Determining Relations of Power Products of Physical Quantities by Generalized Relation

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The relations of power products of physical quantities (PQs) are determined by the generalized relation. Assuming the relations of two, three and four PQs to generalized relation separately, we find the corresponding general formulas. By ordering the exponent of physical constants in relations being zero or fit numbers, we gain many famous equations without factors such as mass-energy relation, formula of event horizon temperature of Schwarzschild black hole (SBH), equation of holographic dark energy (HDE) model, Casimir effect equation, Planck black body radiation formula, Stefan-Boltzmann law, Einstein field equation, Newtonian attraction law, Schrödinger equation, Coulomb law, Newtonian second law, Clapeyron equation, formula of superconducting thin film, centrifugal force formula, etc. Some new relations are given including the square of total energy with energy density of HDE, square of energy with its density of SBH, energy density with sextic radii of SBH, pressure in SBH centre and entropy density of SBH center. We show that the generalized relation can determine the relations of power products of two, three and four PQs, it is useful and significant.

1. Introduction

It is the grail that a general theory can be found and deduced other physical equations in theoretical physics. The standard model [1] succeeds in uniting the weak interaction, electromagnetic force and strong interaction. Predictive 62 elementary particles are detected, including the Higgs boson recently [2], but it doesn't embrace the gravity. Supersymmetry [3], superstring/M theory [4] and loop quantum gravity theory [5] described the four forces, but aren't detected [6]. Recently N. Wu's quantum gauge general relativity [7], T. Ma and S.H. Wang produced unified field equations [8], Zh-Y. Shen's SQS theory [9], also aren't detected. Yin Ye *et al* considered the symmetric approximation [10]; Y. Bao produced the generalized relation [11]. These are making progress.

This paper is organized as follows. In Sec. 2, we determine the relations of power products of two physical quantities (PQs); find the corresponding general formulas; obtain many famous equations such as mass-energy relation [12], temperature of event horizon of Schwarzschild black hole (SBH) [13], equation of holographic dark energy (HDE) model [14], Casimir effect equation [15], Planck black body radiation formula [16], Stefan-Boltzmann law [17], Einstein field equation [18], etc. In Sec. 3, we have the relations of power products of three PQs; find the corresponding general formulas also; get Newtonian attraction law [19], Schrödinger equation [20], Coulomb law [21], Newtonian second law [19], Clapeyron equation [22], power law of thin superconducting films [23] and so on. In Sec. 4, we give the relations of power products of four PQs; gain the centrifugal force formula [19]. We conclude in Sec. 5.

2. Relations of Power products of Two PQs

In this section, we obtain the relations of power products when n = 2 to the generalized relation; and find the corresponding general formulas; obtain the mass-energy relation, temperature of event horizon of SBH, equation of HDE model, Casimir effect equation, Planck black body radiation formula, Stefan-Boltzmann law, Einstein field equation, etc.

2.0 The basic relation [11] is

$$r^{\alpha} m^{\beta} t^{\gamma} T^{\delta} Q^{\varepsilon} \sim [\hbar^{(\alpha+\beta+\gamma+\delta)} \mathrm{G}^{(\alpha-\beta+\gamma-\delta)} \mathrm{c}^{-(3\alpha-\beta+5\gamma-5\delta)} \kappa^{-2\delta} \mathrm{e}^{2\varepsilon}]^{1/2} \quad (1)$$

where r, m, t, T and Q are the length, mass, time, temperature and electric charge separately, α, β, γ, δ and ε are the real number, ħ, G, c, κ and e are the reduced Planck constant, gravitational constant, speed of light, Boltzmann constant and elementary charge separately.

