ISSN 1062-8738, Bulletin of the Russian Academy of Sciences: Physics, 2022, Vol. 86, No. 7, pp. 870–875. © Allerton Press, Inc., 2022.
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Active Objects, the Asymmetry of Matter, Black Holes, and the Higgs Boson in Fractal Systems

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Received February 14, 2022; revised February 28, 2022; accepted March 23, 2022

Abstract—Relationships are established between the main parameters of the Higgs boson, the Higgs field, and the parameters of active model objects and supermassive black holes. Active objects (relict photons and particles of matter) are part of the solar and interstellar winds and cosmic rays. The central region of a supermassive black hole is described in terms of the Bose condensate of black holes. The nature of the Higgs field and the asymmetry of matter for active particles are discussed.

DOI: 10.3103/S1062873822070036

INTRODUCTION

Mechanisms of the transition from black holes with light masses (on the order of 29–32 M_S [1, 2], where M_S is the mass of the Sun) to supermassive (on the order of 4–5 × 10^6 M_S [3, 4]) and relativistic (on the order of $10^{11} M_S$) black holes have yet to be described. Creating such theoretical models requires that we consider stochastic processes and distribution functions of black hole masses in the Universe. Experimental means with high angular resolution [5] allow us to study the nature of the Higgs field using the behavior of active solar regions (coronal holes) as an example. The parameters of active objects (relic photons and particles of matter) are determined by their relationship to the Higgs boson and depend on the different nature of the Higgs field. Experimental proof was obtained in [6] for the Higgs boson's decay into a lepton–photon pair, testifying to the asymmetry of matter and antimatter [6, 7]. The formation and decay of tetraquarks were studied experimentally in [8]. The authors claimed the structure of the new tetraquark contained a charmed diquark and an antidiquark coupled by gluon interaction. A gaseous deuterium target was irradiated with a proton beam in [9], and the cross section of reactions with the formation of a helium isotope was measured. The authors estimated the baryon density for the early Universe during the primordial synthesis of nuclei. However, the contributions to the Higgs fields from antineutrinos with nonzero rest mass have yet to be described. The energies of the vibrational modes of active objects [10–13] lie within forbidden bands and depend on temperature and pressure. Pulsed laser coherent spectroscopy [14], incoherent photon echoes [15], and luminescence spectroscopy [16, 17] can be used to study such active objects. The aim of this work was to describe relationships between the parameters of active model objects, the asymmetry of matter, and supermassive black holes with the Higgs boson and a Higgs field of a different nature.

MODEL ACTIVE OBJECTS

For the ratio of maximum I_m and initial $I(0)$ radiation intensity, we use expressions [10] based on the Dicke superradiance theory and the basic relations for the rest energies of a Higgs boson and a graviton: E_{H0} = 125.03238 GeV and E_G = 12.11753067 μeV, respectively [11, 12]:

$$\begin{gathered} I_m/I(0) = (a_0 + a_m)(a_0 - a_m + 1); \\ a_0^2 = a_m^2 + z'_\mu(z'_\mu + 2)/4; \\ a_m^2 = z'_{A2};\quad N_{ra} = z'_{A2} + z'_\mu; \\ E_{H0}/E_G = \nu^*_{H0}/\nu_{G0} = N_{HG}; \\ E_G/\nu_{G0} = E_{H0}/\nu^*_{H0} = 2\pi\hbar; \\ E_{H0}/E_{0A} = N_{0n};\quad E_{H0}/\varepsilon_{0n} = N^*_{0n}; \\ N^*_{0n} = (1 + n'_{zg})N_{0n}; \\ N_{HG} = N_{0A}N_{0n} = N_{ra}N_{0A}n_{ra}. \end{gathered} \tag{1}$$

