Chapter 36

LEPTONS

Only three lepton particles can be formed from photons corresponding to the Planck equation energy, the potential energy, and the magnetic energy, where each is equal to the mass energy (Eq. (32.27)). As opposed to a continuum of energies, leptons arise from photons of only three energies. Each "resonant" photon can be considered to be the superposition of two photons—each possessing the energy given by Planck's equation, Eq. (32.28), which is equal to the mass energy of the lepton or antilepton, each possessing $\hbar$ of angular momentum, and each traveling at the speed of light in the lab inertial frame.

At particle production, a photon having a radius and a wavelength equal to the Compton wavelength bar of the particle forms a transition state atomic orbital of the particle of the same wavelength. Eq. (32.43) equates the proper and coordinate times at particle production wherein the velocity of the transition state atomic orbital in the coordinate frame is the speed of light and the relationships between the mass energies given by Eq. (32.32) hold. To describe any phenomenon such as the motion of a body or the propagation of light, a definite frame of reference is required. A frame of reference is a certain base consisting of a defined origin and three axes equipped with graduated rules and clocks as described in the Relativity section. In the case of particle production wherein the velocity is the speed of light, only the time ruler need be defined. By defining a standard ruler for time in the coordinate frame, the mass of the particle is then given in terms of the self-consistent system of units based on the definition of the time ruler. The mass of the particle must be experimentally measured with the same time ruler as part of a consistent system of units. In the case that MKS units are used, the permeability of free space is a fundamental constant defined as exactly $\mu_0 = 4\pi\ X\ 10^{-7}\ Hm^{-1}$. Similarly, the coordinate time (Eq. (36.2)) is defined as the "second[1]," and the mass of the particle is given in kilograms based on this definition of the "second" (See Particle Production section). The production of a real particle from a transition state atomic orbital is a spacelike event in terms of special relativity wherein spacetime is contracted by the gravitational radius of the particle during its production as given in the Gravity section. Thus, the coordinate time is imaginary as given by Eq. (32.43). On a cosmological scale, imaginary time corresponds to spacetime expansion and contraction as a consequence of the harmonic interconversion of matter and energy as given by Eq. (33.40).

The mass of each member of a lepton pair corresponds to an energy of Eq. (32.32). The electron and antielectron

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[1] Using an atom to define the unit of time is a means to set a more universal standard. Presently the second is defined as the time required for 9,192,631,770 vibrations within the cesium-133 atom. The "second" as defined in Eq. (36.2) is a fundamental constant, namely, the metric of spacetime. This definition gives the relationship of energy to matter conversion to spacetime contraction, and it sets the clock (ruler of time) to the conversion rate of matter into energy and the corresponding rate of spacetime expansion of the Universe. A theory that unifies all physics must ultimately be able to describe all observations in terms of the definition of time only. All other measurable parameters of matter, energy, charge, spacetime, etc. are ultimately expressed in terms of the unit of time. If coordinate time is defined by Eq. (36.2), then Eq. (32.43) gives the masses of "allowed particles" in terms of that definition. Eq. (32.39) gives another method of experimentally determining the metric of time (sec) which does not require the measurement of the electron mass. The electron Compton wavelength $\bar{\lambda}_C$ is equal to the wavelength of the photon which gives rise to the electron, and the velocity of each mass-density element of the extended particle is equivalent to the gravitational escape velocity, v_g, of the mass of the antiparticle (Eq. (32.43)). Eq. (33.21) gives the circular relationships between matter, energy, and spacetime based on this definition of time. A unified theory can only provide the relationships between all measurable observables in terms of a clock defined according to those observables and used to measure them.

In this case, fundamental physical constants and observables calculated in terms of the fundamental constants have no meaning except with regard to the definition of time in terms of the constants. Then all observables such as the excited states of atoms, ionization energies of atoms, chemical bond energies, scattering of electrons from atoms, nuclear parameters, cosmological parameters, etc. are given in terms of the definition of the "second" (Eq. (36.2) which is extremely close to the MKS second (**See Box 32.1.**). Internal consistency is given with a high degree of accuracy over the scalar range of 85 orders of magnitude (mass of the electron to mass of the Universe). To achieve exact predictions of particle masses and cosmological parameters that require the introduction of the spacetime metric as a fundamental constant, a slight modification of the experimental definition of the second may be required. Presently, all fundamental constants including masses are determined in a self-consistent manner involving definitions and measurements. Ultimately the unit system will have to be revised according to Eq. (33.21), which gives the exact relationships between the measurable constants.

correspond to the Planck equation energy. The muon and antimuon correspond to the electric energy. And, the tau and antitau correspond to the magnetic energy. It is shown that the masses are given by Eq. (32.43) and the relative masses differ in their specific function of the fine structure constant α only. These functions are determined by relativistic coefficients given by Eq. (32.32) according to the kind of energy that is responsible for the respective level (e, μ, τ) of the particular particle within its family.