The generalized relation [11] is

$$\sum_{\mathrm{i}=1}^{\mathrm{n}} A_{\mathrm{i}}^{\alpha_{\mathrm{i}}} \sim \sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{A}_{\mathrm{iP}}^{\alpha_{\mathrm{i}}}; \ \mathrm{i} = 1, 2, 3\ldots n \quad (2)$$

where A_{i} is the physical quantity, α_{i} is the real number, and A_{iP} is the corresponding Planck scale. When n = 2, we obtain

$$A_1^{\alpha_1} A_2^{\alpha_2} \sim \mathrm{A}_{1\mathrm{P}}^{\alpha_1} \mathrm{A}_{2\mathrm{P}}^{\alpha_2} \quad (3)$$

Instructing $\alpha_1 = 1$, $\alpha_2 = \alpha$, $A_1 = A$ and $A_2 = B$, we gain

$$AB^{\alpha} \sim \mathrm{A_P B_P^{\alpha}} \quad (4)$$

Especially when $\alpha = 1$, we obtain

$$AB \sim \mathrm{A_P B_P} \quad (5)$$

When $\alpha = -1$, we gain

$$A \sim \mathrm{A_P} B / \mathrm{B_P} \quad (6)$$

Therefore we can determine the relations of power products of two PQs. For example

2.1 Assuming that energy E has relations with mass M only, we find

$$EM^{\alpha} \sim \mathrm{E_P M_P^{\alpha}} = (\hbar c^5/G)^{1/2} \ (\hbar c/G)^{\alpha/2} = \hbar^{(1+\alpha)/2} G^{-(1+\alpha)/2} \ c^{(5+\alpha)/2} \quad (7)$$

where $\mathrm{E_P} = \sqrt{\hbar c^5/G}$ is Planck energy and $\mathrm{M_P} = \sqrt{\hbar c/G}$ is Planck mass (From basic relation (1)). It is the general formula for energy and mass.

2.1.1 Ordering $1+\alpha = 0$, $\rightarrow \alpha = -1$, we obtain

$$E \sim Mc^2$$

This is the mass-energy relation.

2.1.2 Instructing $5+\alpha = 0$, $\rightarrow \alpha = -5$, we have

$$E \sim G^2 M^5 / \hbar^5 \ ?$$

2.1.3 Ordering $\alpha = 1$, we gain

$$EM \sim \hbar c^3 / G$$

Substituting $E \sim \kappa T$ into above formula, we obtain

$$T \sim \hbar c^3 / \kappa G M$$

where T is the temperature. It is the temperature of event horizon of SBH, but it hasn't $1/8\pi$.

2.2 Supposing that energy E has relations with frequency ω merely, we find

$$E\omega^{\alpha} \sim \mathrm{E_P} \omega_{\mathrm{P}}^{\alpha} = \hbar^{(1-\alpha)/2} G^{-(1+\alpha)/2} c^{5(1+\alpha)/2} \quad (8)$$

where $\omega_{\mathrm{P}} = \sqrt{c^5/\hbar G}$ is Planck frequency. This is the general formula for energy and frequency.

2.2.1 Instructing $1+\alpha = 0$, $\rightarrow \alpha = -1$, we gain

$$E \sim \hbar\omega$$

It is the light quantum relation [24].

2.2.2 Ordering $1-\alpha = 0$, $\rightarrow \alpha = 1$, we obtain

$$E\omega \sim c^5 / G$$

Substituting $E \sim Mc^2$ into above formula, we gain

$$\omega \sim c^3 / GM$$

where $\omega \sim v_{\mathrm{G}}$. This is the inverse correlation between high-frequency quasi-periodic oscillation and black hole mass [25].

2.2.3 Instructing $\alpha = -3$, we have

$$E \sim \hbar^2 G \omega^3 / c^5 \ ?$$

2.3 Assuming that energy E has relations with energy density ρ only, we find

$$E\rho^{\alpha} \sim \mathrm{E_P} \rho_{\mathrm{P}}^{\alpha} = \hbar^{(1-2\alpha)/2} G^{-(1+4\alpha)/2} c^{(5+14\alpha)/2} \quad (9)$$

where $\rho_{\mathrm{P}} = c^7 / \hbar G^2$ is Planck energy density. It is the general formula for energy and energy density.

2.3.1 Ordering $1-2\alpha = 0$, $\rightarrow \alpha = 1/2$, we obtain

$$E^2 \sim c^{12} / G^3 \rho$$

From M. Li *et al* HDE model [14], $\rho_{de} = 3c_L^2 c^3 \mathrm{M_{pl}^2} L^{-2}$, $E = \rho V$ and $V \sim L^3$, we gain

$$E_{\mathrm{de}}^2 \sim 27 c_L^6 c^{12} / 512\pi^3 G^3 \rho_{de}$$

where E_{de} is total energy of HDE, ρ_{de} is HDE density, $c_L \geq 0$ is a dimensionless model parameter, $\mathrm{M_{Pl}} = \sqrt{\hbar c/8\pi G}$ is the reduced Planck mass, L is cosmic cutoff and V is its volume. So the above formula is the square of total energy with its density of HDE, hasn't $27c_L^6 / 512\pi^3$.