Here, $\hbar$ is the Planck constant, and z'_{A2} = 1034.109294 and z'_μ = 7.18418108 are the ordinary and cosmological redshifts. Using z'_{A2}, z'_μ and (1), we find the number of relic photons N_{ra} = 1041.293475 and the sought ratio $I_{\rm m}/I(0) = 81.06580421$ of intensities. It also follows from (1) that we can describe the frequencies of active vibrational modes using the frequencies of a graviton and a Higgs boson, $\nu_{\rm G0} =$ 2.9304515 GHz and $\nu^*_{\rm H0} = N_{\rm a}\nu_{\rm H0}$, where $N_{\rm a} = 6.025438\times10^{23}$ is the Avogadro number and $\nu_{\rm H0} = 50.182731$ Hz. From (1) we find main parameter $N_{\rm HG} = 1.031830522\times10^{16}$, which is a function of parameters N_{ra}, N_{0A}, and N_{0n}. Parameters N_{0A}, N_{0n} were obtained while describing supernonradiative states (intensity of radiation is zero) of models A_0, A_1 from [11]. In model A_0, the number of bosons in the equilibrium state is $N_{0A} = 3.557716045\times10^5$, and their energy is $E_{0A} = N_{0A}E_{\rm G} = 4.3110733$ eV. The distribution density function in model A_1 [11] was found to be $n'_{zg} = 0.114317037$ (where $n'_{zg} + |n_{zg}| = 1$ for Fermi particles), which allowed us to determine parameters $N_{0n} = 2.900261\times10^{10}$, $N^*_{0n} = 3.2318103\times10^{10}$, $n_{ra} = 2.78524845\times10^7$, and energy $\varepsilon_{0n} = 3.868803$ eV in expressions (1). Note that parameters $N_{\rm HG}$, N_{ra}, N_{0A}, n_{ra} are normalized by the last formulas in (1). Function n'_{zg} also allows us to determine frequencies $\nu'_{zg}, \nu^*_{zg}, \nu_{D0}$:

$$\nu'_{zg} = n'_{zg}\nu_{\rm G0};\quad \nu^*_{zg} = \nu'_{zg}/\psi_{01};\quad \psi_{01} = \varepsilon_{01}/E_{\rm H0};\quad \nu_{\rm G0} = N_{0A}\nu_{D0}. \tag{2}$$

Here, $E_{\rm H0}$ and $\varepsilon_{01} = 126.9414849$ GeV are the Higgs boson energies obtained with and without allowing for the Higgs field, and parameter $\psi_{01} = 1.015268884$ was taken from [11]. The frequencies are $\nu'_{zg} =$ 335.00053 MHz and $\nu_{D0} = 8.2368898$ kHz. Calculated value $\nu^*_{zg} = 329.96238$ MHz is close to a frequency of 330 MHz, where observations of radiofilaments show that dark matter dominates [18]. Parameter N_{0A} and energy E_{0A} determine the relations with characteristic parameters N^*_{GE}, N_{db} and energies E^*_{GE}, E_{db} of active particles near a black hole:

$$\begin{gathered} N_{0A}/N_{db} = E_{0A}/E_{db} = \psi_{0A}; \\ N^*_{GE}/N_{db} = E^*_{GE}/E_{db} = \psi^*_{GE}; \\ R_{0a} = A_G E_{0a} = N_{ra}R'_{0a};\quad N_{0A} = \psi_{1A}N^*_{GE}; \\ N^*_{GE} = M_s/M_E = R_{Gs}/R_{GE}; \\ N_{db} = n_g n_{ra} r_{gp}/n_{A0}R'_{0a};\quad \psi^2_{1A} = 1 + \Omega^*_m. \end{gathered} \tag{3}$$

Here, M_s and M_E, R_{Gs} and R_{GE} are the masses and gravitational Schwarzschild radii of the Sun and the Earth. The numerical values are $N^*_{GE} = 3.32958\times10^5$, $N_{db} = 4.3882141\times10^5$, $\psi_{1A} = 1.068517965$, $\psi_{0A} =$ 0.810743494, $\psi^*_{GE} = 0.758755137$, $E_{db} =$ 5.3174319 eV, and $E^*_{GE} = 4.0346288$ eV. The gluon field number of quanta is $n_g = 8$, and the black hole number of quanta is $n_{A0} = 58.04663887$. The characteristic radius is $r_{gp} = 0.6697484$ fm, the rest energy is $E_{0a} = 6.3492809$ keV, and the gravitational Schwarzschild radius of the active particle is $R_{0a} = 6100.6187$ fm. Length $l_{db} = N_{db}R_{0a} =$ 2.6770821 μm of an active particle of these particles is related to lengths $l_{0A} = \psi_{0A}l_{db} = 2.1704269$ μm and $l^*_{GE} = \psi^*_{GE}l_{db} = 2.0312498$ μm of active microparticles. Squared effective charges e^2_{db}, e^2_{0A}, $\left(e^*_{GE}\right)^2$ are given by

$$\begin{gathered} e^2_{db} = l_{db}E_G = R_{0a}E_{db} = R_{db}E_{0a}; \\ e^2_{0A} = \psi_{0A}e^2_{db};\quad (e^*_{GE})^2 = \psi^*_{GE}e^2_{db}; \\ e^2 = r_eE_e;\quad \alpha_{db} = e^2_{db}/e^2;\quad \alpha_{0A} = e^2_{0A}/e^2; \\ \alpha^*_{GE} = (e^*_{GE})^2/e^2;\quad z^*_{bA} = \alpha_{0A} + \sin^2(\varphi_{0g}). \end{gathered} \tag{4}$$

