Cosmology demystified—the first femtoseconds

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THE BIG PICTURE

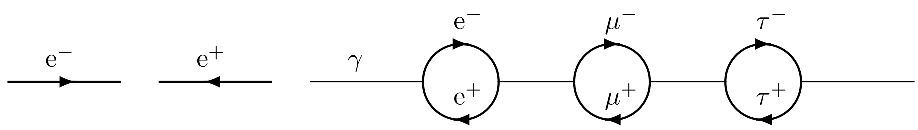
The main ingredients of the standard model of particle physics (SM) are three forces (electromagnetic, strong, and weak) and a number of more-or-less well understood elementary particles. Well understood particles are the electrically charged leptons and quarks, and the massless photon and gluons via which they interact, respectively. Less well understood particles are the weakly interacting ones—the long known neutrino, the more recently discovered W and Z particles, and the elusive Higgs.

When a few forgotten or ignored pieces (the JBW theory, Dirac's neutral particle, and Dirac's large-number hypothesis) and newly discovered pieces (such as the global role played by the law of conservation of energy) are added to SM and all pieces are rearranged, a logical and surprisingly simple picture emerges. In this "extended SM" (xSM) picture, all pieces are assigned precisely specified roles. Thus, it turns out that the purpose of every appearing particle and force—with the exception of gravity—is to produce or maintain a material universe.

The best way to quickly understand the early history of the universe—and see the big picture—is to start from the part of SM that is best known: quantum electrodynamics (QED).

The QED universe—a doomed world

When the universe is one femtosecond (1 fs) or 10^{-15} seconds old, it contains millions of electrons (e^- and e^+ in equal amounts) and photons (γ). The only other particles are muons and tauons (or heavy electrons) occasionally popping up in the form of short-lived vacuum polarization loops in the photon propagator:



The particles interact electromagnetically. Strong and weak forces do not exist, and the gravitational force [see p. 9] is not active. Consequently, at this early stage of the universe spinor quantum electrodynamics (QED) [see p. 12] is the theory of everything (TOE).

The electrons come in pairwise entangled pairs that rapidly annihilate, forming entangled pairs of photons ($e^+e^-\ e^+e^- \rightarrow \gamma\gamma$). The universe is still in an indeterminate quantum state and the particle pairs do not interact. In other words, kinetic energy does not exist—the universe is perfectly cold. ≫ False objection: "The Higgs mechanism proves that the universe began as an immensely hot singularity" [see p. 17, The Higgs mechanism]. ≪

In a few more femtoseconds, when the expanding universe already contains over a billion photon pairs, the last surviving electron pairs are about to annihilate and produce a purely radiative universe—a world only inhabited by massless photons. However, the energy content of an expanding universe void of matter is not conserved—energy gradually disappears because mechanisms do not exist that could counterbalance the continuous decrease in radiation energy caused by the redshift of the photons. Consequently, the law of conservation of energy forbids the existence of such a world. ≫ False objection: "The law of conservation of energy does not apply to the expanding universe" [see p. 7, The energy law's global role]. ≪

The infant universe

The law of conservation of energy demands that the last electrons of the QED universe should somehow rematerialize after they have annihilated themselves. The question to be asked is: How is that possible? History gives a clue. The virtual "heavy electrons" (muon and tauon) witness that the universe already has managed to escape extinction twice. The first time, when all spinless tauons—products of the decaying primordial Dirac particle (D) [see p. 12, Dirac's neutral particle]—had annihilated themselves ($\tau_0^+\tau_0^- \rightarrow \gamma_\tau\gamma_\tau$), matter had been recreated in the form of spinless muons ($\gamma_\tau\gamma_\tau \rightarrow \mu_0^+\mu_0^-$). And a little later, when all spinless-muon pairs in turn had annihilated ($\mu_0^+\mu_0^- \rightarrow \gamma_\mu\gamma_\mu$), the law of conservation of energy had forced matter to be recreated in the form of familiar spin-$\frac{1}{2}$ electrons ($\gamma_\mu \rightarrow \mathrm{e}^+\mathrm{e}^-$).

When the universe is about four femtoseconds (4×10^{-15} s) old, the evolution of matter may be summarized as

$$\begin{array}{cccccccccccc}
\mathrm{D} & \rightarrow & \tau_0^+\tau_0^- & \rightarrow & \underline{\mu}_0^+\underline{\mu}_0^- & \rightarrow & \mu_0^+\mu_0^- & \rightarrow & \underline{\mathrm{e}}^+\underline{\mathrm{e}}^- & \rightarrow & \mathrm{e}^+\mathrm{e}^- \\
1 & & 9 & & 0 & & 23 & & 0 & & 37\,293 \\
1 & & 10^2 & & 10^2 & & 10^3 & & 2 \times 10^3 & & 3 \times 10^9
\end{array}$$

The underlined symbols indicate newborn, "frozen" particles that immediately turn into dynamically interacting particles. The first row of numbers indicates time elapsed during each stage of the evolution of matter in units of $t_c \approx 10^{-19}$ s. The second row of numbers displays the quantity of particles in each phase; hence, phase 1 begins with one D particle and ends with (about) 100 photon pairs resulting from tauon-pair annihilation; phase 2 begins with 100 spinless-muon pairs and ends with (about) 1000 photon pairs; and phase 3 begins with 2000 electron pairs (rematerialized pairwise from pairs of photons, $\gamma_\mu\gamma_\mu \rightarrow \mathrm{e}^+\mathrm{e}^-\ \mathrm{e}^+\mathrm{e}^-$) and ends with about 3 billion background photons.

The big bang

With the final result (matter's dominance over antimatter) and the universe's early evolution known, it is easy to foresee the next development: a proton pair replaces the last electron pair as carrier of the universe's mass ($\mathrm{e}^+\mathrm{e}^- \rightarrow \mathrm{p}\bar{\mathrm{p}}$) after which the antiproton decays into an electron ($\bar{\mathrm{p}} \rightarrow \mathrm{e}^-$), thereby releasing enough kinetic energy to heat the now stable matter (pe^-) to around a trillion Kelvin (10^{12} K) [see p. 16, Heat]. However, two questions need answers:

1. Why is the proton heavier than the electron?
2. How does the proton pair get its mass?

To answer the first question, one must understand the nature of "frozen particles" [see p. 7, Frozen particles]. SM itself provides the answer to the second question if one assumes that every appearing elementary particle is assigned a precisely defined task.