2.3.2 Instructing $1+4\alpha = 0$, $\rightarrow \alpha = -1/4$, we obtain

$$E^4 \sim \hbar^3 c^3 \rho$$

This is the biquadratic quanta energy with its density [17].

2.3.3 Ordering $1+2\alpha = 0$, $\rightarrow \alpha = -1/2$, we gain

$$E^2 \sim \hbar^2 G \rho / c^2$$

From $M_{\mathrm{H}} V_{\mathrm{H}} \sim \hbar^2 G / c^4$ [11], $E = \rho V$ and $E = Mc^2$, where M_H is the mass of SBH, and V_H is its volume, we obtain the above formula. It is the square of energy with its density of SBH.

2.4 Supposing that distance R has relations with mass M merely, we find

$$RM^{\alpha} \sim \mathrm{L_P M_P^{\alpha}} = \hbar^{(1+\alpha)/2} G^{(1-\alpha)/2} c^{-(3-\alpha)/2} \quad (10)$$

where $\mathrm{L_P} = \sqrt{\hbar G/c^3}$ is Planck length. This is the general formula for distance and mass.

2.4.1 Instructing $1+\alpha = 0$, $\rightarrow \alpha = -1$, we obtain

$$R \sim GM / c^2$$

It is the radius of event horizon of stationary black holes [26].

2.4.2 Ordering $1-\alpha = 0$, $\rightarrow \alpha = 1$, we gain

$$R \sim \hbar / Mc$$

This is A.H. Compton wavelength formula [27].

2.4.3 Instructing $3-\alpha = 0$, $\rightarrow \alpha = 3$, we have

$$R \sim \hbar^2 / GM^3 \ ?$$

2.4.4 Ordering $\alpha = -3$, we obtain

$$R \sim G^2 M^3 / \hbar c^3$$

Substituting $R = ct$ into above formula, we gain

$$t \sim G^2 M^3 / \hbar c^4 \propto M^3$$

It is the age of SBH [13].

2.5 Assuming that energy density ρ has relations with distance R only, we find

$$\rho R^{\alpha} \sim \rho_{\mathrm{p}} \mathrm{L_P^{\alpha}} = \hbar^{-(2-\alpha)/2} G^{-(4-\alpha)/2} c^{(14-3\alpha)/2} \quad (11)$$

This is the general formula for energy density and distance.

2.5.1 Instructing $2-\alpha = 0$, $\rightarrow \alpha = 2$, we obtain

$$\rho \sim c^4 / GR^2$$

where $R \sim L$. This is the equation of HDE model $\rho_{de} = 3c_L^2 c^3 \mathrm{M_{pl}^2} L^{-2}$ [14], hasn't $3c_L^2 / 8\pi$.

2.5.2 Ordering $4-\alpha = 0$, $\rightarrow \alpha = 4$, we gain

$$\rho \sim \hbar c / R^4$$

where $R = a$ is the scale factor. It is radiation formula for early universe [28].

2.5.3 Instructing $14-3\alpha = 0, \to \alpha = 14/3$, we have

$$\rho^3 \sim \hbar^4 G / R^{14} \ ?$$

2.5.4 Ordering $\alpha = 6$, we obtain

$$\rho \sim \hbar^2 G / c^2 R^6$$

From $M_H V_H \sim \hbar^2 G / c^4$, $E = \rho V$, $E = Mc^2$ and $V \sim R^3$, we gain the above formula. This is the energy density with sextic radii of SBH.

2.6 Supposing that per area force f has relations with distance R merely, we find

$$fR^\alpha \sim f_P L_P^\alpha = \hbar^{-(2-\alpha)/2} G^{-(4-\alpha)/2} c^{(14-3\alpha)/2} \quad (12)$$

where $f_P = c^7 / \hbar G^2$ is Planck per area force. It is the general formula for per area force and distance.