A neutrino/antineutrino pair is formed in each of three cases of lepton/anti-lepton production to conserve linear and angular momentum during the separation of the world lines of each particle and its antiparticle. The neutrino and antineutrino are photons that travel at velocity c and have energy, but are mass-less. Equations of such photons are given in the Neutrinos section.

THE ELECTRON-ANTIELECTRON LEPTON PAIR

From Eq. (32.43), when the gravitational radius r_g (Eq. (32.36)) is equal to the radius of the transition state atomic orbital, the corresponding gravitational velocity v_g (Eq. (32.35)) is the speed of light c, and the proper time is equal to the coordinate time. Thus, the special relativistic corrections to r_g are the same as those of the transition state radius which gives the energy of the particle equal to its mass times the speed of light squared as given by Eqs. (32.32a-32.32b).

Consider the Planck energy equation, Eq. (32.28). The proper time τ is given by:

$$\tau = \frac{2\pi}{\omega} = 2\pi \frac{\hbar}{mc^2} \tag{36.1}$$

In the lab frame, the relativistic correction of the radius in the derivation of the Planck's equation for the transition state atomic orbital (Eq. (29.12)) is α^{-2}. Substitution of (i) $\alpha^{-2} r_g$, the relativistically corrected gravitational radius (Eq. (32.36)) for r_g, (ii) the sec which is essentially the second—the definition for the coordinate time in MKS units, for *ti*, and (iii) the Compton wavelength bar for the radius r of the transition state atomic orbital, (Eq. (32.21)), into Eq. (32.43) gives:

$$2\pi \frac{\hbar}{m_e c^2} = \sec \sqrt{\frac{2Gm_e^2}{c\alpha^2\hbar}} \tag{36.2}$$

The left-hand side of Eq. (36.2) is the general relativistic correction of the coordinate time. The special relativistic factor, α^{-1} (factored out of the square root), also follows from Eq. (32.34), from Eqs. (2.118) and (2.123), and from Eq. (5.45) of Fowles [1]. The mass of the electron/antielectron in MKS units based on the definition of the coordinate time in terms of the sec is:

$$m_e = \left(\frac{h\alpha}{\sec c^2}\right)^{\frac{1}{2}} \left(\frac{c\hbar}{2G}\right)^{\frac{1}{4}} = \left(\frac{h\alpha}{\sqrt{2}\sec c^2}\right)^{\frac{1}{2}} m_u^{\frac{1}{2}} = 9.0998\ X\ 10^{-31}\ kg \tag{36.3}$$

where m_u is the Planck mass given by Eq. (32.31) and $m_{e\ \mathrm{experimental}} = 9.10945455\ X\ 10^{-31}\ kg$ [3-4].

With lepton production a particle of electrostatic charge $-e$ and an antiparticle of electrostatic charge $+e$ are produced. The corresponding fields travel at the speed of light and interact with each other. In order to conserve mass-energy, the electromagnetic fields of the particles must be included in the mass determination. The correction to the electron mass is given by Eq. (36.15). The corresponding lepton neutrinos carry any energy not accounted for as binding energy, kinetic energy, or carried by photons, and they further conserve linear and angular momentum including the angular momentum of the electromagnetic field fronts (Eq. (4.1)) which propagate at the speed of light to give the electrostatic fields of the particles as discussed in the Neutrinos section.