From (4) we find $e^2_{db} = 32.439625$ μeV μm, $e^2_{0A} =$ 26.300215 μeV μm, $\left(e^*_{GE}\right)^2 =$ 24.613732 μeV μm, and $e^2 = 1.4399652$ μeV mm; $n_{A0} = 58.04663887$. Other parameters are $\alpha_{db} = 0.0225281$, $\alpha_{0A} = 0.0182645$ μeV mm, $\sin\varphi_{0g} = 0.0071508$, and $z^*_{bA} = 0.0183156$. Effective polarizabilities $\bar{\chi}^*_{bA}$, χ^*_{bA}, vibration mode energies $\bar{\Delta}^*_{bA}$, Δ^*_{bA}, and temperatures $\bar{T}^*_{bA}$, T^*_{bA} are calculated with (4) using z^*_{bA}:

$$\begin{gathered} z^*_{bA} = (1 + (\chi^*_{bA})^2)^{1/2} - 1 = 1 - (1 - (\bar{\chi}^*_{bA})^2)^{1/2}; \\ \bar{\Delta}^*_{bA} = \bar{\chi}^*_{bA}\varepsilon_{HG};\quad \Delta^*_{bA} = \chi^*_{bA}\varepsilon_{HG};\quad \bar{T}^*_{bA} = a_T\bar{\Delta}^*_{bA}; \\ T^*_{bA} = a_T\Delta^*_{bA}; \\ \sin^2(\varphi_{0g}) = (n_{A0} - n_g)(E_e + E_{eh})/E_{0g}; \\ E_{0g} = n_gE_{H0}. \end{gathered} \tag{5}$$

Here, the rest energies of gluon and neutrino are $E_{0g} = 1.000259$ TeV and $\varepsilon_{\rm HG} = 280.0460475$ meV, respectively [12]. The electron and electron hole energies are $E_{eh} = E_e = 0.51099907$ MeV, and the angle of radiation polarization is $\varphi_{0g} = 0.409716°$. Using (5), we find $\bar{\chi}^*_{bA} = 0.190514473$, $\chi^*_{bA} = 0.19226723$, $\bar{\Delta}^*_{bA} = 53.35283$ meV, $\Delta^*_{bA} = 53.84368$ meV; $\bar{T}^*_{bA} =$ 309.5946 K, $T^*_{bA} = 312.4429$ K. Note that when $E_{eh} = -E_e$, $\sin^2(\varphi_{0g}) = 0$ from (5) and $z^*_{bA} = \alpha_{0A}$, from (4), indicating the possibility of electron–hole pair annihilation with the emission of photons. Estimates of energies E_{0A}, E_{db}, E^*_{GE} and parameters φ_{0g}, $\overline{\chi}^*_{bA}$, χ^*_{bA}, $\overline{\Delta}^*_{bA}$, Δ^*_{bA}, z^*_{bA}, $\overline{T}^*_{bA}$, T^*_{bA} indicate the possibility of using laser spectroscopy [14–17] to search for and study these active objects.

ASYMMETRY OF MATTER AND ANTIMATTER: THE HIGGS FIELD

The existence of Higgs fields of different natures (e.g., gluon, lepton, neutrino, hadronic [8], and gravitational) alters the rest energy of the Higgs boson in (2), along with energies E_{eh} of holes (antiparticles) in (5) and $E_{\mu h}$, $E_{\tau h}$ for e, μ, and τleptons, respectively. The asymmetry of matter and antimatter energes [7]. Let us introduce the energy E_{0L} based on total energy ε_{0L} of paired leptons and number n_g of gluon quanta:

$$E_{0L} = n_g\varepsilon_{0L};\;\; \varepsilon_{0L} = (E_e + E_{eh}) + (E_\mu + E_{\mu h}) + (E_\tau + E_{\tau h}). \tag{6}$$

Here, $E_\mu = E_{\mu h} = 105.658389$ MeV and $E_\tau = E_{\tau h} = 1777.00$ MeV are the rest energies for μ and τ leptons, respectively. With (6) we find energies $\varepsilon_{0L} = 3.7663388$ GeV, $E_{0L} = 30.1307102$ GeV (which are close to the data in [6]).