The Higgs-neutrino mechanism

It turns out that the proton acquires its large mass ($m_p = 1836.15\, m_e$) through what might be called the Higgs-neutrino—or more precisely H–Z^0–3HνW^+W^-—mechanism, which completes the big picture of the evolution of matter:

$$\begin{array}{ccccccccccccccccc}
\mathrm{D} & \rightarrow & \tau_0^+\tau_0^- & \rightarrow & \underline{\mu}_0^+\underline{\mu}_0^- & \rightarrow & \mu_0^+\mu_0^- & \rightarrow & \underline{\mathrm{e}}^+\underline{\mathrm{e}}^- & \rightarrow & \mathrm{e}^+\mathrm{e}^- & \rightarrow & \text{Higgs-neutrino mechanism} & \rightarrow & \mathrm{p\bar{p}} & \rightarrow & \mathrm{pe}^- \\
1 & & 9 & & 0 & & 23 & & 0 & & 37\,293 & & 1000 & & 0.0 & & \infty \\
1 & & 10^2 & & 10^2 & & 10^3 & & 2\times10^3 & & 3\times10^9 & & & & & &
\end{array}$$

with the Higgs-neutrino mechanism in brief:

$$\begin{array}{cccccccccccccc}
\mathrm{e}^+\mathrm{e}^-\ \mathrm{e}^+\mathrm{e}^- & \rightarrow & \underline{\pi}^+\underline{\pi}^-\ \underline{\pi}^+\underline{\pi}^- & \xrightarrow{\mathrm{H}} & \pi^+_-\pi^-_-\ \pi^+_-\pi^-_- & \rightarrow & \pi^+_-\pi^-_- & \xrightarrow{\mathrm{Z}} & \pi^+_+\pi^-_- & \rightarrow & \pi^+_+\pi^-_+ & \xrightarrow{3\mathrm{H}\nu\mathrm{W}} & \mathrm{p\bar{p}} \rightarrow & \mathrm{pe}^- \\
 & & 0 & & 10^{-5} & & 10^{-5} & & 10^3 & & 10^{-5} & & 10^{-5} & \infty
\end{array}$$

Again, the numbers in the row directly above indicate time duration in terms of the basic time unit t_c, suggesting that the transformation of unstable electronic matter (e^+e^-) to stable proton-electron matter (pe^-) takes about $1000\, t_c$ or 0.1 fs (10^{-16} seconds).

After the last electron pairs have transformed into frozen pion pairs (underlined), Higgs particles (H) ejected by virtual leptons appearing in the propagators of the background photons (see figure on p. 1) deliver their mass to the u and d quarks, which form the pions. The quarks, in turn, use the mass they receive to transform the pions into dynamically interacting, physical particles.

Within less than $10^{-5}\, t_c$ (or about 10^{-24} s), one of the pion pairs annihilates via strong interaction.

After a lapse of another $10^{-5}\, t_c$, the imminent annihilation of the remaining pion pair is prevented by the neutral Z boson coming to the rescue—switching the intrinsic parity [see p. 14] of one of the pions ($\pi^+_- \rightarrow \pi^+_+$), thereby inhibiting strong decay of the pair. However, in about $10^3\, t_c$, the weak parity-switching force brought by the Z causes a second, now spontaneous change of pion intrinsic parity, which again enables strong decay of the pion pair ($\pi^+\pi^- \rightarrow \gamma\gamma$).

The comparatively long time that elapses between the two parity-switching events introduces a small asymmetry between pion (π^+) and antipion (π^-)—that is, between matter and antimatter [see p. 15, The superweak force].

With the universe's pionic matter doomed to extinction, it has to be replaced by protonic matter. A set of three Higgs particles are assigned the task of delivering three times as much mass to the quarks as the original Higgs particle had delivered.

Part of this mass remains unused by the quarks and is restored to the donors—that is, the virtual leptons—by neutrinos (ν), which to accomplish their task require help from charged W bosons.

With all of the universe's matter contained in a single proton pair, the pair's annihilation is forbidden by the law of conservation of energy, which instead forces the antiproton to decay into an electron ($\bar{\mathrm{p}} \to \mathrm{e}^-$). The antiproton decay introduces kinetic energy and heats the now stable particles p and e^- (defined as matter with the oppositely charged negative proton $\bar{\mathrm{p}}$ and positive electron e^+ defined as antimatter).

For a discussion of the universe's later development, see Gravity [p. 9] and Black holes [p. 17].

Four types of particles contribute to the Higgs-neutrino mechanism: the spin-0 Higgs (H), the spin-1 Z and W, and the spin-$\frac{1}{2}$ neutrino (ν). The neutrino [see p. 14], Z, and W particles have been experimentally detected while the Higgs only has been indirectly observed [see p. 13, Higgs observations].

DETAILS

Some features of the universe are discussed in a little more detail below. More information may be found via http://www.physicsideas.com/Index.doc, which contains links to related articles. For example, reference [Index.doc W6, 20] indicates that the subject is discussed on page 6 in the iTWire article http://www.itwire.com/content/view/26822/1066 and on page 20 in http://www.physicsideas.com/Paper.pdf. For a complete list of articles, see Index.doc. The Fortran source code of the simulation program discussed on page 6 is listed in http://www.physicsideas.com/Simulation.for.

For a compact summary of the logic underlying xSM, see Appendix G in Paper.pdf [Index.doc 50]. Note, however, that Paper.pdf was written before the precise roles of the weakly interacting particles (that is, the details of the Higgs-neutrino mechanism) were understood.

Contents

Simulation program

A computer simulation [Index.doc 44] of the evolution of the universe suggests that the tauon-muon mass ratio, the fine-structure constant α, the muon-electron mass ratio, and the photon-baryon number ratio are numerically calculable with arbitrary precision [Index.doc 48, 56]. For details, see source code and documentation in http://www.physicsideas.com/Simulation.for.

So far, attempts to calculate α have failed [Index.doc Y5, 63–65]. However, using the experimentally known values of α and m_τ/m_μ, a quite precise theoretical value is obtained for the ratio m_μ/m_e: 206.768 283 185(78), which may be compared with the 2006 CODATA experimental value of 206.768 2823(52) [Index.doc C].

The successful simulation was preceded by dozens of failed attempts during a period of fifteen years. Only when the simulation was performed in a "global picture" [see p. 7, The energy law's global role] where both the speed of light c and particle lifetimes τ increase over time, did it become possible to adjust the input parameters of the program in such a way that its output fitted the observed photon-baryon number ratio and the two lepton mass ratios.

An unexpected discrepancy between a standard mass calculation (performed in the "local picture" where τ and c are constant) and the corresponding computation in the global picture revealed that a comparatively long time elapses between the decays of the two pion pairs. The fact that this time difference approximately equals the neutral pion's lifetime of about 10^{-16} s demonstrates that the last pion pair decays weakly and not strongly (as one would expect) within about 10^{-24} s [Index.doc 41]. The extra delay, in turn, indicates that the energy law prevents immediate annihilation of the universe's last matter by forcing one of the two matter-carrying real pions (π^+ or π^-) to switch parity. See p. 14, Intrinsic parity.

Another surprisingly detailed revelation made by the simulation program is that the number of (entangled pairs of) particles does not grow as $N = t^2$ (with the universe's global age t measured in units of its initial age t_c) but as $N = (t - 1)^2$ [Index.doc 46–47]. This result suggests that, from its birth at $t = 1$ until $t = 2$, the D particle [see p. 12] is the sole inhabitant of the universe. In other words, the simulation contradicts my original assumption that the primordial particle is synonymous with a pair of spinless tauons. Instead, it indicates that the D particle *is* the nascent universe—an oscillating spacetime bubble, which is forced by the energy of its oscillation to expand and decompose into oppositely charged component particles ($D \to \tau^+\tau^-$).

For the simulation to produce a realistic result, one must assume that both the D particle and tauon pair have a lifetime (or mean life) of $\tau = 1$. This fact suggests that the first oscillation begins at $t = 0$ and ends at $t = 1$ when it has produced a physical universe (a "relativistic harmonic oscillator" described by Dirac's "new equation" [Index.doc D]) out of literally nothing. Then, a second oscillation leads to the D particle's disintegration at $t = 2$.