The difference between the calculated and experimental values of the electron mass is due to the very slight difference between the present MKS second and the definition of the corresponding time unit defined by Eq. (36.2). Eq. (33.21) gives the circular relationships between matter, energy, and spacetime based on the definition of time given by Eq. (36.2). Any fundamental constant is exactly given in terms of the other members of these relationships and may be determined to the experimental accuracy that they are known. An exact value for the imaginary time ruler ti given by Eq. (32.43) can be obtained by using Eq. (36.2) with the results of Eqs. (36.9-36.22).

$$1\ \sec = m_e^{-2}\left(\frac{h\alpha}{c^2}\right)\left(\frac{c\hbar}{2G}\right)^{\frac{1}{2}}\left(1+\frac{2\pi\alpha^2}{2}\right)^{-2} = 0.9975(46714)\ \text{MKS second} \tag{36.4}$$

The accuracy of the conversion factor of 0.9975 second/sec is limited by the error in the value of the gravitational constant (See Boxes 32.1 and 32.2). A new system of units would eliminate the need for conversion and permit a more accurate determination of the constants including the definition of time based on internal consistency.

THE MUON-ANTIMUON LEPTON PAIR

The muon (antimuon) decays to the electron (antielectron) and may be considered a transient resonance which decays to the stable lepton, the electron (antielectron). Given that the electron is "allowed" by the Planck energy equation (Eq. (32.28)) and that the proper time is given by general relativity (Eq. (32.38)), the muon (antimuon) mass can be calculated from the potential energy, *V*, (Eq. (32.27)) and the proper time relative to the electron inertial frame. In this case, the special relativistic corrections to r_g are the inverse of those of the radius of the transition state atomic orbital, which gives the energy of the particle equal to its mass times the speed of light squared as given by Eqs. (32.32a-32.32b). For the lab inertial frame, the relativistic correction of the radius of the transition state atomic orbital given by the potential energy equations (Eq. (29.10) and (29.11)) is α^{-2}. For the electron inertial frame, the relativistic correction of the gravitational radius relative to the proper frame is the inverse, α^2. Furthermore, the potential energy equation gives an electrostatic energy; thus, the electron inertial time must be corrected by the relativistic factor of 2π relative to the proper time. (See the Special Relativistic Correction to the Ionization Energies section.) Multiplication of the right side of Eq. (32.43) by 2π and substitution of (i) m_e, the mass of the electron, for *M*, (ii) the sec which is essentially the second—the definition for the coordinate time in MKS units, for *ti*, (iii) $\alpha^2 r_g$, the relativistically corrected gravitational radius, for r_g (Eq. (32.36)), and the Compton wavelength bar for the transition state atomic orbital radius *r*, (Eq. (32.21)), into Eq. (32.43) gives the relationship between the proper time and the electron coordinate time:

$$2\pi \frac{\hbar}{m_\mu c^2} = 2\pi \sec \sqrt{\frac{2Gm_e\alpha^2 m_\mu}{c\hbar}} \tag{36.5}$$

The mass of the muon/antimuon using the MKS second is:

$$m_\mu = \frac{\hbar}{c}\left(\frac{1}{2Gm_e(\alpha \sec)^2}\right)^{\frac{1}{3}} = 1.8874\ X\ 10^{-28}\ kg \tag{36.6}$$

where $m_{\mu\text{experimental}} = 1.88355\ X\ 10^{-28}\ kg$ [3].

THE TAU-ANTITAU LEPTON PAIR

Given that the electron is "allowed" by the Planck energy equation (Eq. (32.28)) and that the proper time is given by general relativity (Eq. (32.38)), the tau (antitau) mass can be calculated from the magnetic energy (Eq. (32.27)) and the proper time relative to the electron inertial frame. For the lab inertial frame, the relativistic correction of the radius of the transition state atomic orbital given by the magnetic energy equations (Eq. (29.14) and (29.15)) is $\frac{1}{(2\pi)^2\alpha^4}$ [2]. For the electron inertial frame, the relativistic correction of the gravitational radius relative to the proper frame is the inverse, $(2\pi)^2\alpha^4$. Furthermore, the transition state comprises two magnetic moments. For $v = c$, the magnetic energy equals, the potential energy, equals the Planck equation energy, equals mc^2. The magnetic energy is given by the square of the magnetic field as given by Eqs. (1.154-1.162). The magnetic energy corresponding to particle production is given by Eq. (32.32). Because two magnetic moments are produced the magnetic energy (and corresponding photon frequency) in the proper frame is two times that of the electron frame. Thus, the electron time is corrected by a factor of two relative to the proper time. Multiplication of the right side of Eq. (32.43) by 2 and substitution of (i) m_e, the mass of the electron, for M, (ii) the sec which is essentially the second—the definition for the coordinate time in MKS units, for ti, (iii) $(2\pi)^2\alpha^4 r_g$, the relativistically corrected gravitational radius, for r_g (Eq. (32.36)), and the Compton wavelength bar for the transition state atomic orbital radius r, (Eq. (32.21)), into Eq. (32.43) gives the relationship between the proper time and the electron coordinate time:

$$2\pi \frac{\hbar}{m_\tau c^2} = 2\sec \sqrt{\frac{2Gm_e(2\pi)^2\alpha^4 m_\tau}{c\hbar}} \tag{36.7}$$

The mass of the tau/antitau is:

$$m_\tau = \frac{\hbar}{c}\left(\frac{1}{2Gm_e}\right)^{\frac{1}{3}}\left(\frac{1}{2\sec\alpha^2}\right)^{\frac{2}{3}} = 3.1604\ X\ 10^{-27}\ kg \tag{36.8}$$

where $m_{\tau\text{ experimental}} = 3.1676\ X\ 10^{-27}\ kg\ \left(1776.9\ MeV / c^2\right)$ [3].

In the case of the production of each lepton a nucleus is present during particle/antiparticle production to conserve momentum. A fourth particle/antiparticle pair can arise by the gravitational potential energy of Eq. (32.27). However, a pair of particles each of the Planck mass corresponding to the conditions of Eq. (32.22), Eq. (32.32), and Eq. (32.33) is not observed since the velocity of each of the point masses of the transition state atomic orbital is the gravitational velocity v_G that in this case

[2] The special relativistic correction of the particle masses in the transition state given by Eq. (1.273) avoids the situation of encountering an infinite mass at light speed as given by Eq. (33.14).

is the speed of light; whereas, the Newtonian gravitational escape velocity v_g of the superposition of the point masses of the antiparticle would be $\sqrt{2}$ times the speed of light (Eq. (32.35)). In this case, an electromagnetic wave of mass energy equivalent to the Planck mass travels in a circular orbit around the center of mass of another electromagnetic wave of mass energy equivalent to the Planck mass wherein the eccentricity is equal to zero (Eq. (35.21)), and the escape velocity can never be reached. The Planck mass is a "measuring stick." The extraordinarily high Planck mass ($\sqrt{\frac{\hbar c}{G}} = 2.18\ X\ 10^{-8}\ kg$) is the unobtainable mass bound imposed by the angular momentum and speed of the photon relative to the gravitational constant. It is analogous to the unattainable bound of the speed of light for a particle possessing finite rest mass imposed by the Minkowski tensor. It has a physical significance for the fate of blackholes as given in the Composition of the Universe section.

RELATIONS BETWEEN THE LEPTONS

Based on Eqs. (36.3), (36.6), and (36.8), the relations between the lepton masses which are independent of the definition of the imaginary time ruler ti given by Eq. (32.43) are [2] :

$$\frac{m_\mu}{m_e} = \left(\frac{\alpha^{-2}}{2\pi}\right)^{\frac{2}{3}} = 207.48800 \qquad (206.76827) \tag{36.9}$$

$$\frac{m_\tau}{m_\mu} = \left(\frac{\alpha^{-1}}{2}\right)^{\frac{2}{3}} = 16.744 \qquad (16.817) \tag{36.10}$$

$$\frac{m_\tau}{m_e} = \left(\frac{\alpha^{-3}}{4\pi}\right)^{\frac{2}{3}} = 3474.3 \qquad (3477.3) \tag{36.11}$$

The respective experimental lepton mass ratios according to the 1998 CODATA and the Particle Data Group are given in parentheses [3-4]. Eqs. (36.9-36.11) do not include the neutrino energies and the coulomb and magnetic field energies.

With lepton production a particle of electrostatic charge $-e$ and an antiparticle of electrostatic charge $+e$ are produced. The corresponding fields travel at the speed of light and interact with each other. In order to conserve mass-energy, the electromagnetic fields of the particles must be included in the mass determination. Consider the electron given by Eq. (36.3). The coulomb field of the electron and positron correspond to a potential energy. As given in the Positronium section (Eq. (30.5)), the potential energy V between the particle and the antiparticle having the radius r_1 is,

$$V = \frac{-e^2}{4\pi\varepsilon_0 r_1} = \frac{-Z^2 e^2}{8\pi\varepsilon_0 a_0} = -2.18375\ X\ 10^{-18}\ J = -13.59\ eV \tag{36.12}$$

The calculated ionization energy is $\frac{1}{2}V$ which is:

$$E_{ele} = 6.795\ eV. \tag{36.13}$$

The experimental ionization energy is $6.795\ eV$.