We next introduce Bose-type distribution density functions f_{gA} (ground state), and f'_{gA} (excited state) using the number of quanta of black holes (n_{A0}) and gluons (n_g). Energies E_{gA}, E'_{gA} are obtained using E_{H0}:

$$\begin{gathered} f'_{gA} - f_{gA} = 1;\;\; f_{gA} = n_g/(n_{A0} - n_g); \\ f'_{gA} = n_{A0}/(n_{A0} - n_g); \\ E_{gA} = E_{H0}f_{gA}/2;\;\; E'_{gA} = E_{H0}f'_{gA}/2; \\ E'_{gA} - E_{gA} = E_{H0}/2. \end{gathered} \tag{7}$$

We can see from (7) that $f_{gA} = 0.159850895$, $E_{gA} = 9.9932689$ GeV, and $E'_{gA} = 72.509459$ GeV. The expressions for the rest energies of leptons take the form

$$E_e = E_{gA}\sin^2(\varphi_{eg});\;\; E_\mu = E_{gA}\sin^2(\varphi_{\mu g}); \quad E_\tau = E_{gA}\sin^2(\varphi_{\tau g}). \tag{8}$$

Here, the angles are $\varphi_{eg} = \varphi_{0g}$, $\varphi_{\mu g} = 5.901863°$, and $\varphi_{\tau g} = 24.941123°$. To describe the interaction between μ and e leptons, we find energies E'_μ, E^*_μ using the expressions

$$\begin{gathered} E'_\mu = E_{gA}\sin^2(\varphi_{\mu g} + \varphi_{eg}) = \left(E_\mu^2 + 4\Delta_\mu^2\right)^{1/2}; \\ 2\Delta_\mu = n_{A0}E_{ex};\;\; E_{ex} = E_e + E'_h; \\ E^*_\mu = E_{gA}\sin^2(\varphi_{\mu g} - \varphi_{eg}) = (E_\mu^2 - 4(\Delta^*_\mu)^2)^{1/2}; \\ 2\Delta^*_\mu = n_{A0}E^*_{ex};\;\; E^*_{ex} = E_e + E^*_h; \\ E_e/E_{ex} = 0.5 + \sin(\varphi_{ex}); \\ E'_h/E_{ex} = 0.5 - \sin(\varphi_{ex}); \\ E_e/E^*_{ex} = 0.5 + \sin(\varphi^*_{ex}). \end{gathered} \tag{9}$$

For option I (the sum of angles), the parameters are $\varphi_{\mu g} + \varphi_{eg} = 6.311579°$, $E'_\mu = 120.77607$ MeV, $E'_\mu - E_\mu = 15.1176843$ MeV, energy gap $\Delta_\mu = 29.253909$ MeV, energy $E_{ex} = 1.007945$ MeV, hole energy $E'_h = 0.4969459$ MeV, $\sin(\varphi_{ex}) = 0.0069712$, and characteristic angle $\varphi_{ex} = 0.399424°$. For option II (the difference between angles) the parameters are $\varphi_{\mu g} - \varphi_{eg} = 5.492147°$, $E^*_\mu = 91.541092$ MeV, energy gap $\Delta^*_\mu = 26.38145$ MeV, energy $E^*_{ex} = 0.9089743$ MeV, hole energy $E^*_h = 0.3979752$ MeV, $\sin\left(\varphi^*_{ex}\right) = 0.062171$, angle $\varphi^*_{ex} = 3.564441°$, and $E^*_h/E^*_{ex} = 0.5 - \sin\left(\varphi^*_{ex}\right)$. Differences $(\varphi_{eg} - \varphi_{ex})/2 = 18.526''$, $(\varphi_{eg} - \varphi_{ex})/4$ are typical of the angular widths of solar coronal holes [5].