2.6.1 Instructing $4-\alpha = 0, \to \alpha = 4$, we gain

$$f \sim \hbar c / R^4$$

This is H. Casimir effect formula, hasn't $-\pi^2 / 240$.

2.6.2 Ordering $2-\alpha = 0, \to \alpha = 2$, we obtain

$$f \sim c^4 / GR^2 = F_P / R^2$$

where $F_P = c^4 / G$ is Planck force, and $M_P^2 = \hbar F_P / c^3$. From $\rho_{de} = 3c_L^2 c^3 M_{pl}^2 L^{-2}$ and $p = \omega\rho$, we gain

$$p_{de} = 3w_{de} c_L^2 c^3 M_{pl}^2 L^{-2} = 3w_{de} c_L^2 F_{Pl} L^{-2}$$

where $w_{de} < 0$ is the coefficient of state, $F_{Pl} = F_P / 8\pi$ is reduced Planck force. So it is the negative pressure $p_{de} \sim f$ of HDE [14], hasn't $3w_{de}$.

2.6.3 Instructing $14-3\alpha = 0, \to \alpha = 14/3$, we have

$$f^3 \sim \hbar^4 G / R^{14} \ ?$$

2.6.4 Ordering $\alpha = 6$, we obtain

$$f \sim \hbar^2 G / c^2 R^6$$

From 2.5.4 and $p = \omega\rho$, we gain

$$p \sim \omega \hbar^2 G / c^2 R^6$$

This is the pressure $p \sim f$ in SBH centre.

2.7 Assuming that radiation density ρ_r has relations with frequency γ only, we find

$$\rho_r \gamma^\alpha \sim \rho_{rP} \gamma_P^\alpha = \hbar^{-(1+\alpha)/2} G^{-(3+\alpha)/2} c^{(9+5\alpha)/2} \quad (13)$$

where $\rho_{rP} = \sqrt{c^9/\hbar G^3}$ is Planck radiation density, and γ_P is Planck frequency. It is the general formula for radiation density and frequency.

2.7.1 Instructing $3+\alpha = 0, \to \alpha = -3$, we obtain

$$\rho_r \sim \hbar \gamma^3 / c^3$$

Comparing M. Planck black body radiation formula, it hasn't $8\pi / (e^{\hbar\gamma/\kappa T} - 1)$.

2.7.2 Ordering $1+\alpha = 0, \to \alpha = -1$, we gain

$$\rho_r \sim c^2 \gamma / G \ ?$$

2.7.3 Instructing $9+5\alpha = 0, \to \alpha = -9/5$, we have

$$\rho_r^5 \sim \hbar^2 \gamma^9 / G^3 \ ?$$

2.7.4 Ordering $\alpha = -5$, we get

$$\rho_r \sim \hbar^2 G \gamma^5 / c^8 \ ?$$

2.8 Supposing that radiation density ρ_r has relations with temperature T merely, we find

$$\rho_r T^\alpha \sim \rho_{rP} T_P^\alpha = \hbar^{-(2-\alpha)/2} G^{-(4+\alpha)/2} c^{(14+5\alpha)/2} \kappa^{-\alpha} \quad (14)$$

It is the general formula for radiation density and temperature.

2.8.1 Instructing $4+\alpha = 0, \to \alpha = -4$, we obtain

$$\rho_r \sim \kappa^4 T^4 / \hbar^3 c^3$$

This is Stefan-Boltzmann law, hasn't $\pi^2 / 15$.

2.8.2 Ordering $2-\alpha = 0, \to \alpha = 2$, we gain

$$\rho_r \sim c^{12} / G^3 \kappa^2 T^2 \ ?$$

2.8.3 Instructing $14+5\alpha = 0, \to \alpha = -14/5$, we obtain

$$\rho_r^5 \sim \kappa^{14} T^{14} / \hbar^6 G^3 \ ?$$

2.8.4 Ordering $\alpha = -2$, we get

$$\rho_r \sim c^2 \kappa^2 T^2 / \hbar^2 G \ ?$$

2.9 Assuming that acceleration a has relations with temperature T only, we find

$$aT^\alpha \sim a_P T_P^\alpha = \hbar^{-(1-\alpha)/2} G^{-(1+\alpha)/2} c^{(7+5\alpha)/2} \kappa^{-\alpha} \quad (15)$$

where $a_P = \sqrt{c^7/\hbar G}$ is Planck acceleration. It is the general formula for acceleration and temperature.