Going into a little more detail, one might imagine that the evolution of the primordial particle proceeds as follows. Beginning at time $t = 0$, an oscillation—that is, a quantum of energy—builds up from literally nothing until its physical delivery at time $t = 1$ signals the birth of the D particle together with the universe it defines. Unable to reproduce itself, the D particle is the sole inhabitant of the universe. Because of its limited lifetime (i.e., mean life or average life) of $\tau = 1$, the particle soon decays. However, unlike Schrödinger's famous cat [Index.doc

51, 58], which is dead and alive at the same time, the primordial particle may simultaneously take on three shapes: dead after annihilating into a pair of photons (D $\rightarrow \gamma_\tau\gamma_\tau$), alive in its original shape (D), and alive in the form of a tauon pair ($\tau^+\tau^-$) it has decayed into. The D particle's decay into a tauon pair creates the electric force and the ability of particles to reproduce themselves. Which, in turn, leads to cloning and multiplication of particle pairs in the expanding universe until the last massive pair out of perhaps 86 pairs in total annihilates at about $t = 10$ [Index.doc 46].

Because the simulation is performed in the global picture where τ grows from its initial value of t_c (or 1), the age of the universe is now considerably greater than $10\,t_c$ in our local (standard) picture, where time is measured in units of $\tau = t_c =$ constant. Compare with p. 17, The age of the universe.

Frozen particles

Frozen or stationary particles are described by equations without time dependence (stationary differential equations). See p. 10, A stationary space equation.

Both the spinless muon and spinning electron are born in the form of stationary particles that immediately turn into dynamically interacting, physical particles ($\gamma_\tau\gamma_\tau \rightarrow \underline{\mu}_0^+\underline{\mu}_0^- \rightarrow \mu_0^+\mu_0^-$ and $\gamma_\mu\gamma_\mu \rightarrow \underline{\mathrm{e}}^+\underline{\mathrm{e}}^-\ \underline{\mathrm{e}}^+\underline{\mathrm{e}}^- \rightarrow \mathrm{e}^+\mathrm{e}^-\ \mathrm{e}^+\mathrm{e}^-$) with their mass deriving from virtual photons ($m_{\mu_0} = m_{\mu_0}(\gamma_\mu)$ and $m_e = m_e(\gamma)$, respectively). Since the two particles do not contain conserved "mechanical" mass components [see p. 12, The JBW theory], the dynamical particles acquire the same mass as the stationary particles from which they evolve.

Similarly, the last annihilating electrons are recreated in the form of stationary pions ($\mathrm{e}^+\mathrm{e}^-\ \mathrm{e}^+\mathrm{e}^- \rightarrow \underline{\pi}^+\underline{\pi}^-\ \underline{\pi}^+\underline{\pi}^-$) of the same mass as the electrons. The stationary pions are split into stationary d and u quarks with total mass conserved. Since the stationary masses are defined at the birth of the quarks and remain conserved, also the dynamical masses of the quarks, as well as the dynamical mass of the charged pion, are predefined. Therefore, the transformation of electronic matter to pionic matter requires an energy injection of $4(m_{\pi^\pm} - m_e)c^2$. This energy must be transferred from the background photons to the newborn quarks making up the pions.

The energy law's global role

A credible model for the early universe must explain three numbers: the tauon-muon mass ratio (about 17), the muon-electron mass ratio (about 207), and the photon-baryon number ratio (of order 10^9). A computer simulation [see p. 6] of the universe's early evolution shows this is possible provided that energy is globally conserved. That is, in a volume (V) coexpanding with the universe, particle rest energy grows to compensate for the decrease in radiation energy experienced by the massless background photons because of the increase in their wavelength (λ) caused by the expansion. For the QED universe, this implies that [Index.doc W4]

$$Mc^2 + Nhc/\lambda = \text{constant}, \tag{1}$$

where M is the mass of all electrons (positive and negative) in V, N the number of background photons, and h the Planck constant. With M, N, and h constant, Eq. (1) implies that the speed of light c increases over time, but at a slower rate than the wavelength λ is stretched.

For the view (showing a varying c) of the universe presented by this "global picture" to be compatible with the view (showing a constant c) presented by our familiar, "local picture" of the world, time must be measured differently in the two pictures. If τ is the lifetime (or mean life) of a radioactive particle, one might expect that a distance $c\tau$ measured in the local picture (where it is constant because c and τ do not change over time) should be constant in the global picture, too. That is, particle lifetimes should decrease to compensate for the increase in c.

However, the computer simulation demonstrates that in the global picture particle lifetimes grow with c, which means that the distance $c\tau$ increases, too.

If the universe was governed by the rules of classical physics, the two pictures would be irreconcilable: a well-defined distance, $c\tau$, cannot both grow over time and be constant in time. See p. 18, False premises of elementary particle physics. However, in our actual (quantum) universe, there does not exist well-defined distances—a fact that the famous "spooky action at a distance" demonstrates. See p. 11, Distance indeterminacy.

Conservation laws rule the world—and explain it

According to our familiar, local picture of the world, the laws of conservation of charge, mass, energy, linear momentum, and angular momentum govern processes in physics, chemistry, biology, astrophysics, etc. In relativistic theories such as QED, the laws of conservation of energy and linear momentum combine into one law: conservation of four momentum [Index.doc 66]. In addition to governing more-or-less instant processes, the conservation laws imply constancy over extended periods of time. For instance, the electron's mass m_e, its rest energy $m_e c^2$, and (consequently) the speed of light (c) are the same today as they were before stars began to form. Also particle lifetimes (τ) are constant; uranium-235 still has the same half-life ($T_{1/2} = \tau \log 2$) as it had when heavy elements were first produced in supernova explosions.

Not only do the conservation laws rule the world; they also explain the world. Together with the standard model of particle physics (SM), they explain why and how the presently existing elementary particles and the forces acting between them came to be — this is one of the fundamental features of xSM.

The law of conservation of momentum applied to a fluid is given by Eq. (2) on page 9. It has a particular solution, the "stationary space equation" (7) [p. 10], which explains charge, spin, and creation of space. Creation of space, in turn, explains the universe's expansion and the gravitational force.

In the global picture of the world (when looking at large regions coexpanding with the universe) the law of conservation of energy affects matter differently than it does in the local picture. See page 7, The energy law's global role. Thus, the law in its global form (with particle lifetimes and c increasing over time) explains why the universe was forced to evolve from a maximally symmetric, single-particle universe to a matter-dominated universe containing three generations of leptons and quarks. Since it governed in detail the symmetry-breaking events that once took place, the law of conservation of energy enables physicists to mathematically simulate the early evolution of the universe. See page 6, Simulation program.

Gravity

Gravity is a force acting between masses that possess well-defined positions relative to each other. In the newborn universe, position of its entangled particle pairs is undefined and gravitational effects do not exist [Index.doc Y2].

Gravity is but a consequence of the universe's expansion and cannot, therefore, affect the expansion. This fact implies that gravity must exert a long-range repulsive force on the universe to counterbalance its short-range attractive force and produce a null overall global force [Index.doc 12–14].

That is, if one considers a particle at the epoch before macroscopic structures have begun to form and matter is still evenly distributed throughout the universe, balance requires that the sum of the gravitational very-long-range pushing and shorter-range pulling forces exerted on the reference particle by all other particles in a given solid angle must add up to zero.

Because gravity is linked to expansion, it weakens with time. Today, the gravitational force between two electrons is about 10^{-40} times the corresponding electromagnetic force. When gravity began to act (after stable matter in the form of protons and electrons had appeared), it may have been some 10^{30} times stronger than today. See p. 17, Black holes.

The expanding universe

Expansion is caused by creation of space. Creation of space, in turn, is a property of the elementary particles that make up the universe. Thus, electric charge, spin, and creation of space are properties unified in a single equation describing the frozen electron [see p. 10, A stationary space equation].

