The Big Bounce Theory

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Abstract: Over the past few years, we have been hearing the term "The Big Bounce Theory", quite a lot. The Big Bounce Theory is a hypothetical scientific theory of the formation of the universe which claims that our present universe was formed after the collapse of a previous universe, and that these cosmological events are repeated infinitely. As we know there are many models about the formation of the universe and we could write several articles about them, but in this article the Big Bounce is at the forefront of much discussion.
[Manjunath R. **The Big Bounce Theory.** *Academ Arena* 2018;10(2):1-12]. ISSN 1553-992X (print); ISSN 2158-771X (online). http://www.sciencepub.net/academia. 1. doi:10.7537/marsaaj100218.01.

Keywords: Big Bounce; Energy; Vibration; Quantum mechanics; Physical Constants; Universe.

In the beginning, there was nothing but a universe whose space was simply the lowest energy state of the universe. It was neither empty nor uninteresting, and its energy was not necessarily zero. Because $E = mc^2$ (the equation that represents the correlation of energy to matter: essentially, energy and matter were but two different forms of the same thing) and due to the fuzziness of quantum theory (that implied: photon carried mass proportional to its frequency i.e., $h\upsilon = mc^2$), some of the most incredible mysteries of the quantum realm (a jitter in the amorphous haze of the subatomic world) got far less attention than Schrödinger's famous cat. Virtual particle-antiparticle pairs of mass ($\Delta m = h\Delta\upsilon/c^2$) were continually created out of energy ΔE of the empty space consistent with the Heisenberg's uncertainty principle of quantum mechanics (which implied:

$$\Delta mc^2 \times h\Delta\upsilon \times \Delta t^2 = \hbar^2$$

where: Δt stood for time during which virtual particle-antiparticle pairs of energy ($\Delta mc^2 = h\Delta\upsilon$) appeared together, moved apart, then came together and annihilated each other giving energy back to the space without violating the law of energy conservation (which stated that energy can neither be created nor destroyed; rather, it can only be transformed from one form to another).

$$\Delta t = L_{Planck} / (\bar{\upsilon}\mu)^{1/2}$$

Where: L_{Planck} stood for Planck length (a hundred billion billion times [10^{20}] smaller than an atomic nucleus), $\bar{\upsilon}$ for angular wave number of virtual particle-antiparticle pairs and μ implied standard gravitational parameter for virtual particle-antiparticle pairs). Spontaneous births and deaths of roiling frenzy of particles so called virtual matter – antimatter pairs momentarily occurred everywhere, all the time -- violated the Energy-momentum relationship: $E^2 = m_{particle}^2c^4 + p^2c^2$ -- was the conclusion that mass and energy were interconvertible; they were two different forms of the same thing. However, spontaneous births and deaths of so called virtual particles could have produced some remarkable problem, because an infinite number of virtual particle-antiparticle pairs of energy (P_{Planck} $(\bar{\upsilon}\mu)^{1/2}$, P_{Planck}→ Planck momentum) were spontaneously created out of energy ΔE of the empty space, therefore, by Einstein's famous equation $E = mc^2$, infinite number of virtual particle-antiparticle pairs bared an infinite amount of mass and according to general relativity, the infinite amount of mass could have curved up the universe to infinitely small size. But which obviously had not happened. The word virtual particles literally meant that these particles were not observed directly, but their indirect effects were measured to a remarkable degree of accuracy. Their properties and consequences were well established and well understood consequences of quantum mechanics.

The entire universe was governed by a set of physical constants:

Planck's constant: $h = 6.625 \times 10^{-34}$ *Js*

[Since the Planck's constant was almost infinitesimally small, quantum mechanics was for little things. Suppose this number would have been too long to keep writing down i.e., h would have been = 6.625 × 10 to the power of 34 Js, then the wavelength of photon would have been very large. Since the area of the photon was proportional to the square of its wavelength, photon area would have been sufficiently large to consider the photon to be macroscopic. And quantum mechanical effects would have been noticeable for macroscopic objects. For example, the De Broglie wavelength of a 100 kg asteroid moving at 1000 m/s would have been = h/mv = (6.625×10^{34} Js) / (100kg) (100m/s) = 6.625 × 10 to the power of 29 m (very large to be noticeable)].

Planck hbar: $\hbar = 6.5821 \times 10^{-16}$ *eV s*

Newton's gravitational constant: $G = 6.6743 \times 10^{-8}\ cm^3\ g^{-1}\ s^{-2}$

[If the value of G would have been far greater than its actual value, then according to the equation $F_{Gravity} = GMm/r^2$ (which asserted-- that the strength of attraction between two bodies was larger for larger-mass bodies and smaller for smaller-mass bodies and was larger for smaller separations between the bodies and smaller for larger separations): Each star in that universe would have been attracted toward every other star by a force far greater than its present value, so it seemed the stars would have got very near each other, the attractive forces between them would have become stronger and dominate over the repulsive forces so that the stars would have fell together at some point to form a sphere of roughly infinite density. And if the value of G would have been far greater than its actual value, then according to the equation $U = -3GM^2/5r$: The gravitational binding energy of a star would have been far greater than its present value, so it seemed the matter inside the star would have been very much compressed and far hotter than it is. And the distance between the constituents of the star would have been decreased beyond the optimum distance (maximum distance below which the gravitational force is no longer attractive it turns to a repulsive force) then all the stars would have exploded spraying the manufactured elements into space. No life sustaining star would have existed to support life on the living planet.]