Eq. (36.12) may written in terms of the mass-energy of the electron:

$$V = \frac{-e^2}{4\pi\varepsilon_0 r_1} = \frac{-Z^2 e^2}{8\pi\varepsilon_0 a_0} = -\frac{\alpha^2}{2} m_e c^2 = -2.18375\ X\ 10^{-18}\ J = -13.59\ eV \tag{36.14}$$

Since the electron mass-energy is given by the Planck energy equation given by Eqs. (29.12) and (32.32), the special relativistic factor for the bound particle-antiparticle state relative to the particle-production transition state given in Eq. (36.14) is α^2. In addition, due to time dilation at $v = c$ relative to the velocity of the bound state, the frequency and thus the energy increases by 2π as given by Eq. (1.281). From Eqs. (1.281) and (36.14) the electron mass is corrected by a factor γ^* of:

$$\gamma^* = \left(1 + 2\pi\frac{\alpha^2}{2}\right)^{-1} \tag{36.15}$$

Similarly to the positron and following Eq. (36.12), the muon mass must be corrected due to the particle fields. Since the muon is given by the electrostatic coulomb energy equation given by Eqs. (28.9) and (32.32), the special relativistic factor for the bound particle-antiparticle state relative to the transition state frame given in Eqs. (28.9), (32.32), and (36.5) is α corresponding to the relative radii where the corresponding potential energy is given by:

$$V = -\frac{\alpha}{2} m_\mu c^2 = -6.17671\ X\ 10^{-14}\ J = -3.85517\ X\ 10^5\ eV \tag{36.16}$$

From Eq. (36.16) the muon mass is corrected by a factor γ^* of:

$$\gamma^* = \left(1 + \frac{\alpha}{2}\right)^{-1} \tag{36.17}$$

From Eqs. (36.15) and (36.17), the ratio of the differential relativistic correction of the electron mass to that of the muon mass due to charge interactions is given by Eq. (1.281).

Similarly to the positron and following Eq. (36.12), the tau mass must be corrected due to the particle fields where the tau is given by the magnetic energy equation given by Eqs. (29.14) and (32.32). In this case, two magnetic dipoles are formed that are spin paired in order to conserve angular momentum. Since the particle and antiparticle are oppositely charged and the magnetic dipoles are antiparallel, the force is repulsive rather than attractive. In this case, the corresponding energy increases the mass of the tau and antitau since the corresponding special relativistic factor for the bound particle-antiparticle state relative to the transition state frame is negative. The magnitude is four times that of the electron correction corresponding to replacing the reduced mass in Eq. (36.12) by the mass (Eqs. (30.1-30.4) where the force is purely magnetic) and a factor of two corresponding to the interaction of two magnetic dipoles rather than electric monopoles as given by Eqs. (1.154-1.162). The corresponding potential energy is given by:

$$V = 4\pi\alpha^2 m_\tau c^2 = 1.905\ X\ 10^{-13}\ J = 1.189\ X\ 10^6\ eV \tag{36.18}$$

From Eq. (36.16) the tau mass is corrected by a factor γ^* of:

$$\gamma^* = \left(1 - 4\pi\alpha^2\right)^{-1} \tag{36.19}$$

Based on Eqs. (36.3), (36.6), (36.15), and (36.17), the relation between the muon and electron masses (Eq. (36.9)) which is independent of the definition of the imaginary time ruler ti given by Eq. (32.43) including the contribution of the fields due to charge production of magnitude e is:

$$\frac{m_\mu}{m_e} = \left(\frac{\alpha^{-2}}{2\pi}\right)^{\frac{2}{3}} \frac{\left(1 + 2\pi\frac{\alpha^2}{2}\right)}{\left(1 + \frac{\alpha}{2}\right)} = 206.76828 \qquad (206.76827) \tag{36.20}$$