2.9.1 Instructing $1+\alpha = 0, \to \alpha = -1$, we gain

$$a \sim c\kappa T / \hbar$$

This is Unruh formula [29], hasn't $1/2\pi$.

2.9.2 Ordering $1-\alpha = 0, \to \alpha = 1$, we obtain

$$aT \sim c^6 / \kappa G \ ?$$

2.9.3 Instructing $7+5\alpha = 0, \to \alpha = -7/5$, we have

$$a^5 \sim G\kappa^7 T^7 / \hbar^6 \ ?$$

2.9.4 Ordering $\alpha = -3$, we obtain

$$a \sim G\kappa^3 T^3 / \hbar^2 c^4 \ ?$$

2.10 Supposing that entropy density s has relations with temperature T merely, we find

$$sT^\alpha \sim s_P T_P^\alpha = \hbar^{-(3-\alpha)/2} G^{-(3+\alpha)/2} c^{(9+5\alpha)/2} \kappa^{(1-\alpha)} \quad (16)$$

where $s_P = \sqrt{\kappa^2 c^9 / \hbar^3 G^3}$ is Planck entropy density. It is the general formula for entropy density and temperature.

2.10.1 Instructing $3+\alpha = 0, \to \alpha = -3$, we obtain

$$s \sim \kappa^4 T^3 / \hbar^3 c^3$$

This is entropy density with cube of temperature [28] [30].

2.10.2 Ordering $3-\alpha = 0, \to \alpha = 3$, we have

$$sT^3 \sim c^{12} / G^3 \kappa^2 \ ?$$

2.10.3 Instructing $9+5\alpha = 0, \to \alpha = -9/5$, we get

$$s^5 \sim \kappa^{14} T^9 / \hbar^{12} G^3 \ ?$$

2.10.4 Ordering $1-\alpha = 0, \to \alpha = 1$, we gain

$$sT \sim c^7 / \hbar G^2 \ ?$$

2.10.5 Instructing $\alpha = -1$, we obtain

$$s \sim \kappa^2 c^2 T / \hbar^2 G$$

It is the entropy density of SBH center [31].

2.11 Assuming that curvature tensor $R_{\mu\nu}$ has relations with energy- momentum tensor $T_{\mu\nu}$ only, we find

$$R_{\mu\nu} T_{\mu\nu}{}^{\alpha} \sim R_{\mu\nu P} T_{\mu\nu P}{}^{\alpha} = \hbar^{-(1+\alpha)} G^{-(1+2\alpha)} c^{(3+7\alpha)} \quad (17)$$

where $R_{\mu\nu P} = c^3 / \hbar G$ is Planck curvature tensor, and $T_{\mu\nu P} = c^7 / \hbar G^2$ is Planck energy-momentum tensor. This is the general formula for curvature tensor and energy-momentum tensor.

2.11.1 Ordering $1+\alpha = 0, \rightarrow \alpha = -1$, we gain

$$R_{\mu\nu} \sim G T_{\mu\nu} / c^4$$

It is Einstein field equation, hasn't $-R g_{\mu\nu} / 2$ and -8π.

2.11.2 Instructing $1+2\alpha = 0, \rightarrow \alpha = -1/2$, we obtain

$$R_{\mu\nu}{}^2 \sim T_{\mu\nu} / \hbar c \ ?$$

2.11.3 Ordering $3+7\alpha = 0, \rightarrow \alpha = -3/7$, we have

$$R_{\mu\nu}{}^7 \sim T_{\mu\nu}{}^3 / \hbar^4 G \ ?$$

2.12 Supposing that Lagrange density function φ has relations with electromagnetic field tensor $F_{\mu\nu}$ merely, we find

$$\varphi F_{\mu\nu}{}^{\alpha} \sim \varphi_P F_{\mu\nu P}{}^{\alpha} = \hbar^{-(1+\alpha)} G^{-(2+\alpha)} c^{(7+3\alpha)} e^{\alpha}$$
$$\sim \hbar^{-(2+\alpha)/2} G^{-(2+\alpha)} c^{7(2+\alpha)/2} \quad (18)$$

where $\varphi_P = c^7 / \hbar G^2$ is Planck Lagrange density function, $F_{\mu\nu} = e\, c^3 / \hbar G$ is Planck electromagnetic field tensor, and $e \sim \sqrt{\hbar c}$. This is the general formula for Lagrange density function and electro- magnetic field tensor.