Speed of light (in vacuum): $c = 3 \times 10^{8}\ m/s$

[c was not just the constant namely the maximum distance a light can travel in one second in vacuum but rather a fundamental feature of the way space and time were married to form space-time. If c would have been = 3 × 10 to the power of −8 meters per second, then according to the equation E = mc squared (which asserted: energy and mass was the ultimate convertible currency): 1 kg of mass would have yielded only 9 × 10 to the power of −16 joules of energy. Hence, thousands and thousands of hydrogen atoms in the life sustaining star would have to burn up to release tiny joules of energy per second in the form of radiation. Therefore, life sustaining stars would have ceased to black hole even before an ooze of organic molecules would react and built earliest cells and then advance to a wide variety of one – celled organisms, and evolve through a highly sophisticated form of life to primitive mammals.]

Mass of electron: $m_{electron} = 9.1 \times 10^{-31}\ kg$
Mass of proton: $m_{proton} = 1.672 \times 10^{-27}\ kg$
Mass of neutron: $m_{neutron} = 1.675 \times 10^{-27}\ kg$
Electron charge (magnitude): $e = 1.602 \times 10^{-19}\ C$
Boltzmann's constant: $k_B = 1.3807 \times 10^{-16}\ cm^2\ g\ s^{-2}\ K^{-1}$
Stefan-Boltzmann constant: $\sigma = 5.6704 \times 10^{-5}\ g\ s^{-3}\ K^{-4}$
Fine structure constant: $\alpha = e^2/\hbar c = 1/137.036$
Classical electron radius: $r_{electron} = e^2/m_{electron}c^2 = 2.81 \times 10^{-15}\ m$
Bohr radius: $a = \hbar / m_{electron}e^2 = 5.29 \times 10^{-11} m$
Bohr energies: $E_n = -m_{electron}e^4/2\hbar n^2$
$E_n = -(13.6/n^2)\ eV$
QED coupling constant: $g_e = (4\pi/\hbar c)^{1/2} = 0.302822$
Weak coupling constants: $g_w = g_e/\sin\theta_w = 0.6295$; $g_z = g_w/\cos\theta_w = 0.7180$
Weak mixing angle: $\theta_w = 28.76^o$
Strong coupling constant: $G = 1.214$

And out of which three constants (G, c, ℏ) framed the existence of Planck units such as:

Planck length: $L_{Planck} = (\hbar c/G)^{1/2} = 1.6 \times 10^{-35}$ m (about 10^{-20} times the size of a proton)

Planck time: $t_{Planck} = (\hbar G/c^5)^{1/2} = 10^{-43}$ seconds (the time it took for light to travel 1 Planck length, or 1.6×10^{-35} m).

Planck temperature: $T_{Planck} = M_{Planck}c^2/k_B = 1.416808(33) \times 10^{32}$ K

Planck force: $F_{Planck} = c^4/G = 1.210295 \times 10^{44}$ N

A remarkable consequence of this was that entire space was not continuous and infinite but rather quantized and measured in units of quantity called Planck length i.e., the entire space of volume V and area A was divided into N unit cells each of volume i.e., L_{Planck}^3, the smallest definable volume (i.e., the Planck volume) and of area i.e., L_{Planck}^2, the smallest definable area (i.e., the Planck area) and time in units of quantity called Planck time.

$V = N\ L_{Planck}^3$
$A = N\ L_{Planck}^2$
$V/A = L_{Planck}$

The total energy ($E = Mc^2$) of the universe remained the same; no energy was being created or destroyed. The entire universe was getting more disordered and chaotic with time i.e., the entropy of the universe was increasing toward greater disorder (i.e., dS/dt was > 0 and entropic energy of the universe was never less than or greater than T × S but = T × S). And this observation was elevated to the status of a law; the so called Second law of thermodynamics i.e., the universe was tending toward a state of maximum entropy, such as a uniform gas near absolute zero (T→0).

$E= Mc^2$

$E= Mc \times (L_{Planck} / t_{Planck})$

$\rho = \alpha_{Planck} (M/A)$

Where: ρ stood for energy density of the universe, α_{Planck} implied the Planck acceleration and (M/A) for mass distributed per unit area of the universe. The rest mass energy of each particle in that universe was given by: $m_{particle}c^2 = k_B T_{particle}$, where: $T_{particle}$ implied the threshold temperature below which that particle was effectively removed from the universe. All particles had an intrinsic real internal vibration in their rest frame, $\upsilon_0 = m_{particle}c^2 /h$.

$E_{rest}^2 = h\upsilon_0 \times m_{particle}c^2$

$E_{rest} = M_{Planck} (\mu\omega_0 c)^{1/2}$

$T_{particle} = T_{planck} (\mu\omega_0 c^3)^{1/2}$

And Compton wavelength of each particle was given by:

$\lambda_{Compton} = h/m_{particle}c$

$m_{particle}c^2 = hc/ \lambda_{Compton}$

$\upsilon_0 = c/ \lambda_{Compton}$

Space had three dimensions, I mean that it took three numbers − length, breadth and height− to specify a point. And adding time to its description, then space became space-time with 4 dimensions. For n spatial dimensions: The gravitational force between two massive particles was given by: $F_G = GMm / (r^{n-1})$ where G was the gravitational constant, M and m denoted the masses of the two particles and r was the distance between them. The electrostatic force between two point charges was given by: $F_E = Qq/ 4\pi\varepsilon_0 (r^{n-1})$ where ε_0 was the absolute permittivity of free space, Q and q denoted the charges and r was the distance between them.