The pressureless momentum equation

The momentum equation—also referred to as the fundamental hydrodynamic equation—describes the motion of fluids (liquids and gases). It derives from the law of conservation of momentum (Newton's second law of motion) and connects a fluid's velocity ($\boldsymbol{v}$) and pressure (p) to its density (ρ). For a nonviscous fluid [Index.doc 29],

$$\frac{\partial \boldsymbol{v}}{\partial t} - \boldsymbol{v} \times (\nabla \times \boldsymbol{v}) + \frac{1}{2}\nabla \boldsymbol{v}^2 + \frac{1}{\rho}\nabla p = 0 \tag{2}$$

holds in the absence of external forces. For an ideal gas and an adiabatic process (a process in which heat does not enter or leave the system), $p\rho^{-\gamma} = p_0\rho_0^{-\gamma}$, where γ is a numerical constant. That is, $\nabla p = p_0\rho_0^{-\gamma}\nabla\rho^\gamma$, from which follows that $\frac{1}{\rho}\nabla p = p_0\rho_0^{-\gamma}\rho^{-1}\nabla\rho^\gamma = p_0\rho_0^{-\gamma}\frac{\gamma}{\gamma-1}\nabla\rho^{\gamma-1}$ (since normal rules of derivation apply to the gradient: $\rho^{-1}\frac{\mathrm{d}}{\mathrm{d}x}\rho^\gamma = \frac{\gamma}{\gamma-1}\frac{\mathrm{d}}{\mathrm{d}x}\rho^{\gamma-1}$ because both expressions equal $\gamma\rho^{\gamma-2}\frac{\mathrm{d}}{\mathrm{d}x}\rho$). Thus, elimination of p from Eq. (2) yields

$$\frac{\partial \boldsymbol{v}}{\partial t} - \boldsymbol{v} \times (\nabla \times \boldsymbol{v}) + \nabla\left(\frac{1}{2}\boldsymbol{v}^2 + \frac{\gamma}{\gamma-1}p_0\rho_0^{-\gamma}\rho^{\gamma-1}\right) = 0. \tag{3}$$

Introducing the velocity of sound v_0 and the number of degrees of freedom f via $v_0^2 = \gamma p_0/\rho_0$

and $\gamma = 1 + 2/f$, which hold for an ideal gas [Index.doc 29], Eq. (3) becomes

$$\frac{\partial \boldsymbol{v}}{\partial t} - \boldsymbol{v} \times (\nabla \times \boldsymbol{v}) + \frac{1}{2} v_0^2 \, \nabla \left(\left(\frac{\boldsymbol{v}}{v_0} \right)^2 + f \left(\frac{\rho}{\rho_0} \right)^{2/f} \right) = 0. \tag{4}$$

The value of f is 3 for monatomic, 5 for diatomic, and 6 for polyatomic molecules (such as He, O_2, and CO_2, respectively).

A stationary space equation

The momentum equation—also referred to as the fundamental hydrodynamic equation—describes the motion of fluids (liquids and gases). It derives from the law of conservation of momentum (Newton's second law of motion) and connects a fluid's velocity ($\boldsymbol{v}$) and pressure (p) to its density (ρ). For the potential (or irrotational) flow of a nonviscous fluid,

$$\frac{\partial \boldsymbol{v}}{\partial t} + \frac{1}{2} \operatorname{grad} \boldsymbol{v}^2 + \frac{1}{\rho} \operatorname{grad} p = 0 \tag{5}$$

holds in the absence of external forces [Index.doc 29, 58]. For an ideal gas, elimination of p [see p. 9, The pressureless momentum equation] results in the equation,

$$\frac{\partial \boldsymbol{v}}{\partial t} + \frac{1}{2} v_0^2 \operatorname{grad} \left(\left(\frac{\boldsymbol{v}}{v_0} \right)^2 + f \left(\frac{\rho}{\rho_0} \right)^{2/f} \right) = 0, \tag{6}$$

which in its stationary ($\partial \boldsymbol{v} / \partial t = 0$) form has the solution

$$\rho = \rho_0 \left(1 - \frac{1}{f} \frac{\boldsymbol{v}^2}{v_0^2} \right)^{f/2}, \tag{7}$$

where v_0 is the velocity of sound in the gas and f the number of degrees of freedom of the gas molecules.

Imagining that space in some respects may be compared to a physical fluid, one must assume that, unlike a gas, space cannot possess internal pressure (which would make it rapidly thin out unless the entire universe was contained in a kind of pressure cooker). Therefore, one may try to apply Eq. (7) to space, assuming it to be a kind of pressureless "space equation" that describes a "static" or "frozen" elementary particle (such as the electron) as a stationary whirl in space.

The density of a gas is defined as mass per volume ($\rho = m/V$), while its pressure results from molecules bouncing off each other. The fact that space must lack pressure suggests that it lacks molecules, too. Consequently, ρ should not be looked upon as mass (or number of molecules) per volume, but must be regarded as a fundamental, unobservable property of space. Also, the nonexistence of "space molecules" means absence of an intrinsic yardstick in space. In other words, space cannot be used as a coordinate system for position determination.

Since the number of degrees of freedom appearing in the space equation (7) cannot characterize molecules, it must instead characterize the velocity $\boldsymbol{v}$ of the flow. Thus, $f = 3$ should be associated with a spherically symmetric rotation that gives rise to the electric charge and rest energy (or mass) of charged spinless (μ_0 and τ_0) and spinning (e, μ, and τ) leptons. Similarly, $f = 2$ apparently is linked to a cylindrically symmetric rotation responsible for the spin of the electron, muon, and tauon. Finally, energy causes creation of space that leads to an essentially one-dimensional ($f = 1$) flow of space away from the particle. This effect, in turn, causes expansion and gravity [Index.doc 8–9, 12–14].

A detailed analysis of Eq. (7) shows that it may be used to picture a newborn electron, which instantly—retaining its nascent mass, charge, and spin—transforms into a dynamical particle: the familiar electron described by QED.

The distribution of energy described by Eq. (7) is characterized by a numerical "lepton structure constant," $B = 0.666\ 001\ 731\ 498$ [Index.doc 31], which connects the muon-electron mass ratio to the fine-structure constant $\alpha = 1/137.035\ 999$ via [Index.doc 11, 17]

$$m_\mu/m_e = 1/B\alpha = 205.759\ 223. \tag{8}$$

Upon addition of corrections [Index.doc W8, H7, 20–22, 39–40] to the masses of the three charged leptons, the mass ratio becomes

$$m_\mu/m_e = 206.768\ 2832(1) \tag{9}$$

in agreement with the 2006 CODATA value of 206.768 2823(52) [Index.doc W2, C].

Nature of space

The fact that the pressureless "space equation" (7) lacks reference to molecules suggests space—unlike abstract mathematical coordinate systems—is not made up from "space points" or space molecules [Index.doc X3].

Consequently, there is no way of defining position in empty space. In a pointless space, the position of a particle is only defined in relation to other particles with which it interacts. In such a space, quantum phenomena—instead of being counterintuitive—are a logical necessity [Index.doc 35].

In a universe where position, and consequently also distance and direction, is undefinable, the global and local pictures [see p. 7, The energy law's global role] do not conflict with each other.

