2019) Solar Influence on Radon Decay Rates: Irradiance or Neutrinos? *The European Physical Journal C*, **79**, Article 73. https://inspirehep.net/files/4c82ef43884e03b3f868a0b0d011a40a

[12] Li, Z. and Bambi, C. (2014) Measuring the Kerr Spin Parameter of Regular Black Holes from Their Shadow. *Journal of Cosmology and Astroparticle Physics*, **2014**. https://arxiv.org/pdf/1309.1606.pdf

[13] Romero, G.E. and Gutiérrez, E. (2020) The Origin of Matter at the Base of Relativistic Jets in Active Galactic Nuclei. *Universe*, **6**, Article 99. https://arxiv.org/pdf/2007.09717.pdf

[14] Crater, H. and Wong, C.Y. (2014) On the Question of the Point-Particle Nature of the Electron. *High Energy Physics—Phenomenology*. https://arxiv.org/abs/1406.7268

[15] Crater, H., Schiermeyer, J., Whitney, J. and Wong, C.H. (2014) Applications of Two Body Dirac Equations to Hadron and Positronium Spectroscopy. *JPS Conference Proceedings*, **7**, Article 010002 https://arxiv.org/pdf/1403.6466.pdf

[16] Kaburaki, O. and Okamoto, I. (1991) Kerr Black Holes as a Carnot Engine. *Physical Review D*, **43**, Article 340. https://doi.org/10.1103/PhysRevD.43.340

[17] Narlikar, J.V. (2003) The Quasi-Steady State Cosmology. *Chaos, Solitons & Fractals*, **16**, 469-477.

[18] Kragh, H. (2012) Quasi-Steady-State and Related Cosmological Models: A Historical Review. *History and Philosophy of Physics*. https://arxiv.org/ftp/arxiv/papers/1201/1201.3449.pdf