Since n was =3:

Both of these forces were proportional to $1/ r^2$

For the electron and proton, the ratio of the forces was given by the equation: $F_E / F_G = e^2 / 4\pi\varepsilon_0 G m_{proton} m_{electron}$ where e was the charge = 1.602×10^{-19} Coulombs, G was the gravitational constant, ε_0 was the absolute permittivity of free space = 8.8×10^{-12} F/m, m_{proton} was the mass of the proton = 1.672×10^{-27} kg and $m_{electron}$ was the mass of the electron = 9.1×10^{-31} kg. Plugging the values we get: $F_E / F_G = 10^{39}$ which meant: F_E was > F_G. [If the gravitational force between the proton and electron were not much smaller than the electrostatic force between them, then the hydrogen atom would have collapsed to neutron long before there was a chance for stars to form and life to evolve. $F_E > F_G$ must have been numerically fine - tuned for the existence of life. Taking $F_E / F_G = 10^{39}$ as an example it was found that gravity was the weakest of all forces, many orders of magnitude weaker than electromagnetism. But this did not made sense any way and it was not true always and in all cases. The ratio F_E / F_G was not a universal constant; it was a number that depended on the particles we used in the calculation. For example: For two particles each of Planck mass (mass on the order of 10 billion billion times that of a proton) and Planck charge the ratio of the forces was 1 i.e., $F_E / F_G = 1$. Moreover, when the relativistic variation of electron mass with velocity was taken into account then the ratio F_E / F_G was velocity dependent.]

Planck force was the highest possible force and half of this force was responsible for keeping the energy ($E= Mc^2$) of the black hole to a distance ($R_s = 2GM/c^2$)

$E= (F_{Planck}/2) R_s$

And 1/4th of this force was responsible for keeping the entropic energy ($E_s= T_{BH}\times S_{BH}$) of the black hole to a distance ($R_s = 2GM/c^2$)

$Mc^2 = 2 T_{BH} \times S_{BH}$

$E_s= (F_{Planck}/4) R_s$

A photon was the quantum of electromagnetic radiation that described the particle properties of an electromagnetic wave. The energy of a photon was given by:

$E_{photon} = h\upsilon$

(which implied the energy a photon was proportional to its frequency: larger frequency (shorter wavelength) implied larger photon energy and smaller frequency (longer wavelength) implied smaller photon energy) – Because h was constant, energy and frequency of the photon were equivalent and were different forms of the same thing. And since h -- which was one of the most fundamental numbers in physics, ranking alongside the speed of light c and confined most of these radical departures from life-as-usual to the microscopic realm − was incredibly small (i.e., 6 × 10 to the power of ⁻34 -- a decimal point followed by 33 zeros and a 6 -- of a joule second), the frequency of the photon was always greater than its energy, so it did not took many quanta to radiate even ten thousand megawatts.

$E_{photon} = M_{Planck}^2 \mu_{Planck} \bar{\upsilon}$

where: μ_{Planck} → standard gravitational parameter for Planck mass. Taking into account the particle nature, the energy of a photon was given by:

$E_{photon} = mc^2$

$E_{photon}^2 = mc^2 \times h\upsilon$

$E_{photon} = P_{Planck} (\bar{\upsilon}\mu)^{1/2}$

(where: P_{Planck}→ Planck momentum, υ → angular wave number of photon, μ → standard gravitational parameter for photon). And its wavelength 'λ' was related to its momentum 'p' by the equation:

$\lambda = h/mc = h/p$

$d\lambda = (-dp/p^2)\, h$

$F = p^2/ h\, (-d\lambda/dt)$

Which implied: force which moved the photon mass was proportional to the rate of decrease of its wavelength. And the photon power was given by the equation:

$P_{photon} = F \times c$

Which implied: the rate of work done in moving the photon mass was proportional to the force which moved the photon mass. Since the photon entropy (S_{photon}) was > k_B: the energy of the photon ($h\upsilon$) was greater than its entropic energy ($T \times S_{photon}$). All the known subatomic particles in the universe belonged to one of two groups, Fermions or bosons. Fermions were particles with integer spin ½ and they made up ordinary matter. Their ground state energies were negative. Bosons were particles (whose ground state energies were positive) with integer spin 0, 1, 2 and they acted as the force carriers between fermions (For example: The electromagnetic force of attraction between electron and a proton was pictured as being caused by the exchange of large numbers of virtual massless bosons of spin 1, called photons).

Positive ground state energy of bosons plus negative ground state energy of fermions was = 0

Because $E = mc^2$, the energy which a particle possessed due to its motion added to its rest mass. This effect was only really significant for particles moving at speeds close to the speed of light. For example, at 10 percent of the speed of light a particle's mass m was only 0.5 percent more than its rest mass $m_{particle}$, while at 90 percent of the speed of light it was more than twice its rest mass. And as a particle approached the speed of light, its mass raised ever more quickly, it acquired infinite mass and since an infinite mass cannot be accelerated any faster by any force, the issue of infinite mass remained an intractable problem. For this reason all the particles in that universe were forever confined by relativity to move at speeds slower than the speed of light. Only tiny packets / particles of light (dubbed "photons") that had no intrinsic mass moved at the speed of light. Tachyons the putative class of hypothetical particles (with negative mass squared: $m^2 < 0$) was believed to travel faster than the speed of light. But, the existence of tachyons was in question. The mass m in motion at speed v was the mass $m_{particle}$ at rest divided by the factor $(1- v^2/c^2)^{1/2}$ implied: the mass of a particle was not constant; it varied with changes in its velocity.