With (9) we find expressions that are convenient for analyzing the asymmetry of individual contributions from E_e, E_μ of different angles to energies E'_μ, E^*_μ of the form

$$\begin{gathered} \left(E'_\mu + E^*_\mu\right)/2 = E_e\cos^2(\varphi_{\mu g}) + E_\mu\cos^2(\varphi_{eg}); \\ E'_\mu - E^*_\mu = E_{gA}\sin(2\varphi_{\mu g})\sin(2\varphi_{eg}). \end{gathered} \tag{10}$$

Using energy E_{0L} and (6), we obtain typical energies ε_{dL}, ε_{d0}, ε'_{dz} and Higgs boson energies E_{Hd}, E'_{Hd}, E_{Hg}, E'_{Hg}, E_{HL}, E'_{HL}:

$$\begin{gathered} E_{0L} = n_g\varepsilon_{0L} = n_G\varepsilon_{dL};\;\; \varepsilon_{d0} = n_{A0}\varepsilon_{dL}; \\ \varepsilon'_{dz} = z'_\mu(z'_\mu + 1)\varepsilon_{dL};\;\; \varepsilon'_{dz} = \varepsilon_{d0} + 2\varepsilon_{0L}; \\ E^2_{Hd} = E^2_{H0} + \varepsilon^2_{dL};\;\; (E'_{Hd})^2 = E^2_{H0} - \varepsilon^2_{dL}; \\ E^2_{Hg} = E^2_{H0} + E^2_{gA};\;\; (E'_{Hg})^2 = E^2_{H0} - E^2_{gA}; \\ E^2_{HL} = E^2_{H0} + \varepsilon^2_{0L};\;\; (E'_{HL})^2 = E^2_{H0} - \varepsilon^2_{0L}. \end{gathered} \tag{11}$$

Typical energies are $\varepsilon_{dL} = 10.04357$ GeV (close to that of dark matter in [18]), $\varepsilon_{d0} = 582.99548$ GeV, and $\varepsilon'_{dz} = 590.52816$ GeV. Energies ε_{dL}, E_{gA}, and ε_{0L} describe different natures of the Higgs field.

The existence of the Higgs field results in active particles with energies $E_{Hd} = 125.43512$ GeV, $E'_{Hd} = 124.62834$ GeV, $E_{Hg} = 125.43110$ GeV, $E'_{Hg} = 124.63238$ GeV, $E_{HL} = 125.08909$ GeV (corresponds to the decay process peak of the Higgs boson from [6]), and $E'_{HL} = 124.97564$ GeV. Energy differences $\delta E_{Hg} = E_{Hd} - E_{Hg} = 4.0176$ MeV, $\delta E'_{Hg} = E'_{Hg} - E'_{Hd} = 4.04343$ MeV describe the linewidth in the energy spectrum for the Higgs boson [6]. To describe other processes that determine the linewidth, we consider the classical decay of a neutron into a proton–electron pair and an antineutrino (based on n_{ra} from (1)):

$$\begin{gathered} E_n = (E_p + E_e) + n_{ra}\varepsilon_{\nu n}; \\ \varepsilon_{\nu n} = (\varepsilon_{HG}^2 + \Delta_{\nu n}^2)^{1/2}; \\ \Delta_{\nu n}^2 = z_{\nu n}(z_{\nu n} + 2)\varepsilon_{HG}^2; \quad n_{\nu n}^2 = \Omega_{\tau L}^*; \\ \Omega_{\tau L} E_{W0} = \Omega_{\tau L}^* E_{Z0}; \\ \varepsilon_{\nu n} = \varepsilon_{HG} + z_{\nu n}\varepsilon_{HG} = \psi_{\nu n}\varepsilon_{HG}; \\ \psi_{\nu n} = 1 + z_{\nu n}; \quad \varepsilon_{h\nu} = 0.5 n_{\nu n}\varepsilon_{HG}. \end{gathered} \tag{12}$$

Here, the neutrino rest energy is $\varepsilon_{HG} = 280.0460475$ MeV [12]. Neutron energy $E_n = 946.7027435$ MeV, and proton energy $E_p = 938.2723226$ MeV. Lepton quantum number $\Omega_{\tau L} = 0.002402187$ is associated with quantum number $\Omega_{\tau L}^* = 0.002116741$ through rest energies $E_{W0} = 80.35235464$ GeV and $E_{Z0} = 91.188$ GeV for bosons $W0$ and $Z0$, respectively. From (12) we find antineutrino energy $\varepsilon_{\nu n} = 284.33448$ meV, energy gap $\Delta_{\nu n} = 49.196651$ meV, neutrino field parameters $z_{\nu n} = 0.015313329$ and $\psi_{\nu n} = 1.015313329$, parameter $n_{\nu n} = 0.046008054$, and energy $\varepsilon_{h\nu} = 6.4421868$ meV. We can see from (12) that energy $\varepsilon_{\nu n}$ of an antineutrino depends on neutrino field state $z_{\nu n}$; energy $\varepsilon_{h\nu}$, on parameter $n_{\nu n}$. On the other hand, parameters $z_{\nu n}$, $n_{\nu n}$ determine the baryon densities of the Universe. Ground state of matter Ω_{b1} and hole state of matter Ω_{b2} are determined as