Distance indeterminacy

The space equation (7) on page 10 is assumed to describe the three known charged leptons (e, μ, and τ), which according to observations would be identical in all respects ("lepton universality") if it was not for their different masses (approximately relating to each other as $1:207:3277$). This general description of three particles by a single equation is possible because the lepton radius r_0 [Index.doc 9], which is the only length or distance appearing in the space equation, may take on different values in different connections. That is, the values of the electric, spin, and gravitational radii of the three leptons (r_e, r_{es}, r_{eg}; r_μ, $r_{\mu s}$, $r_{\mu g}$; r_τ, $r_{\tau s}$, $r_{\tau g}$) may differ from each other even though they all appear as "r_0" in the defining equation [Index.doc 16, 35].

Distance indeterminacy is not a feature peculiar to the pure QED universe, but still applies today. Also, it is not restricted to the microscopic world of elementary particles. Thus, the so-called spooky action at a distance, or EPR paradox [Index.doc 35], may be observed over unlimited distances. Another consequence is that a macroscopic length defined as the speed of light c multiplied by a particle's lifetime τ or half-life $T_{1/2} = \tau \log 2$ (such as the muon's 2.2 microsecond lifetime or the uranium-238 nuclide's 4.5 billion year half-life) may be constant in one picture and grow in another. This fact explains why both c and τ, as well as particle rest energy (mc^2), may increase over time in the global picture while they remain constant in the local picture. See p. 7, The energy law's global role.

Dirac's neutral particle (D)

In 1971, Paul Dirac published a paper titled *A positive-energy relativistic wave equation* (Proc. R. Soc. Lond. A322, 435). The equation describes a massive particle that has precisely the characteristics wanted from a primordial particle defining a newborn universe [Index.doc D].

Thus, being maximally symmetric (that is, neutral and spinless), the particle defines the physical state that is closest to the perfectly symmetric state of literally nothing (the state of ultimate simplicity). Therefore, the spontaneous breaking of the symmetry of literally nothing that must occur (because undeniably a universe containing matter is possible, there is a nonzero probability for the transition, which can only take place at the beginning of time) should result in a single D particle [Index.doc 51, 57–58].

The D particle pops up in literally nothing to define a one-particle expanding spacetime bubble of finite (that is, nonzero) dimensions [Index.doc F]. Thus, the universe is born at a finite age—the time of creation, t_c, which may be defined as the natural time unit ($t_c = 1$). Also, see page 18, False premises of elementary particle physics.

Spinor QED

Spinor QED—or QED for short—describes interactions between the electrically charged spin-$\frac{1}{2}$ leptons (τ, μ, and e) and the photon [Index.doc W6].

Scalar QED

Scalar QED describes interactions between leptons and photons before the former particles (the spin-0 bosons τ_0 and μ_0) acquire spin [Index.doc W6].

The JBW theory

In the early 1960s, Kenneth Johnson, Marshal Baker, and Raymond Willey developed a perturbation theory "within the usual formalism of quantum electrodynamics" in which the electron's mass equals its self-mass ($m = \delta m$), implying that "the electron mass must be totally dynamical in origin." In other words, the electron's rest energy mc^2 originates from virtual photons that form the electron. Other virtual particles give small additional contributions to the electron mass. To lowest (second) order in perturbation theory, the sum of the contributions from photon and Higgs is [Index.doc B2, 33]

$$\delta m^{(2)}(\gamma) + \delta m^{(2)}(\mathrm{H}) = \ln \frac{\Lambda}{m} \left(\frac{3\alpha}{2\pi} + \frac{3G_F m^2}{8\sqrt{2}\pi^2} \right) m, \tag{10}$$

for the renormalized (i.e., physical) mass m of the electron. Here, Λ is an ultraviolet (UV) cutoff mass introduced to make the mathematics finite. Finite terms of order unity are not shown, since they are negligible in comparison with the leading, divergent terms. Equation (10) suggests that the ratio between the Higgs and photon contributions to the electron mass is [Index.doc B2]

$$\frac{m(\mathrm{H})}{m(\gamma)} = \frac{G_F m^2}{4\sqrt{2}\pi\alpha} = 2.348\ 476(20) \times 10^{-11}. \tag{11}$$

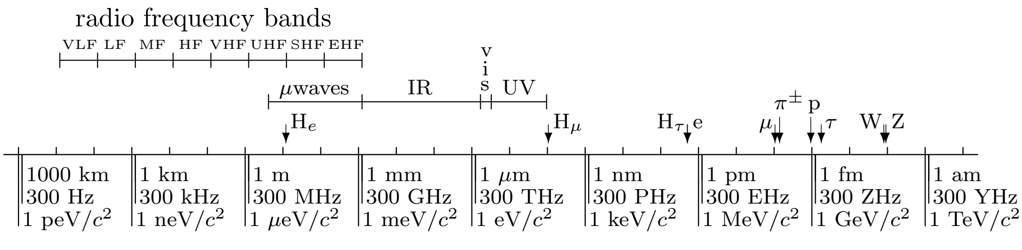
The Higgs mass

In the QED universe, the electron mass is of purely photonic origin. The appearance of the Higgs causes the mass to split into two components. Assuming that there exists a connection between the mass component deriving from the Higgs and the mass of the Higgs itself, the only possible precise and unambiguous prediction for the Higgs mass is $m_H = m(\mathrm{H})$, which gives

$$m_H/m = G_F m^2/4\sqrt{2}\pi\alpha \tag{12}$$

for the Higgs-to-electron mass ratio when $m(\gamma)$ is set equal to m [Index.doc B2]. Letting m equal, in turn, m_e, m_μ, and m_τ gives the corresponding masses for Higgs particles emitted by electrons, muons, and tauons, respectively. Thus, $m_{H_e} = 12.0007(1)\ \mu\mathrm{eV}/c^2$, $m_{H_\mu} = 106.086(1)\ \mathrm{eV}/c^2$, and $m_{H_\tau} = 0.505\ \mathrm{MeV}/c^2$ [Index.doc E2, H4]. Compare with the electron mass $m_e = 0.510\ 9989\ \mathrm{MeV}/c^2$ [Index.doc E20].

The figure indicates the masses of the predicted Higgs boson (H_e, H_μ, or H_τ) relative to the masses of the charged leptons (e, μ, and τ), the charged and neutral weakly interacting spin-1 bosons (W and Z), and the charged pion and proton ($\pi^\pm$ and p), which are composite particles built from two and three quarks, respectively [Index.doc E3]:



Higgs observations

When the quarks appear, the universe contains about 2 786 275 000 photons [Index.doc 53] from which the energy needed to give four pions their dynamical mass has to be obtained with the help of the Higgs. The main contributor to the pion mass is the tauon appearing in the propagator of one out of 137 photons [Index.doc 38] (a statement that should be understood in a "quantum probabilistic" sense, since the background photons form identical and indistinguishable pairs—a single ubiquitous two-photon particle state).

After the lepton has ejected a Higgs with mass fixed by Eq. (12), the Higgs continues its existence as a virtual particle in the lepton propagator. This virtual Higgs should affect the anomalous magnetic moment (a) of the lepton, which via $g = 2(1+a)$ is related to the so-called lepton $g-2$ [Index.doc B1]. And, indeed, the E821 muon $g-2$ experiment at Brookhaven convincingly demonstrates the presence of a Higgs of mass $m_{H_\mu} \ll m_\mu = 105.658$ MeV/c^2 [Index.doc B3, E20].

Similarly, the Pioneer anomaly [Index.doc B4, E13, Z9] seems to confirm the prediction of an electron-type Higgs of mass in the microwave region of the spectrum [Index.doc E3]. (The rest energy $m_{H_e}c^2 = 12.0007$ μeV equals the energy of a photon of frequency 2.9018 GHz [Index.doc E2]. Compare with the standard 2.45 GHz frequency used in microwave ovens.)