$m = m_{particle} / (1- v^2/c^2)^{1/2}$

$m^2c^2 - m^2v^2 = m_{particle}{}^2c^2$

$mv\, dv + v^2dm = c^2dm$

$dm\, (c^2 - v^2) = mv\, dv$

The energy which a particle possessed due to its motion i.e., kinetic energy was $= dmc^2 = dp \times v$. Therefore:

$dp\, (c^2 - v^2) = mc^2\, dv$

$(dp/dt) = mc^2 / (c^2 - v^2)\, (dv/dt)$

$F = mac^2 / (c^2 - v^2)$

For non-relativistic case ($v \ll c$), the above equation was reduced to $F = m_{particle} \times a$

$F = m^3a / m_{particle}{}^2$

The force which moved the particle mass was given by:

$F^2 = (m^3a / m_{particle}{}^2) \times [\, p^2/ h\, (-d\lambda/dt)]$

$F = (m^{5/2}\, v / m_{particle})\, [a\, (-d\lambda/dt) /h]^{1/2}$

The known forces of the universe were divided into four classes:

Gravity: This was the weakest of the four; it acted on everything in the universe as an attraction. And if not for this force, everything would have gone zinging off into outer space and the life sustaining star would have detonated like trillions upon trillions of hydrogen bombs.

Electromagnetism: This was much stronger than gravity; it acted only on particles with an electric charge, being repulsive between charges of the same sign and attractive between charges of the opposite sign.

Weak nuclear force: This caused radioactivity and played a vital role in the formation of the elements in stars.

Strong nuclear force: This force held together the protons and neutrons inside the nucleus of an atom. And it was this same force that held together the quarks to form protons and neutrons.

If these forces were unified, the protons -- which constituted up much of the mass of ordinary matter -- would have been unstable, and eventually decayed into lighter particles such as antielectrons. However, the probability of a proton in the universe gaining sufficient energy to decay was so small that one has to wait at least a million million million million million years. Like raisins in expanding dough, galaxies that were further apart were increasing their separation more than nearer ones. And as a result, the light emitted from distant galaxies and stars was shifted towards the red end of the spectrum. Observations of galaxies indicated that the universe was expanding: the distance D between almost any pair of galaxies was increasing at a rate

$v = dD/dt = HD$

Beyond a certain distance, known as the Hubble distance (c / H), it exceeded the velocity greater than the speed of light in vacuum. But, this was not a violation of relativity, because recession velocity was caused not by motion through space but by the expansion of space. Since D was proportional to the wavelength 'λ' of the light emitted from distant galaxies: ν was = dλ/dt = Hλ

$z = H \times dt$

Where: z → cosmological red shift. The universe was very rapidly expanding and cooling in a way consistent with Einstein field equations. As the universe was expanding, the temperature was decreasing. The expansion of the universe was actually accelerating or speeding up. The acceleration of the expansion of the universe was given by:

$a = d\nu/dt = (dH/dt)\, D + (dD/dt)\, H$

$a = -H^2 (1+q)\, D + (dD/dt)\, H$

$a = -Hq\nu$

Where: q → deceleration parameter (which was a dimensionless measure of the cosmic acceleration of the expansion of space).

$d\nu = -zq\nu$

Since GM^2/r was $= -5U/3$ (where U → gravitational binding energy of a star): the stars of radius

$r = 2GM/c^2$

$Mc^2 = 2GM^2/r$

$Mc^2 = -3.33U$

i.e., stars of rest mass energy = 3.33 times their negative gravitational binding energy further collapsed to produce dark or frozen stars (i.e., the mass of a star was concentrated in a small enough spherical region, so that its mass divided by its radius exceeded a particular critical value, the resulting space-time warp was so radical that anything, including light, that got too close to the star was unable to escape its gravitational grip). And these dark stars were sufficiently massive and compact and possessed a strong gravitational field that prevented even light from escaping out its influence: any light emitted from the surface of the star was dragged back by the star's gravitational attraction before it could get very far. Such stars become black voids in space and were coined "the black holes" (i.e., black because they cannot emit light and holes because anything getting too close falls into them, never to return). Classically, the gravitational field of the black holes (which seemed to be among the most ordered and organized objects in the whole universe) was so strong that they prevented any information including light from escaping out of their influence i.e., any information was sent down the throat of a black hole or swallowed by a black hole was forever hidden from the outside universe. Anything which fell through the black hole soon reached the region of infinite density and the end of time. However, the laws of classical general relativity did not allowed anything (not even light) to escape the gravitational grip of the black hole but the inclusion of quantum mechanics modified this conclusion− quantum field scattered of a black hole. Because of quantum mechanical effects, the pair of short-lived virtual particles (one with positive energy and the other with negative energy) appeared close to the event horizon of a black hole. The gravitational might of the black hole injected energy into a pair of virtual particles... that teared them just far enough apart so that one with negative energy was sucked into the hole even before it can annihilate its partner... its forsaken partner with positive energy... escaped outward to infinity with an energy boost from the gravitational force of the black hole... where it appeared as a real particle (and to an observer at a distance, it appeared to have been emitted from the black hole). Because $E = mc^2$ (i.e., energy is equivalent to mass), a fall of negative energy particle into the black hole therefore reduced its mass with its horizon shrinking in size. As the black hole lost mass, the temperature of the black hole (which was $= \hbar c^3 / 8\pi GMk_B$) raised and its rate of emission of particle increased, so it lost energy more and more quickly at a rate proportional to $2 \times (-dE_s/dt)$.