Based on Eqs. (36.6), (36.8), (36.17), and (36.19), the relation between the tau and muon masses (Eq. (36.10)) which is independent of the definition of the imaginary time ruler ti given by Eq. (32.43) including the contribution of the fields due to charge production of magnitude e is:

$$\frac{m_\tau}{m_\mu} = \left(\frac{\alpha^{-1}}{2}\right)^{\frac{2}{3}} \frac{\left(1 + \frac{\alpha}{2}\right)}{\left(1 - 4\pi\alpha^2\right)} = 16.817 \qquad (16.817) \tag{36.21}$$

Based on Eqs. (36.3), (36.8), (36.15), and (36.19), the relation between the tau and electron masses (Eq. (36.11)) which is independent of the definition of the imaginary time ruler *ti* given by Eq. (32.43) including the contribution of the fields due to charge production of magnitude *e* is:

$$\frac{m_\tau}{m_e} = \left(\frac{\alpha^{-3}}{4\pi}\right)^{\frac{2}{3}} \frac{\left(1 + 2\pi\frac{\alpha^2}{2}\right)}{\left(1 - 4\pi\alpha^2\right)} = 3477.2 \qquad (3477.3) \tag{36.22}$$

For Eqs. (36.20-36.22), the respective experimental lepton mass ratios according to the 1998 CODATA and Particle Data Group tables are given in parentheses [3-4]. There is remarkable agreement. The corresponding lepton neutrinos carry any energy not accounted for as binding energy, kinetic energy, or carried by photons, and they further conserve linear and angular momentum including the angular momentum of the electromagnetic field fronts (Eq. (4.1)) which propagate at the speed of light to give the electrostatic fields of the particles as discussed in the Neutrinos section.

X17 PARTICLE

As shown in this section, the electron, muon, and tau masses are based on the relativistic corrections of the Planck, electric, and magnetic energies, respectively, as given in Eq. (32.48) wherein, the masses of the heavier leptons, the muon and tau are dependent on the first lepton's mass, the electron mass, and each can be considered a relativistic effect of the electron mass. As shown in the Muonic Hydrogen Lamb shift section, the radiation reaction force F_{RR} of muonic hydrogen comprises three terms that follow from Eq. (2.135) and arise from lepton-photon-momentum transfer during the ${}^2P_{1/2} \rightarrow {}^2S_{1/2}$ transition wherein the photon couples with the three possible states of the electron mass corresponding to the three possible leptons. The radiation reaction force of relativistic origin is determined by the action on the electron mass with each mass hierarchy having a corresponding force component. Similarly, neutral mass-energy resonances arising from simultaneously satisfaction of Maxell's equations and the spacetime particle-production condition (Eq. 32.43)) involve the higher mass-energy muon and tau leptons states and give rise to particles that may decay to an electron-positron pair e^+e^-. A resonance exists for the tau relativistic correction of the muon resonance of the electron mass given by the ratio of the muon to tau masses (Eq. (36.10)) times the mass of the electron. The neutral electromagnetic production of the tau-to-muon resonance predicts a neutral particle of 16.744 times the mass of the electron-positron pair e^+e^-. Since the electron mass is 511 keV, the predicted mass is 17.11 MeV.

$$m_{X17} = 2\left(\frac{a^{-1}}{2}\right)^{\frac{2}{3}} m_e = 17.11 MeV \tag{36.23}$$

Krasznahorkay et al. have reported a particle of 17 MeV that decays to e^+e^- [5]. Specifically, when protons were fired at thin targets of lithium-7 to create unstable beryllium-8 nuclei that then decayed to pairs of electrons and positrons excess decays were observed at an opening angle of 140° between the e^+ and e^- having a combined energy of approximately 17 MeV, which indicated that a small fraction of beryllium-8 nuclei each lost excess energy in the form of a new particle. Recently, a 17 MeV particle was also was evident by the discovery of a e^+e^- angular correlation of 115 ° and a combined energy of approximately 17 MeV from the decay of the 21 MeV excited nuclear state of helium-4 formed by the firing of 900 keV protons at helium-3 [6]. The authors speculate that the existence 17 MeV particle missed by the Standard Model regards a new so-called fifth force with further speculation that it has relevance to dark matter. Particles do not mediate forces; rather all forces are either electromagnetic in nature or arise from the curvature of spacetime. Furthermore, the identity of dark matter is hydrogen in lower chemical energy states [7].

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