Higgs ghosts

In the Feynman-'t Hooft gauge, there are three so-called "Higgs ghosts"—one neutral and two charged particles. They are spin-0 analogues of the spin-1 Z^0 and $W^\pm$ particles [Martinus Veltman's *Diagrammatica*, page 259]. Their role in electroweak theory is purely algebraic, which means that they do not correspond to physical particles.

Therefore, the Higgs ghosts do not take part in the Higgs-neutrino (or H–Z^0–3HνW^+W^-) mechanism, where the only conveyors of mass are the Higgs particle (H) and the neutrino (ν). See p. 19, Corrections.

The neutrino

The neutrino is its own antiparticle [Index.doc H10], and oscillates between three mass states [Index.doc Z3, H11]. For speculations about its internal structure, see p. 16, The origin of mass.

Intrinsic parity

Elementary particles and simple composite particles often possess a definite—positive or negative—intrinsic parity. Thus, the photon, pions, and positively charged leptons (e^+, μ^+, and τ^+) have negative intrinsic parity, while protons (both the positive p and negative $\bar{p}$) and the negatively charged leptons (e^-, μ^-, and τ^-) have positive parity [Index.doc 41].

Parity (indicated in subscript) is conserved both in electromagnetic interactions ($e^+_-e^-_+ \to \gamma_-$) and in strong interactions, for example in $\pi^+_-\pi^-_- \to \gamma_-\gamma_-$ and $p_+\bar{p}_+ \to \gamma_-\gamma_-$ with positive overall parity of the pion and photon pairs: $(-1)(-1) = +1$.

The appearance and subsequent influence of the weakly interacting Z boson cause the real, matter-carrying pions to reverse their intrinsic parity before passing it on to the protons ($\pi^+_-\pi^-_- \to \pi^+_+\pi^-_- \to \pi^+_+\pi^-_+ \to p_+\bar{p}_+ \to p_+e^-_+$). The time that elapses between the switchings of intrinsic parity of the two charged pions is sufficently long to produce a detectable matter-antimatter asymmetry, which, for instance, announces its presence in kaon decay [see p. 15, The superweak force].

The superweak force

The CPT theorem states that simultaneous application of charge (C), parity (P), and time (T) reversals to a particle leaves it unchanged. For instance, since the negatively charged electron has positive parity (indicated in subscript), the operation $CP(\mathrm{e}^-_+)$ results in a positron (e^+_-) of negative parity. Because the positron is mathematically described as an electron moving backward in time, $T(\mathrm{e}^+_-)$ reproduces the original electron. That is, the CPT operation leaves the electron unchanged or invariant.

In the QED universe, particle interactions (such as $\mathrm{e}^+_-\mathrm{e}^-_+ \rightarrow \gamma_-$) violate neither C, P, nor T symmetry, since the photon is its own antiparticle.

The appearance of the weakly interacting Z particle introduces a new force capable of violating P symmetry and enabling annihilation of the neutral pion ($\pi^0_- \rightarrow \gamma_-\gamma_-$ with a lifetime of about 10^{-16} s). Because the neutral pion is its own antiparticle, T (or matter-antimatter) symmetry is conserved in the decay. It follows from the CPT theorem that CP symmetry, too, must be conserved while C (the neutral pion is composed of $\mathrm{u\bar{u}}$ and $\mathrm{d\bar{d}}$ quark pairs) and P symmetries are separately violated.

The time difference of about 10^{-16} s between the forced and the spontaneous switching of pion parity occurring in the Higgs-neutrino mechanism ($\pi^+_-\pi^-_- \rightarrow \pi^+_+\pi^-_- \rightarrow \pi^+_+\pi^-_+$) [see p. 3] by necessity introduces a small asymmetry between the pion ($\pi^+ = \mathrm{u\bar{d}}$) and its antipion ($\pi^- = \mathrm{d\bar{u}}$), and thereby between one of the quarks (presumably the d quark) and its antiquark—that is, between matter and antimatter. The computer simulation [see p. 6], reveals this fact because it shows that in the global picture [see p. 7, The energy law's global role], particle rest energy grows by one percent and particle lifetimes increase by 0.5 percent during the time that elapses between the two parity-switching events [Index.doc 41, 60]. Even if it is not obvious that this matter-antimatter asymmetry should cause detectable physical effects violating CP and T symmetries, a natural guess is that it lies behind the so-called "superweak force" observed in the decay of neutral kaons and B mesons [Index.doc 42, 53, 60]. Note that the neutral π meson is its own antiparticle and that both the neutral K and neutral B mesons contain a down quark: $\pi^0 = (\mathrm{u\bar{u}} - \mathrm{d\bar{d}})/\sqrt{2}$, $\mathrm{K}^0 = \mathrm{d\bar{s}}$, and $\mathrm{B}^0 = \mathrm{d\bar{b}}$ with $\bar{\mathrm{K}}^0 = \mathrm{s\bar{d}}$ and $\bar{\mathrm{B}}^0 = \mathrm{b\bar{d}}$.

Maybe the observed matter-antimatter asymmetry can be explained as follows. Let E_{π^+} be the rest energy of the pion when a parity-switching force, f_{π^+}, causes it to flip its intrinsic parity ($\pi^+_- \rightarrow \pi^+_+$). Denote by E_{π^-} and f_{π^-} the corresponding rest energy and force when a little later the antipion flips its parity ($\pi^-_- \rightarrow \pi^-_+$). As just mentioned, the pion rest energy grows by about one percent during the time interval between the two parity-switching events. Thus, $E_{\pi^-} > E_{\pi^+}$, which means that

$$f_{\pi^+}/E_{\pi^+} > f_{\pi^-}/E_{\pi^-} \tag{13}$$

holds if the force remains constant ($f_{\pi^-} = f_{\pi^+}$) or increases at a slower rate than the rest energy does. Interpreted in the local picture, where particle rest energy is constant, Eq. (13) implies that $f_{\pi^+} > f_{\pi^-}$. Therefore, one expects that $f_{\bar{\mathrm{K}}^0} > f_{\mathrm{K}^0}$, since both π^+ and $\bar{\mathrm{K}}^0$ contain a positively charged anti-d quark. Consequently, the antikaon should transform into a kaon more often than the kaon transforms into an antikaon.

Forces and particles

Forces are needed to create new matter from annihilating particles [Index.doc W7, 40]. Initially, no forces are present in the nascent universe (forces are mediated by particles, so there cannot be forces in a one-particle universe [Index.doc D]). In the universe's first two phases, spin is not globally defined (there is not a Planck constant h), and the only active force is purely electric. In phase 3, the electric force is replaced by the electromagnetic force, which together with the strong force appearing in phase 4, still governs the world today. The primary purpose of the auxiliary weak force is transport of mass (the Higgs-neutrino mechanism), while gravity is a direct consequence of creation of space, which is an inherent property of particles ($f = 1$ in Eq. (4) on page 10).

Mass comes in fixed quanta. Once a new particle has been created, its mass is preserved in virtual particles appearing in the photon propagator, but only as long as the particle is physically viable. Thus, the D particle ceases to exist when the electric force appears [Index.doc D2], and the virtual spinless μ_0 and τ_0 transform into spinning muons and tauons when the electric force is replaced by the electromagnetic force that transforms photons into pairs of electrons.