$P = -c^2\, (dM/dt)$

$P = 2 \times (-dE_s/dt)$

The black hole ought to emit particles and radiation as if it were a hot body with a temperature that depended only on the black hole's mass: the higher the mass, the lower the temperature. A photon generated at the center of the star took up to several million years to get to the surface, and the gravitational potential energy of the photon at the surface of the star was given by: $PE = -GMm/r$, where $G = 6.673 \times 10^{-11}\ Nm^2/kg^2$ was Gravitational constant, m was the photon mass, M and r denoted the mass and radius of the star. When the photon detached the star surface, its energy shifted from $h\upsilon$ to $h\upsilon_0$. The change in photon energy was equivalent = gravitational potential energy of the photon i.e.,

$(h\upsilon - h\upsilon_0) = -GMm/r$

Since $m = h\upsilon/c^2$:

$(h\upsilon - h\upsilon_0)/h\upsilon = -GM/rc^2$

The gravitational binding energy of a star was given by $U = -3GM^2/5r$. Therefore, the equation

$(h\upsilon - h\upsilon_0)/h\upsilon = -GM/rc^2$ turned out to be:

$(h\upsilon - h\upsilon_0)/h\upsilon = 5U/3Mc^2$

$z = 1.66U / Mc^2$

Where: z → gravitational redshift. Since z was always < than 1, Mc^2 was greater than 1.66 times the gravitational binding energy of a star i.e.

$Mc^2 > 1.66U$

Which meant: $Mc^2 > 1.66U$ was a condition that must be satisfied for a star to allow the photon to escape from its surface. Like the formation of bubbles of steam in boiling water – many tiny bubbles of radius r were created, started expanding at a rate

$v = dr/dt = Hr$

simply because of an uncaused accident called spontaneous creation. Since the area 'A' of the bubble was proportional to r^2 and volume 'V' of the bubble was proportional to r^3:

$dV/dt = 3HV$

Since the bubble was expanding adiabatically then it satisfied the first law of thermodynamics:

$0 = dQ = dU + PdV$

$-dU = 3HPV$

$-dU = 3HF (V/A)$

$-dU = 3Fv$

Which implied: the decrease in the internal energy of the bubble was = 3 Fv (where: F → Force of expansion, v → rate of expansion of the bubble). When an electron and a positron approached each other, they annihilated i.e., destroyed each other. During the process their masses were converted into energy in accordance with $E = mc^2$. The energy thus released manifested as γ photons. A positron had the same mass as an electron but an opposite charge equal to +*e*. The energy released in the form of 2γ photons during the annihilation of a positron and an electron was therefore $E = 2h\upsilon = 2m_0c^2$ where m_0 is the rest mass of the electron or positron.

$2h\upsilon = 2m_0c^2$

Since $\upsilon = c/\lambda$. Therefore:

$\lambda = h/ m_0c$

$\lambda = \lambda_{Compton}$

Which implied: wavelength of the resulted gamma photon was = Compton wavelength of the annihilated electron. The massive bodies that were accelerated caused the emission of gravity waves, ripples in the curvature of 4 dimensional fabric of space-time that traveled away in all directions like waves in a lake at a specific speed, the speed of light. Like light, gravity waves carried energy away from the bodies that emit them. The movement of the living planet in its orbit round the life sustaining star produced gravitational waves. The effect of the energy loss was able to change the orbit of the living planet so that gradually it got nearer and nearer to the life sustaining star at a rate =

$- dr/dt = 64G^3 (M_{star} \times m_{planet}) (M_{star} + m_{planet}) / 5 c^5 r^3$

The rate of energy loss into space in the form of gravity waves was very low – about enough to run a small electric heater and was =

$- dE/dt = 32 G^4 (M_{star} \times m_{planet})^2 (M_{star} + m_{planet}) / 5c^5 r^5$

$2 \times (-dE/dt) = G (M_{star} \times m_{planet}) / r^2 \times (- dr/dt)$

Since $G (M_{star} \times m_{planet}) / r^2 = F_{Gravitation}$ (the force of gravitation between the planet and the star). Therefore:

$2 (-dE/dt) = F_{Gravitation} \times (- dr/dt)$

Suppose no gravity waves was emitted by the planet-star system, then

$(-dE/dt) = 0$ and $(-dr/dt) = 0$

$F_{Gravitation} = 2 \times \{(-dE/dt) / (-dr/dt)\} = 2 \times (0/0) = 0 / 0$

i.e., the force of gravitation between the planet and the star would have became undefined. The planet-star system should have to lose its energy in the form of weak gravity waves in order to maintain a well-defined force of gravitation between them. Every particle was nothing but a vibrating, oscillating, dancing filament named a string. A string did something aside from moving – it oscillated in different ways. Each way represented a particular mode of vibration. Different modes of vibration made the string appear as a dark energy or a cosmic ray, since different modes of vibration were seen as different masses or spins. A new field called the Higgs field which was analogous to the familiar electromagnetic field but with new kinds of properties permitted all over the space. Different masses of the particles were due to the different strengths of interaction of the particle with the Higgs field (more the strength of interaction of the particle with the Higgs field, more the mass of the particle). The different masses of the particles were due to (the different modes of vibration of the string plus the different strengths of interaction of the string with the Higgs field). The gravitational binding force that confined the mass M of the star to the radius R was given by the equation:

$F_B = 3GM^2/5R^2$

The gravitational binding pressure of the star was given by the relation:

$P_{GB} = F_B/4\pi R^2 = 3GM^2/20 \pi R^4$

The core pressure of a star of mass M and radius R was given by the equation:

$P_c = 5GM^2/4 \pi R^4$

P_{GB} /P_C was = 0.12

$P_{GB} = 0.12P_C$

Which implied:

P_{GB} was < than P_C

The ultimate fate of that universe was determined by a parameter called critical density:

- Density of the universe > critical density implied: the universe will eventually stop expanding then collapse.
- Density of the universe < critical density implied: the universe will expand forever.