$$\begin{gathered} \Omega_{b1} = (0.5 - z_{\nu n})n_{\nu n}; \\ \Omega_{b2} = (0.5 + z_{\nu n})n_{\nu n}; \quad \Omega_{b1} + \Omega_{b2} = n_{\nu n}. \end{gathered} \tag{13}$$

Numerical values are $\Omega_{b1} = 0.022299491$; and $\Omega_{b2} = 0.023708563$. $\Omega_{b1} < \Omega_{b2}$, confirming the existence of two states of baryon matter because of Higgs field $z_{\nu n}$. On the other hand, the anisotropic model (allowing for relic radiation polarization) says main parameter $n_{\nu n}$ can be determined independently using the expressions

$$\begin{gathered} n_{\nu n} = |\chi_{ef}|\sin(\varphi_{0g}) + \psi_{rc} + 2\Omega_{0G}; \\ \Omega_{b1} = 0.5 n_{\nu n} - 2 n_{\tau L}\sin(\varphi_{0g}); \quad n_{\tau L}^2 = \Omega_{\tau L}. \end{gathered} \tag{14}$$

Here, $|\chi_{ef}| = 0.2504252$, $\psi_{rc} = 0.04420725$, and $\Omega_{0G} = 4.99501 \times 10^{-6}$ are taken from [12]. The Ω_{b1} values from (14) and (13) coincide with baryon density 0.0223 in the Universe, according to experimental data in [9]. As an example, we consider here the possibility of describing energies E_{TQ}, E'_{TQ} of the tetraquark and hadron, respectively, using the equations

$$\begin{gathered} E_{TQ} = 2E_c + 2\bar{E}_c; \quad \bar{E}_c = E_c + E_{\alpha S} + \Delta_\mu^* \\ = E_c + \xi_{gS}E_{0g} + \Delta_\mu^* = E_{\alpha u} + \Delta_\mu^*; \\ E_{TQ} - E'_{TQ} = 2(E_\mu + E'_\mu); \\ E_{T1} = E_{TQ} - 2E'_\mu - \Delta_\mu; \\ E_{T2} = E_{TQ} - 2E_\mu^* + \Delta_\mu^*; \quad E_{\alpha u}/E_{H0} = S_{12u}; \\ E_{\alpha S} = S_{012}E_{H0} = \xi_{gS}E_{0g}; \\ \xi_{gS} = S_{012}/n_g; \quad E_{\alpha u} - E_{\alpha S} = E_c. \end{gathered} \tag{15}$$

Here, we use parameters $S_{12u} = 0.013690291$, $S_{012} = 0.005451282$, and $\xi_{gS} = 0.00068141$; c-quark rest energy $E_c = 1.0301429$ GeV; $E_{\alpha S} = 0.6815868$ GeV, $E_{\alpha u} = 1.7117297$ GeV, and muon pair energy $E_\mu + E'_\mu = 226.43446$ MeV. With (15) we find energy $\bar{E}_c = 1.7381111$ GeV. of an antiquark. Energies $E_{T1} = 6628.8755$ MeV, $E_{T2} = 6742.9808$ MeV determine such features as a local maximum or minimum on the experimental dependence of the number of events on the state of a tetraquark [8]. The main narrow peak and the broadened peak correspond to tetraquark energy $E_{TQ} = 6899.6816$ MeV and hadron energy $E'_{TQ} = 6446.8126$ MeV.

SUPERMASSIVE BLACK HOLES

Using energies ε_{0n} from (1) and E_{db} from (3), along with equations

$$\begin{gathered} E_{H0} = N_{0n}^*\varepsilon_{0n}; \quad E_{GE}^* = \psi_{GE}^*E_{db}; \\ \varepsilon_{0n}/E_{db} = 0.5 + \Omega_{c1}^* \end{gathered} \tag{16}$$

we find characteristic parameter $\Omega_{c1}^* = 0.2275699$, which can be interpreted as the density of the cold dark matter near a black hole.