The origin of mass

From $E = mc^2$, it follows that mass (m) is rest energy (E) divided by the square of the speed of light (c). Particle rest energy, in turn, derives from oscillations, waves, or vibrations in space [Index.doc Z10]. Thus, the electron's mass arises from virtual, massless photons (that is, electromagnetic waves) appearing in its propagator [Index.doc B1].

In the global picture, particle rest energies grow at the same rate as c^2 ($E \propto c^2$), implying that particle masses are conserved both locally and globally.

The similarity between photons (spin-1 bosons) and spin-0 Higgs bosons suggests that the Higgs is formed by a photon bent into a ring to form a standing wave. The mass or rest energy of this closed vibrating string is determined by its frequency ν in the same way as the photon's energy is given by $E = h\nu$, where h is the Planck constant.

Similarly, the neutrino might resemble a closed string that vibrates with three superposed frequencies forming traveling waves, which make the particle's energy oscillate and give it spin [Index.doc B7].

Heat

When the process of forming a proton starts with the creation of pions and quarks, there are about $n_\gamma = 2\ 786\ 275\ 000$ background photons in the universe [Index.doc 53]. Consequently, once the proton (uud), which—together with the neutron (udd) and a number of unstable three-quark particles—belongs to the so-called baryons, has appeared, the photon-baryon number ratio is $n_\gamma/n_b = 2\ 786\ 275\ 000$. (This number remains constant until the first black hole is formed [Index.doc 61].) The antiproton's decay into an electron and (presumably electromagnetic) radiation signals the start of physical interactions between real particles and transforms the universe from a perfectly cold to a very hot world. It releases an energy of $(m_p - m_e)c^2 = 937.76$ MeV corresponding to a temperature of 1.09×10^{13} K [Index.doc 54, 60]. At this moment, the energy of the background photons is about 0.097 MeV, corresponding to $T = 1.126 \times 10^9$ K [Index.doc 53, 54].

Black holes

Black holes are abundantly produced at a time when gravity [see p. 9] is still very strong. They determine the large-scale structure of the universe [Index.doc W9, E16, C, 23, 26, 27, **54**, 61, 62, 78–80]. Thanks to the rapid expansion of the universe accompanied by a weakening gravity, not all of the universe's energy content is converted into black holes. As gravity weakens in strength, those black holes that do not merge into successively more and more massive ones evaporate. The result is a universe with the bulk of its mass (the so-called dark matter) coming in the form of a large number of presumably "Jupiter-mass" black holes [Index.doc E16, 78–80].

Spacetime

There is a fundamental difference between time and space: time ticks, space doesn't. That is, position in time is well-defined, while position in space is undefinable. See p. 11, Distance indeterminacy. Thus, the initial age of the universe, t_c, provides the natural unit of time used in the computer simulation [Index.doc 44], while "the variables r, ri, and rf were removed from the calculation to demonstrate the fact that r is an arbitrary parameter without precise physical meaning" (quote from beginning of http://www.physicsideas.com/Simulation.for).

The age of the universe

It follows from Dirac's large-number hypothesis (LNH) [Index.doc 7–8] that the Hubble expansion rate H decreases with increasing age t of the universe. In the global picture, $H = 1/3t$, which gives $t_0 = 1/3H_0 = 5.7$ Gyr (billion years) [Index.doc 19, 48] for the present age of the universe. In our local (standard) picture where $t_c \approx 10^{-19}$ s [Index.doc P4, 41] is constant, the universe is very much older [Index.doc 49], which means that G and H decrease so slowly that they appear to be constant. A constant H, in turn, implies an accelerating universe [Index.doc 37].

The Higgs mechanism

The success of the "hot" Higgs mechanism is generally taken as proof that the newborn universe was immensely hot. However, what it actually proves is that SM is a consistent model, which in theory is valid up to extremely high—in reality unattainable—energies where forces of different strengths (electromagnetic, strong, weak, and maybe even gravity) converge into a single force [Index.doc B8].

False premises of elementary particle physics

1. Space forms a coordinate system built from (coordinate) points

This assumption results from attributing physical meaning to abstract mathematical concepts. It appears implicitly in physical theories but is seldom explicitly worded.

Now, a point is an infinitely small "object." And infinity, in turn, is an abstract mathematical concept that should not be applied to real physics. Therefore, physical space cannot conceivably be composed of points.

When it is realized that space is not made up of points or "space molecules," much of the mystery of quantum physics disappears. Compare with page 11, Nature of space.

2. The law of conservation of energy does not apply to the expanding universe

This negative assumption is a consequence of the belief that space forms a coordinate system, which precisely defines position and distance. Compare with page 11, Distance indeterminacy.

It prevents cosmologists from building their theories on the solid base—the conservation laws—on which all experimentally verified physics securely rests.

3. The universe began as an "infinitely" small and hot point

This assumption implies that the universe is created in a transition from the perfectly symmetric state of literally nothing to an extremely complex physical state containing three families (or generations) of elementary particles, with the particles engaged in violent collisions with each other already at the exact instant of their birth.

It forms a sharp contrast to the assumption that the universe began via a transition from the maximally simple state of literally nothing to the next simplest state—a maximally symmetric one-particle universe void of forces and temperature.

This universe was described by Paul Dirac in 1971 [Proc. R. Soc. Lond. A322 (1971) 435]. His "new equation" pictures a single massive, spinless, and neutral particle that can only exist alone, in the absence of forces (since, when an electromagnetic field is introduced, Dirac's equations are no longer consistent). Compare with page 12, Dirac's neutral particle.

Unfortunately, Dirac did not realize his particle's potential of forming the universe's initial phase: an oscillating spacetime bubble with only its nonzero energy breaking an otherwise perfect symmetry. And, of course, without knowledge of the stationary space equation, he could hardly imagine that the bubble's oscillations generate space, which causes it to expand in accordance with his large-number hypothesis.

4. Gravity and expansion are unrelated phenomena that by chance happen to balance each other in a very delicate way

This assumption originated from the idea that the Einstein equations govern the evolution of the universe. It contradicted Dirac's large-number hypothesis (LNH), which suggested the existence of a direct connection between gravity and expansion [Index.doc 7–8]. However, no plausible connection between the two phenomena could be conceived of. Therefore, Dirac's hypothesis deduced from observation was abandoned in favor of the "gravitation-expansion balance hypothesis," which did not have any observational support. In fact, it was later found to conflict with observations, thereby leading theorists to assume the existence of an additional, repulsive force of unknown nature (compare with "Lambda," "dark energy," "quintessence").

With the discovery that the momentum equation is applicable to space, the situation has changed. The stationary space equation [see p. 10] reveales the connection: gravity is but a consequence of the expansion, which is determined by the energy content of the universe. Therefore, gravity does not affect the universe's overall expansion.

5. QED does not provide a consistent, self-contained physical theory

It has not been possible to obtain an explicit solution to the defining equations of QED. Instead, physicists use a "perturbative" approach, which yields solutions in the form of infinite series in powers of the fine-structure constant α. However, perturbative QED is notorious for its infinite renormalization constants and divergent series. These problematic features of the theory are generally taken to indicate that QED is an inconsistent theory. Which, if true, would suggest that a pure QED universe that only contains photons and charged leptons is physically impossible. Consequently, consensus among physicists has been that the theory of spinor quantum electrodynamics must be imbedded in a larger theoretical framework encompassing strongly and weakly interacting particles.