As the universe was expanding, the density of the universe was decreasing with time and at a certain point of expansion, the density of the universe was greater than critical density. The universe stopped expansion and started contracting with time. At a certain point of contraction: all the forces were unified into a single force and this force was > Planck force and this force was attractive enough to cause further contraction. The nature of the force was similar to intermolecular force – attractive up to certain distance (i.e., x A^0) and turns to repulsive. At certain point of contraction, the distance was < x A^0 -- the contraction turned to explosion. This was not any ordinary explosion as might occur today, which would have a point of origin (center) and would spread out from that point. The explosion occurred simultaneously everywhere, filling all space with infinite heat and energy. At this time, order and structure were just beginning to emerge − the universe was hotter and denser than anything we can imagine (at such temperatures and densities (of about a trillion trillion trillion trillion trillion trillion (1 with 72 zeros after it) tons per cubic inch) gravity and quantum mechanics were no longer treated as two separate entities as they were in point-particle quantum field theory, the four known forces were unified as one unified super force) and was very rapidly expanding. The quantum black holes (with mass < mass of the electron) were created, they were extremely difficult to spot - and they were the large emitters of radiation (because $T = ħc^3/8πGMk_B$) and they shrinked and dissipated faster even before they were observed. As the universe was expanding, the temperature was decreasing. Since the temperature was decreasing, the universe was cooling and its curvature energy was converted into matter like a formless water vapor freezes into snowflakes whose unique patterns arise from a combination of symmetry and randomness. Approximately 10^{-37} seconds into the expansion, a phase transition caused a cosmic inflation, during which the universe underwent an incredible amount of superliminal expansion and grew exponentially by a factor e^{3Ht} (where H was a constant called Hubble parameter and t was the time) – just as the prices grew by a factor of ten million in a period of 18 months in Germany after the First World War and it doubled in size every tiny fraction of a second – just as prices double every year in certain countries. After inflation stopped, the universe was not in a de Sitter phase and its rate of expansion was no longer proportional to its volume since H was no longer constant. At that time, the entire universe had grown by an unimaginable factor of 10^{50} and consisted of a hot plasma "soup" of high energetic quarks as well as leptons (a group of particles which interacted with each other by exchanging new particles called the W and Z bosons as well as photons). And quarks and gluons were "deconfined" and free to move over distances much larger than the hadron size (>>1 fm) in a soup called quark gluon plasma (QGP). There were a number of different varieties of quarks: there were six "flavors," which we now call up, down, strange, charmed, bottom, and top. And among the leptons the electron was a stable object and muon (that had mass 207 times larger than electron and now belongs to the second redundant generation of particles found in the Standard Model) and the tauon (that had mass 3,490 times the mass of the electron) were allowed to decay into other particles. And associated to each charged lepton, there were three distinct kinds of ghostly particles called neutrinos (the most mysterious of subatomic particles, are difficult to detect because they rarely interact with other forms of matter. Although they can easily pass through a planet or solid walls, they seldom leave a trace of their existence. Evidence of neutrino oscillations prove that neutrinos are not massless but instead have a mass less than one-hundred-thousandth that of an electron):

- the electron neutrino (which was predicted in the early 1930s by Wolfgang Pauli and discovered by Frederick Reines and Clyde Cowan in mid-1950s).
- the muon neutrino (which was discovered by physicists when studying the cosmic rays in late 1930s).
- the tauon neutrino (a heavier cousin of the electron neutrino).

Temperatures were so high that these quarks and leptons were moving around so fast that they escaped any attraction toward each other due to nuclear or electromagnetic forces. However, they possessed so much energy that whenever they collided, particle – antiparticle pairs of all kinds were being continuously created and destroyed in collisions. And the uncertainty in the position of the particle times the uncertainty in its velocity times the mass of the particle was never smaller than a certain quantity, which was known as Planck's constant. Similarly, $\Delta E \times \Delta t$ was $\leq h/4\pi$ (where h was a quantity called Planck's constant and $\pi = 3.14159...$ was the familiar ratio of the circumference of a circle to its diameter). Hence the Heisenberg's uncertainty principle (which captures the heart of quantum mechanics – i.e. features normally thought of as being so basic as to be beyond question (e.g. that objects have definite positions and speeds and that they have definite energies at definite moments) are now seen as mere artifacts of Planck's constant being so tiny on the scales of the everyday world) was a fundamental, inescapable property of the universe. At some point an unknown reaction led to a very small excess of quarks and leptons over antiquarks and antileptons — of the order of one part in 30 million. This resulted in the predominance of matter over antimatter in the universe. The universe continued to decrease in density and fall in temperature, hence the typical energy of each particle was decreased in inverse proportion to the size of the universe (since the average energy – or speed – of the particles was simply a measure of the temperature of the universe). The symmetry (a central part of the theory [and] its experimental confirmation would be a compelling, albeit circumstantial, piece of evidence for strings) however, was unstable and, as the universe cooled, a process called spontaneous symmetry breaking phase transitions placed the fundamental forces of physics and the parameters of elementary particles into their present form. After about 10^{-11} seconds, the picture becomes less speculative, since particle energies drop to values that can be attained in particle physics experiments. At about 10^{-6} seconds, there was a continuous exchange of smallest constituents of the strong force called gluons between the quarks and this resulted in a force that pulled the quarks to form little wisps of matter which obeys the strong interactions and makes up only a tiny fraction of the matter in the universe and is dwarfed by dark matter called the baryons (protons – a positively charged particles very similar to the neutrons, which accounts for roughly half the particles in the nucleus of most atoms − and neutrons – a neutral subatomic particles which, along with the protons, makes up the nuclei of atoms – belonged to the class baryons) as well as other particles. The small excess of quarks over antiquarks led to a small excess of baryons over antibaryons. The proton was composed of two up quarks and one down quark and the neutron was composed of two down quarks and one up quark. And other particles contained other quarks (strange, charmed, bottom, and top), but these all had a much greater mass and decayed very rapidly into protons and neutrons. The charge on the up quark was = + 2/3 e and the charge on the down quark was = – 1/3 e. The other quarks possessed charges of + 2/3 e or – 1/3 e. The charges of the quarks added up in the combination that composed the proton but cancelled out in the combination that composed the neutron i.e.,