We next introduce the distribution density functions in ground and excited states f_{ra} and f'_{ra} for relic photons:

$$f'_{ra} - f_{ra} = 1;\quad f'_{ra} = \left\langle \hat{c}_{ra}\hat{c}^{+}_{ra} \right\rangle = N_{ra} \Big/ \left(N_{ra} - z'_{\mu} \right);$$
$$f_{ra} = \left\langle \hat{c}^{+}_{ra}\hat{c}_{ra} \right\rangle = z'_{\mu} \Big/ \left(N_{ra} - z'_{\mu} \right), \quad (17)$$

where $\hat{c}^{+}_{ra}, \hat{c}_{ra}$ are the creation and annihilation operators of relic photons; $\langle ... \rangle$ denotes the averaging operation. Using (17) and (1), we find $f_{ra} = 0.006947216$. Masses M_{0B}, M_{b0}, and M'_{b0} of black holes are estimated using the equations

$$M_{0B} = f'_{ra} M_{b0};\quad M_{b0}/M_{\mathrm{S}} = n_g \left(1 + n'_{zg}\right) n_{ra} \Big/ n_{A0}; \quad (18)$$
$$M'_{b0} = M_{0B} - M_{b0} = f_{ra} M_{b0}.$$

Our estimate of the mass, $M_{0B}/M_{\mathrm{S}} = 4.30717 \times 10^{6}$, virtually coincides with mass 4.31×10^{6} of the central body (a supermassive black hole in the center of the Milky Way). Value $2M'_{b0}\big/M_{\mathrm{S}} = 0.05943 \times 10^{6}$ determines the error of 0.06×10^{6} associated with the error in measuring the parameters of the orbit of star S2 revolving around the central body [3, 4]. The fractal Universe is characterized by the mass distribution of black holes found at the centers of galaxies. Near the upper mass boundary, we write the expression for I_m from (1)

$$I_m = I^{*}_1 + I^{*}_2;\quad I^{*}_1 = n'_{zg} I_m = u^2_{1J} I_m \sin^2(\theta^{*}_W);$$
$$I^{*}_2 = n_{zg} I_m = (u^2_{1J} + v^2_{1J}\cos^2(\theta^{*}_W)) I_m;$$
$$v^2_{1J} = k^2_{1J} = 0.5(1 - I(0)/I_m);$$
$$u^2_{1J} = (k'_{1J})^2 = 0.5(1 + I(0)/I_m); \quad (19)$$
$$u^2_{1J} + v^2_{1J} = 1;\quad I^{*}_1/I_m = k^2_{1J}\mathrm{sn}^2(u_{1W}; k_{1J}) = n'_{zg};$$
$$I^{*}_2/I_m = \mathrm{dn}^2(u_{1W}; k_{1J}) = n_{zg}.$$

Here, k_{1J}, k'_{1J} and u_{1W} are the moduli and the effective displacement for elliptical functions $\mathrm{sn}(u_{1W}; k_{1J})$, $\mathrm{cn}(u_{1W}; k_{1J})$, $\mathrm{dn}(u_{1W}; k_{1J})$; the role of the effective Cabibbo angle for supermassive black holes is played by angle θ^{*}_W; and parameters u_{1J}, v_{1J} depend on the initial and maximum intensity of radiation, since they are analogs of Bogolyubov's transformation parameters in the theory of superconductivity. Numerical values are $k^2_{1J} = 0.4938322$, $\left(k'_{1J}\right)^2 = 0.5061678$, and $\sin^2\left(\theta^{*}_W\right) = 0.2314897$. The functions of the intensity distribution density are $f_{J1} = I^{*}_1 \big/ I^{*}_2 = 0.1290722$ and $f'_{J1} = I_m \big/ I^{*}_2 = 1.1290722$. Expressions (19) allow us to estimate black hole masses M'_{J1}, M_{J1} near the upper mass boundary using the equations

$$M'_{J1} - M_{J1} = M_{J0};\quad M'_{J1} = f'_{J1} M_{J0}; \quad (20)$$
$$M_{J1} = f_{J1} M_{J0};\quad f'_{J1} - f_{J1} = 1.$$

Ratio $M_{J1}/M_{\mathrm{S}} = 1.96422 \times 10^{11}$ is close to experimental value $1.96 \times 10^{11} M_{\mathrm{S}}$ for supermassive black hole SDSS J140821.67+025733.2.