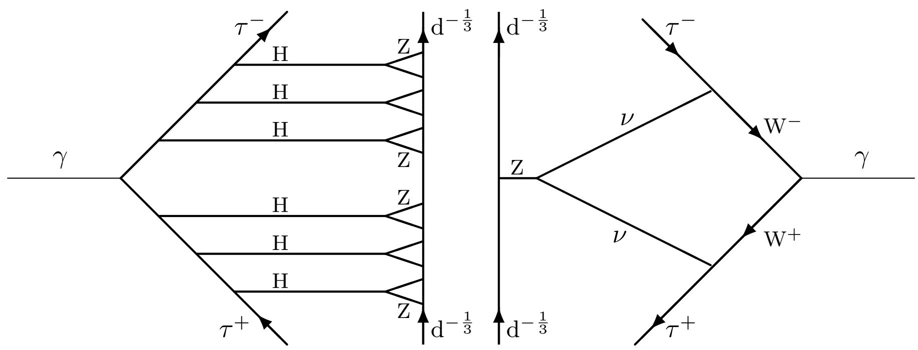
Still, the JBW theory [see p. 12] suggests that the assumption is wrong; that the QED theory may be rid of its infinities and thereby turned into a consistent, self-contained theory. If the JBW theory would have attracted a broader and more lasting interest in the 1960s, sooner or later somebody would have asked the question: What if our present universe was preceded by a pure QED universe with only electromagnetic forces acting in it? This question would have been immediately followed by the next one: Why didn't the QED universe annihilate into pure radiation? And to that question there would have been but one plausible answer: Because the law of conservation of energy forbade it. This answer, in turn, would have rapidly led to a description of the evolution of the universe including a mechanism explaining the creation of strongly and weakly interacting particles. And, it would have led Dirac in 1971 to suggest that his newly discovered equation describes the nascent universe.

Corrections

Common sense suggests that contributions from virtual particles to the masses of matter-carrying particles such as the electron should not be negative. That this is true for the Higgs contribution to the lepton mass is confirmed by the result in Eq. (10) on page 13, which is obtained through a direct calculation [Index.doc B2]. However, it was the erroneous negative result of my original calculation [Index.doc 33] that hinted at the solution to the problem of how the proton's creation from an electron is energetically possible. Still, the fact that the correction is positive does not invalidate the conclusion because the actual decrease in the lepton's mass is caused by its physical ejection of the Higgs, and does not have any direct coupling to the lepton self-mass produced by virtual Higgs particles in the lepton propagator.

The erroneous minus sign made me think that the birth of a new particle (its first appearance) might simultaneously cause leptons to decrease in mass and quarks to acquire energy (through some complex and to me unimaginable mechanism).

The plus sign instead suggests a maximally simple mechanism: emission and absorbtion of only two mass conveyors — the Higgs and neutrino particles. At its birth, the Higgs gets equipped with the mass needed to give four newborn pions life — that is, to transform them from static to dynamic particles. The next major step, transformation of a pion pair into a proton pair, requires renewed use of the existing Higgs particle together with employment of the neutrino — another conveyor particle that takes care of the unused mass. That is, the quarks emit pairs of oppositely spinning neutrinos, which deliver their mass to the virtual leptons — a process necessitating "neutrino oscillation."



In the figure, I further suggest that the absorption of Higgs particles and emission of neutrino pairs are mediated by the neutral Z particle. This implies that unphysical four-legged vertices do not appear in the diagram and that, independent of what their own masses may be, the quarks are able to absorb Higgs particles of any mass. Also, it provides another good reason why the Z particle should appear before the proton is formed.

For details about the vertices in the figure, see Veltman's *Diagrammatica*. From left to right (page and vertex number): 271.2, 271.5, 260.6, 269.4, 269.4, 270.8, 270.7 and 270.6, 259.1.

Paper.pdf
Page 6, Eq. (1.9): see p. 41, Eq. (E.16)
Page 23, Eq. (9.1): see B2, Eq. (1.3) ($- \to +$)
Page 25, line 1: see p. 40, Eq. (E.15)
Page 25, Eq. (10.3): see p. 41, Eq. (E.16)
Page 25, Eq. (10.4): see p. 41, line after Eq. (E.16)
Page 31, 3rd line from below: delete right parenthesis
Page 33, Eq. (C.2): see B2, Eq. (1.3) ($- \to +$)
Page 33, Eq. (C.4): see B2, Eq. (1.3) ($- \to +$ twice)
Page 34. last paragraph: see E1, last paragraph

Page 37, Appendix E.6: obsolete; see p. 24
Page 39, 3rd line after Eq. (E.8): flavor-changing → neutrino
Page 39, before Eq. (E.12): contribution → correction
Page 40, first line: contribution → correction
Pages 46–48: see pp. 39–41 and source code in Simulation.for
Higgs.pdf
Remove references to Higgs ghosts and Higgs triplets
Page 9, first full paragraph: delete from "but so slowly" to end of paragraph
Page 13, first figure: 49 000 → 37 293
Page 14, 4th paragraph: magnetic moment → reduced gyromagnetc ratio
Experiments.pdf
Sign of Higgs contribution ($\delta m^{(2)}(\mathrm{H}) > 0$, $m(\mathrm{H}) > 0$)
Draft.pdf
Sign of Higgs contribution ($\delta m^{(2)}(\mathrm{H}) > 0$, $\delta m(\mathrm{H}) > 0$)

Notes and questions

I have assumed that the Higgs comes in three masses determined by Eq. (12) on page 13 [Index.doc E3]. However, in *Higgs demystified* [Index.doc B7], I speculate that the similarity between photon and Higgs (their coupling to charged particles are described by analogous Feynman diagrams) implies that the Higgs in analogy with the photon may possess any energy given to it by the emitting particle, which would mean that it comes in nine mass states with its actual mass determined by the mass of the lepton or quark that emits it. If that is so, the top-type Higgs should be found somewhere between 400 and 600 GeV.

If free Higgs particles can be produced and observed, it should be possible to precisely pinpoint m_{H_e} and thereby obtain a very accurate value for the Fermi coupling constant G_F through Eq. (12) on page 13 [Index.doc E3].

How can a particle rotate in a spherically symmetric manner (interpretation of $f = 3$ in Eq. (7) on page 10)? The answer is that it cannot, and that the newborn particle's attempt at this impossible feat causes it to disintegrate into a cloud of virtual photons.

Shouldn't a 12 μeV virtual Higgs cause an attractive force between electrons—and thereby between atoms and molecules—of sufficiently long range for the force to be observable? The answer is that such a force would make the universe contract and therefore must not exist. That is, when calculating the force to all orders in perturbation theory, the result should be zero.

Is the proton stable or unstable? In other words, was the forced decay of the antiproton an unphysical, unrepeatable event, or did it proceed via the proton decay mehanism predicted by some "grand unified theory" (GUT), in which case it may have produced both electromagnetic and neutrino radiation? If the latter is true, was the antiproton decay accompanied by the appearance of superparticles and the graviton? Note, however, that simplicity [Index.doc 35] in the form of Occam's razor suggests that the only existing particles are those necessitated (and already described) by SM.

Updated on 2011-04-10/stigS

Added on 2011-11-30:

Contrary to what I state on page 48 in http://www.physicsideas.com/Paper.pdf, $t = R/3c = 1/3H = 5.7$ Gyr (F.13) is the local and global age that the universe would have if it did not contain any background photon or neutrino-type radiation undergoing expansion-related redshifting.

For further details and recent progress, see http://www.physicsideas.com/Conclusions.pdf — *On the origin of particles.*