Proton charge was = (2/3 e) + (2/3 e) + (–1/3 e) = e

Neutron charge was = (2/3 e) + (–1/3 e) + (–1/3 e) = 0

And the force that confined the rest mass energy of the proton or the neutron (i.e., total energy of its constituent particles) to its radius was = its rest mass energy divided by its radius i.e., for the proton of radius ≈ 1.112×10^{-15} meter: F was = 13.52 × 10 to the power of 26 Newton. And this force was so strong that it is now proved very difficult if not impossible to obtain an isolated quark. As we try to pull them out of the proton or neutron it gets more and more difficult. Even stranger is the suggestion that the harder and harder if we could drag a quark out of a proton this force gets bigger and bigger – rather like the force in a spring as it is stretched causing the quark to snap back immediately to its original position. This property of confinement prevented one from observing an isolated quark (and the question of whether it makes sense to say quarks really exist if we can never isolate one was a controversial issue in the years after the quark model was first proposed). However, now it has been revealed that experiments with large particle accelerators indicate that at high energies the strong force becomes much weaker, and one can observe an isolated quark. In fact, the standard model (one of the most successful physical theories of all time and since it fails to account for gravity (and seems so ugly), theoretical physicists feel it cannot be the final theory) in its current form requires that the quarks not be free. The observation of a free quark would falsify that aspect of the standard model, although nicely confirm the quark idea itself and fits all the experimental data concerning particle physics without exception. Each quark possessed baryon number = 1/3: the total baryon number of the proton or the neutron was the sum of the baryon numbers of the quarks from which it was composed. And the electrons and neutrinos contained no quarks; they were themselves truly fundamental particles. And since there were no electrically charged particles lighter than an electron and a proton, the electrons and protons were prevented from decaying into lighter particles – such as photons (that carried zero mass, zero charge, a definite energy E_{photon} = pc and a momentum p = mc) and less massive neutrinos (with very little mass, no electric charge, and no radius — and, adding insult to injury, no strong force acted on it). And a free neutron being heavier than the proton was not prevented from decaying into a proton (plus an electron and an antineutrino). The temperature was now no longer high enough to create new proton–antiproton pairs, so a mass annihilation immediately followed, leaving just one in 10^{10} of the original protons and neutrons, and none of their antiparticles (i.e., antiparticle was sort of the reverse of matter particle. The counterparts of electrons were positrons (positively charged), and the counterparts of protons were antiprotons (negatively charged). Even neutrons had an antiparticle: antineutrons). A similar process happened at about 1 second for electrons and positrons (positron: the antiparticle of an electron with exactly the same mass as an electron but its electric charge is +1e). After these annihilations, the remaining protons, neutrons and electrons were no longer moving relativistically and the energy density of the universe was dominated by photons − (what are sometimes referred to as the messenger particles for the electromagnetic force) − with a minor contribution from neutrinos. The density of the universe was about 4×10^{9} times the density of water and much hotter than the center of even the hottest star – no ordinary components of matter as we know them – molecules, atoms, nuclei – could hold together at this temperature. Entropy (a thermodynamic measure of untidiness in a system and a measure of how much information a system contains) was defined as