2.12.1 Instructing $2+\alpha = 0, \rightarrow \alpha = -2$, we obtain only

$$\varphi \sim F_{\mu\nu}{}^2 \sim F_{\mu\nu} F^{\mu\nu}$$

It is electromagnetic Lagrange density function under Lorentz gauge [32], hasn't $-1/4$ and $-(\partial_\mu A^\mu)^2 / 2$.

3. Relations of Power products of Three PQs

In this section, we obtain the relations of power products when $n = 3$ to the generalized relation; find the corresponding general formulas also; and obtain the Newtonian attraction law, Schrödinger equation, Coulomb law, Newtonian second law, Clapeyron equation, etc.

3.0 Similarly when $n = 3$, we obtain

$$A_1^{\alpha_1} A_2^{\alpha_2} A_3^{\alpha_3} \sim A_{1P}^{\alpha_1} A_{2P}^{\alpha_2} A_{3P}^{\alpha_3} \quad (19)$$

Ordering $\alpha_1 = 1$, $\alpha_2 = \alpha$, $\alpha_3 = \beta$, $A_1 = A$, $A_2 = B$, and $A_3 = C$, we give

$$A B^{\alpha} C^{\beta} \sim A_P B_P^{\alpha} C_P^{\beta} \quad (20)$$

when $\beta = 0$, (4) is recovered. Thus we can determine the relations of power products of three PQs. For example

3.1 Assuming that energy E has relations with mass M and distance r, we find

$$E M^{\alpha} r^{\beta} \sim \hbar^{(1+\alpha+\beta)/2} G^{-(1+\alpha-\beta)/2} c^{(5+\alpha-3\beta)/2} \quad (21)$$

This is the general formula for energy, mass and distance.

3.1.1 Instructing $1+\alpha+\beta = 0$, and $5+\alpha-3\beta = 0 \rightarrow \alpha = -2$ and $\beta = 1$, we obtain

$$E \sim G M^2 / r = G M m / r$$

It is Newtonian attraction law, hasn't -1, where $M = m$.

3.1.2 Ordering $1+\alpha-\beta = 0$, and $5+\alpha-3\beta = 0 \rightarrow \alpha = 1$ and $\beta = 2$, we gain

$$E \sim \hbar^2 / M r^2$$

Substituting $E \rightarrow i\hbar\, \partial / \partial t$ and $1 / r^2 \rightarrow \nabla^2$ into above formula, we obtain

$$i\hbar\, \partial \psi / \partial t \sim \hbar^2 \nabla^2 \psi / M$$

where ψ is wave function. This is Schrödinger equation, hasn't $-1/2$.

3.1.3 Instructing $1+\alpha+\beta = 0$, and $1+\alpha-\beta = 0 \rightarrow \alpha = -1$ and $\beta = 0$, we obtain

$$E \sim M c^2$$

It is mass-energy relation again.

3.2 Supposing that energy E has relations with electric charge Q and distance r, we find

$$E Q^{\alpha} r^{\beta} \sim \hbar^{(1+\beta)/2} G^{-(1-\beta)/2} c^{(5-3\beta)/2} e^{\alpha}$$
$$\sim \hbar^{(1+\alpha+\beta)/2} G^{-(1-\beta)/2} c^{(5+\alpha-3\beta)/2} \quad (22)$$

It is the general formula for energy, electric charge and distance.

3.2.1 Ordering $1+\alpha+\beta = 0$, and $1-\beta = 0 \rightarrow \alpha = -2$ and $\beta = 1$, also $5+\alpha-3\beta = 0$, we gain only

$$E \sim Q^2 / r = Q_1 Q_2 / r$$

This is Coulomb law, where $Q_1 = Q_2$.

3.3 Assuming that acceleration a has relations with force F and mass M, we find

$$a F^{\alpha} M^{\beta} \sim \hbar^{(1-\beta)/2} G^{-(1+2\alpha+\beta)/2} c^{(7+8\alpha+\beta)/2} \quad (23)$$

It is the general formula for acceleration, force and mass.