Using the density distribution function f'_{J1} from (20) and number of quanta $\overline{n}_{0\nu} = 0.05434$, we find radius r_{JB} of the central body using the equations

$$N_{G0} r_{JB} = \delta'_{JB} + l_{AB};\quad \delta'_{JB} = \overline{\delta}_{AB} f'_{J1};\quad l_{AB} = \overline{\delta}_{AB}\sin(\theta_{0\nu});$$
$$N_{G0} = N_a / N_{HG};\quad N_{G0} E_{H0} = N_a E_G; \quad (21)$$
$$\sin(\theta_{0\nu}) = \overline{n}_{0\nu}(1 - \overline{n}_{0\nu}) = \overline{n}_{0\nu} - \overline{\Omega}_{0\nu}.$$

The parameter values are $N_{G0} = 5.83956 \times 10^{7}$, $\theta_{0\nu} = 2.94555°$, $\sin(\theta_{0\nu}) = 0.05139$, $l_{AB} = 5.07659 \times 10^{5} L_{c0}$, $\delta'_{JB} = 11.1543 \times 10^{6} L_{c0}$, $\overline{\delta}_{AB} = 9.87915 \times 10^{6} L_{c0}$, $r_{JB} = 0.19971 L_{c0}$, and $L_{c0} = 0.306598$ pc. Estimates of distance R_0 from the Sun to the supermassive black hole at the center of the Milky Way and error δR_0 are found using the equations [13]

$$R_0 = \overline{\delta}_{AB}/n_{R0};\quad \delta R_0 = \overline{\delta}_{AB}/N_{R0};\quad \overline{\delta}_{AB} = (1 + \delta_Q)\delta_{AB};$$
$$\delta_{AB} = \overline{R}_{AB} - R_{AB};\quad N_{R0} = n_g(N_{ra} + 0.5 I_m/I(0)); \quad (22)$$
$$n_{R0} = Q_{H2}(N_{ra} + n_{A0} - n_g - \xi_{0J}).$$

The numerical values of the parameters are $N_{R0} = 8654.61$, $n_{R0} = 363.5796$, $\delta_{AB} = 9.87915 \times 10^{6} L_{c0}$, $R_{AB} = 45.7231 \times 10^{9} L_{c0}$, and $\overline{R}_{AB} = 45.7330 \times 10^{9} L_{c0}$. Using (22), we find distance $R_0 = 8.33085$ kpc and error $\delta R_0 = 0.34998$ kpc. Half-axes x_{0S}, y_{0S} of the elliptical orbit of star S2 are

$$y_{0S} = r_{JB}/\overline{n}_{AB}\left(1 + \Omega^{*}_m\right);$$
$$x^2_{0S}\big/y^2_{0S} = S^2_{1u}\sin(\varphi_{0g})\big/S^2_{2u}. \quad (23)$$

Here, $\overline{n}_{AB} = 11.062529$ is the refractive index of a medium of particles. Density of matter $\Omega^{*}_m = 0.1417306$ near supermassive black holes is close to the value of 0.141 obtained by the Planck observatory, based on new Hubble constant H^{*}_0 using the attenuation of γ-rays against the intergalactic background. Parameters S_{1u}, S_{2u} were presented in

[12]. Half-axes $y_{0S} = 999.924$ au, $x_{0S} = 119.580$ au. Estimates of parameters R_0, δR_0, r_{JB}, x_{0S}, y_{0S} agree with the data in [3, 4] for distance 8.33 kpc from the Sun to the supermassive black hole at the center of the Milky Way, error 0.35 kpc, central body radius $0.2L_{c0}$, and half-axes 120 au, 1000 au of the elliptical orbit of star S2 revolving around the central body.

CONCLUSIONS

To describe the masses of black holes and their relationship to the parameters of the Higgs boson, we proposed models using the density distribution functions of the number of quanta for relic photons and radiation intensity. It was shown the existence of a Higgs field of different natures alters the Higgs boson rest energy and hole (antiparticle) energies for paired leptons, producing active micro-objects with different energies and sizes and resulting in the asymmetry of matter and antimatter. Models were proposed for the classical decay of a neutron into a proton–electron pair and an antineutrino with a non-zero rest mass; for describing tetraquarks; and for the baryon density of the Universe, depending on the states of the antineutrino. The parameter estimates agree with experimental data. Our results can be used to study the structure of hadrons in high-energy physics based on the Higgs boson and the Higgs field, in cosmology, and in the physics of elementary particles.

CONFLICT OF INTEREST

The author declares that he has no conflicts of interest.

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Translated by G. Dedkov