$S = k_B \ln$ {number of states}

which, for N particles of the same type, was

$S = k_B \ln$ {(no of one-particle states) N}

$S = k_B N \ln$ {a not-too-big number}

$S = k_B N$

This meant: the more particles, the more disorder. And the total positive charge due to protons plus the total negative charge due to electrons in the universe was = 0 (Just what it was if electromagnetism would not dominate over gravity and for the universe to remain electrically neutral). And a few minutes into the expansion, when the temperature was about a billion (one thousand million; 10 to the power of 9) Kelvin and the density was about that of air, protons and neutrons no longer had sufficient energy to escape the attraction of the strong nuclear force and they started to combine together to produce the universe's deuterium and helium nuclei in a process called Big Bang nucleosynthesis. And most of the protons remained uncombined as hydrogen nuclei. And inside the tiny core of an atom, consisting of protons and neutrons, which was roughly 10^{-13} cm across or roughly an angstrom, a proton was never permanently a proton and also a neutron was never permanently a neutron. They kept on changing into each other. A neutron emitted a π meson (a particle predicted by Hideki Yukawa (for which he was awarded the Nobel Prize in physics in 1949) – composed of a quark and antiquark, which is unstable because the quark and antiquark can annihilate each other, producing electrons and other particles) and became proton and a proton absorbed a π meson and became a neutron. That is, the exchange force resulted due to the absorption and emission of π mesons kept the protons and neutrons bound in the nucleus. And the time in which the absorption and emission of π mesons took place was so small that π mesons were not detected. And a property of the strong force called asymptotic freedom caused it to become weaker at short distances. Hence, although quarks were bound in nuclei by the strong force, they moved within nuclei almost as if they felt no force at all. Within only a few hours of the explosion, the Big Bang nucleosynthesis stopped. And after that, for the next million years or so, the universe just continued expanding, without anything much happening. Eventually, once the temperature had dropped to a few thousand degrees, there was a continuous exchange of virtual photons between the nuclei and the electrons. And the exchange was good enough to produce — what else? — A force (proportional to a quantity called their charge and inversely proportional to the square of the distance between them). And that force pulled the electrons towards the nuclei to form neutral atoms (the basic unit of ordinary matter, made up of a tiny nucleus (consisting of protons and neutrons) surrounded by orbiting electrons). And these atoms reflected, absorbed, and scattered light and the resulted light was red shifted by the expansion of the universe towards the microwave region of the electromagnetic spectrum. And there was cosmic microwave background radiation (which, through the last 15 billion years of cosmic expansion, has now cooled to a mere handful of degrees above absolute zero (–273ºC − the lowest possible temperature, at which substances contain no heat energy and all vibrations stop—almost: the water molecules are as fixed in their equilibrium positions as quantum uncertainty allows) and today, scientists measure tiny deviations within this background radiation to provide evidence for inflation or other theories). The irregularities in the universe meant that some regions of the nearly uniformly distributed atoms had slightly higher density than others. The gravitational attraction of the extra density slowed the expansion of the region, and eventually caused the region to collapse to form galaxies and stars. And the nuclear reactions in the stars transformed hydrogen to helium (composed of two protons and two neutrons and symbolized by ${}_2He^4$, highly stable—as predicted by the rules of quantum mechanics) to carbon (with their self-bonding properties, provide the immense variety for the complex cellular machinery— no other element offers a comparable range of possibilities) with the release of an enormous amount of energy via Einstein's equation $E = mc^2$. This was the energy that lighted up the stars. And the process continued converting the carbon to oxygen to silicon to iron. And the nuclear reaction ceased at iron. And the star experienced several chemical changes in its innermost core and these changes required huge amount of energy which was supplied by the severe gravitational contraction. And as a result the central region of the star collapsed to form a neutron star. And the outer region of the star got blown off in a tremendous explosion called a supernova, which outshone an entire galaxy of 100 billion stars, spraying the manufactured elements into space. And these elements provided some of the raw material for the generation of cloud of rotating gas which went to form the sun and a small amount of the heavier elements collected together to form the asteroids, stars, comets, and the bodies that now orbit the sun as planets like the Earth and their presence caused the fabric of space around them to warp (more massive the bodies, the greater the distortion it caused in the surrounding space).

The earth was initially very hot and without an atmosphere. In the course of time the planet earth produced volcanoes and the volcanoes emitted water vapor, carbon dioxide and other gases. And there was an atmosphere. This early atmosphere contained no oxygen, but a lot of other gases and among them some were poisonous, such as hydrogen sulfide (the gas that gives rotten eggs their smell). And the sunlight dissociated water vapor and there was oxygen. And carbon dioxide in excess heated the earth and balance was needed. So carbon dioxide dissolved to form carbonic acid and carbonic acid on rocks produced limestone and subducted limestone fed volcanoes that released more carbon dioxide. And there was high temperature and high temperature meant more evaporation and dissolved more carbon dioxide. And as the carbon dioxide turned into limestone, the temperature began to fall. And a consequence of this was that most of the water vapor condensed and formed the oceans. And the low temperature meant less evaporation and carbon dioxide began to build up in the atmosphere. And the cycle went on for billions of years. And after the few billion years, volcanoes ceased to exist. And the molten earth cooled, forming a hardened, outer crust. And the earth's atmosphere consisted of nitrogen, oxygen, carbon dioxide, plus other miscellaneous gases (hydrogen sulfide, methane, water vapor, and ammonia). And then a continuous electric current through the atmosphere simulated lightning storms. And some of the gases came to be arranged in the form of more complex organic molecules such as simple amino acids (the basic chemical subunit of proteins, when, when linked together, formed proteins) and carbohydrates (which were very simple sugars). And the water vapor in the atmosphere probably caused millions of seconds of torrential rains, during which the organic molecules reached the earth. And it took two and a half billion years for an ooze of organic molecules to react and built earliest cells as a result of chance combinations of atoms into large structures called macromolecules and then advance to a wide variety of one – celled organisms, and another billion years to evolve through a highly sophisticated form of life to primitive mammals endowed with two elements: genes (a set of instructions that tell them how to sustain and multiply themselves), and metabolism (a mechanism to carry out the instructions). But then evolution seemed to have speeded up. It only took about a hundred million years to develop from the early mammals (the highest class of animals, including the ordinary hairy quadrupeds, the whales and Mammoths, and characterized by the production of living young which are nourished after birth by milk from the teats (MAMMAE, MAMMARY GLANDS) of the mother) to Homosapiens.

Conclusion:

The Big Bounce is a hypothetical cosmological model for the origin of the present universe. It was originally suggested as a phase of the cyclic model or oscillatory universe interpretation of the Big Bang, where the first cosmological event was the result of the collapse of a previous universe. It receded from serious consideration in the early 1980s after inflation theory emerged as a solution to the horizon problem, which had arisen from advances in observations revealing the large-scale structure of the universe.

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2/21/2018