3.3.1 Instructing $1-\beta = 0$, and $1+2\alpha+\beta = 0 \rightarrow \alpha = -1$ and $\beta = 1$, also $7+8\alpha+\beta = 0$, we obtain merely

$$a \sim F / M$$

This is Newtonian second law [19].

3.4 Supposing that acceleration a has relations with mass M and distance r, we find

$$a M^{\alpha} r^{\beta} \sim \hbar^{-(1-\alpha-\beta)/2} G^{-(1+\alpha-\beta)/2} c^{(7+\alpha-3\beta)/2} \quad (24)$$

It is the general formula for acceleration, mass and distance.

3.4.1 Ordering $1-\alpha-\beta = 0$, and $7+\alpha-3\beta = 0 \rightarrow \alpha = -1$ and $\beta = 2$, we gain

$$a \sim G M / r^2$$

This is Newtonian gravitational acceleration [19].

3.4.2 Instructing $1+\alpha-\beta = 0$, and $7+\alpha-3\beta = 0 \rightarrow \alpha = 2$ and $\beta = 3$, we have

$$a \sim \hbar^2 / M^2 r^3 \ ?$$

3.4.3 Ordering $1-\alpha-\beta = 0$, and $1+\alpha-\beta = 0 \rightarrow \alpha = 0$ and $\beta = 1$, we obtain

$$a \sim c^2 / r$$

From $\rho_{de}= 3c_L^2 c^3 M_{pl}^2 L^{-2}$, $p = \omega\rho$, $F \sim pL^2$, $a \sim F / M$, $M c^2 = \rho V$ and $V \sim L^3$, we gain

$$a \sim 3w_{de} c^2 / 8\pi L$$

where $r \sim L$. It is the acceleration of HDE, hasn't $3w_{de} / 8\pi$.

3.5 Assuming that pressure p has relations with volume V and temperature T, we find

$$pV^{\alpha}T^{\beta} \sim p_P V_P^{\alpha} T_P^{\beta}$$
$$= \hbar^{-(2-3\alpha-\beta)/2} G^{-(4-3\alpha+\beta)/2} c^{(14-9\alpha+5\beta)/2} \kappa^{-\beta} \quad (25)$$

where $p_P = c^7 / \hbar G^2$ is Planck pressure. This is the general formula for pressure, volume and temperature.

3.5.1 Instructing $2-3\alpha-\beta = 0$, and $4-3\alpha+\beta = 0 \rightarrow \alpha = 1$ and $\beta = -1$, also $14-9\alpha+5\beta = 0$, we obtain only

$$pV \sim \kappa T$$

It is Clapeyron equation, hasn't WN_A / M, where W is the gaseous mass, N_A is the Avogadro constant and M is the mass of gaseous mole molecule.

3.6 Assuming that thickness d has relations with temperature T and resistance R, we find

$$dT^{\alpha}R^{\beta} \sim L_P T_P^{\alpha} R_P^{\beta}$$
$$= \hbar^{(1+\alpha+2\beta)/2} G^{(1-\alpha)/2} c^{-(3-5\alpha)/2} e^{-2\beta} \kappa^{-\alpha} \quad (26)$$

where $R_P = \hbar / e^2$ is Planck resistance. This is the general formula for thickness, temperature and resistance.

3.6.1 Ordering $1-\alpha = 0 \rightarrow \alpha = 1$, we obtain

$$dT \sim \hbar^{(1+\beta)} c\kappa^{-1} e^{-2\beta} R^{-\beta}$$

It is the power law of thin superconducting films $d\,T_S = AR_S^{-B}$, where T_S is critical temperature, R_S is thin-film resistor, A and B are constant.

3.6.2 Instructing $1+\alpha+2\beta = 0$, and $1-\alpha = 0 \rightarrow \alpha = 1$ and $\beta = -1$, we gain

$$dT \sim c\kappa^{-1} e^2 R \ \ ?$$

3.6.3 Ordering $1+\alpha+2\beta = 0$, and $3-5\alpha = 0 \rightarrow \alpha = 3/5$ and $\beta = -4/5$, we have

$$d^5 T^3 \sim G e^8 \kappa^{-3} R^4 \ \ ?$$

4. Relations of Power products of Four PQs

In this section, we obtain the relations of power products when $n = 4$ to the generalized relation; obtain the centrifugal force formula.

4.0 Similarly when $n = 4$, we obtain

$$A_1^{\alpha_1} A_2^{\alpha_2} A_3^{\alpha_3} A_4^{\alpha_4} \sim A_{1P}^{\alpha_1} A_{2P}^{\alpha_2} A_{3P}^{\alpha_3} A_{4P}^{\alpha_4} \quad (27)$$

Instructing $\alpha_1 = 1$, $\alpha_2 = \alpha$, $\alpha_3 = \beta$, $\alpha_3 = \gamma$, $A_1 = A$, $A_2 = B$, $A_3 = C$ and $A_4 = D$, we gain

$$AB^{\alpha}C^{\beta}D^{\gamma} \sim A_P B_P^{\alpha} C_P^{\beta} D_P^{\gamma} \quad (28)$$

when $\gamma = 0$, (20) is recovered. Therefore we can determine the relations of power products of four PQs. For example

4.1 Supposing that force F has relations with mass M, speed v and distance r, we find

$$FM^{\alpha}v^{\beta}r^{\gamma} \sim \hbar^{(\alpha+\gamma)/2} G^{-(2+\alpha-\gamma)/2} c^{(8+\alpha+2\beta-3\gamma)/2} \quad (29)$$

This is the general formula for force, mass, speed and distance.

4.1.1 Ordering $\alpha+\gamma = 0$, $2+\alpha-\gamma = 0$ and $8+\alpha+2\beta-3\gamma = 0$ $\rightarrow \alpha = -1$, $\beta = -2$ and $\gamma = 1$, we obtain

$$F \sim Mv^2 / r$$

It is the centrifugal force formula. And so on.

5. Conclusion

In this paper we determine the relations of power products of PQs by the generalized relation. We find the following results:

1) The relations of power products of two PQs are determined when $n = 2$ to the generalized relation. Specially two PQs have direct proportion or inverse relation when their exponents are equal to -1 or 1.

2) The corresponding general formulas are found by Assuming the relation between energy and mass, energy and frequency, energy and energy density, distance and mass, energy density and distance, per area force and distance, radiation density and frequency, radiation density and temperature, acceleration and temperature, entropy density and temperature, curvature tensor and energy-momentum tensor, Lagrange density function and electromagnetic field tensor respectively.

3) Many famous equations without corresponding factors are obtained including mass-energy relation [12], temperature of event horizon of Schwarzschild black hole (SBH) [13], light quantum relation [24], inverse correlation between high- frequency quasi-periodic oscillation and black hole mass [25], biquadratic quanta energy with its density [17], radius of event horizon of stationary black holes [26], A.H. Compton wavelength formula [27], age of SBH [13], equation of HDE model [14], radiation formula for early universe [28], Casimir effect equation [15], negative pressure of HDE [14], Planck black body radiation formula [16], Stefan-Boltzmann law [17], Unruh formula [29], entropy density with cube of temperature [28] [30], Einstein field equation [18], electromagnetic Lagrange density function under Lorentz gauge [32], etc.

4) Some new relations are found including square of total energy with energy density of HDE, square of energy with its density of SBH, energy density with sextic radii of SBH, pressure in SBH centre, entropy density of SBH [31] center, etc.

5) The relation of power products of three and four PQs are determined when $n = 3$ and 4 to the generalized relation.

6) The corresponding general formulas are found also by

Assuming the relation between energy, mass and distance; energy, electric charge and distance; acceleration, force and mass; acceleration, mass and distance; pressure, volume and temperature; thickness, temperature and resistance; force, mass, speed and distance respectively.

7) Also some famous equations without factors are gained including Newtonian attraction law [19], Schrödinger equation [20], Coulomb law [21], Newtonian second law [19], Newtonian gravitational acceleration [19], acceleration of HDE, Clapeyron equation [22], power law of thin superconducting films [23], and centrifugal force formula [19].

8) Some relations which are given can't be understood.

9) The generalized relation can determine the relations of power products of two, three and four PQs, but can't give the corresponding factors. It is useful and significant.

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