Spacetime Conversion into Matter

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1. Introduction

The model put forth in this paper presupposes that spacetime is not a mathematical abstraction but has a basis in physical reality with matter and spacetime being convertible states of the same theoretical quantum particle. This postulated quantum particle is composed of D-branes and Type I strings and the nomenclature for this brane/string complex is the B-string.

2. B-string Physical Structure

Specific orientation and attachment of D-branes and Type I Strings to one another determines the physical structure of the B-string quantum.

2.1 Relating Type I strings and D-branes to B-string Structure

Planck's length [1] and Planck's time [2] quantify two of the physical parameters of the B-string. The maximally contracted B-string is a cubic hexahedron, with the length along any side equal to Planck's length (l_p). Each individual expansion or contraction of a B-string occurs in a quantum jump, and the time interval from initiation to completion of a quantum jump is equal to Planck's time and is invariant. After the first and any subsequent volumetric changes of the B-string, the cubic shape of the B-string distorts along multiple axes but maintains hexahedral shape with six planar faces. The range between maximally expanded and maximally contracted states of a B-string defines spacetime curvature.

D-branes were discovered independently by Petr Horava, [3] and by the team of Jim Dai, Rob Leigh, and Joe Polchinski. [4] The D-brane is named after 19th century mathematician Johann Peter Gustav Dirichlet [5]. Dirichlet's boundary conditions [6] are a set of restraints in that the Type I string ends are fixed in position, i.e. both ends of the Type I strings are attached to D-branes.

2.2 B-string model postulates:

1. The B-string is composed of Type I strings and D-branes. A fully contracted B-string is matter. An expanded B-string is spacetime.
2. D-branes occupy the surface of the six facets of the hexahedral B-string.
3. The Type I strings are within the B-string and attach from one facet D-brane across to the opposing parallel facet D-brane, see figure 1(A).

4. The string attachment pattern of two opposing D-branes of the B-string along any of the x, y, and z-axes are mirror image nonsuperposable enantiomers. This results in spacetime and matter having chirality, see figure 1(B).
5. All B-strings have identical numbers and types of strings and D-branes.
6. Attachment between spacetime quanta is not continuous. A volumetric change, e.g. expansion or contraction of a spacetime quantum by any mechanism will result in the quantum detaching from the abutting spacetime quanta. The abutting B-strings will equilibrate to reattach to the contracted B-string. Expansion and contraction of spacetime quanta can visualized as oscillating bubbles within a quantum foam.
7. B-strings can spontaneously expand but can never spontaneously contract. Absorption of energy by the B-string is necessary in order for a B-string to contract.
8. String lengths within a B-string spontaneously equilibrate to approach or attain identical lengths when a B-string undergoes an initial geometric change along any axis.
9. Abutting B-strings with unequal contracted states will interact in quantum jumps to approach or attain equal levels of contraction.

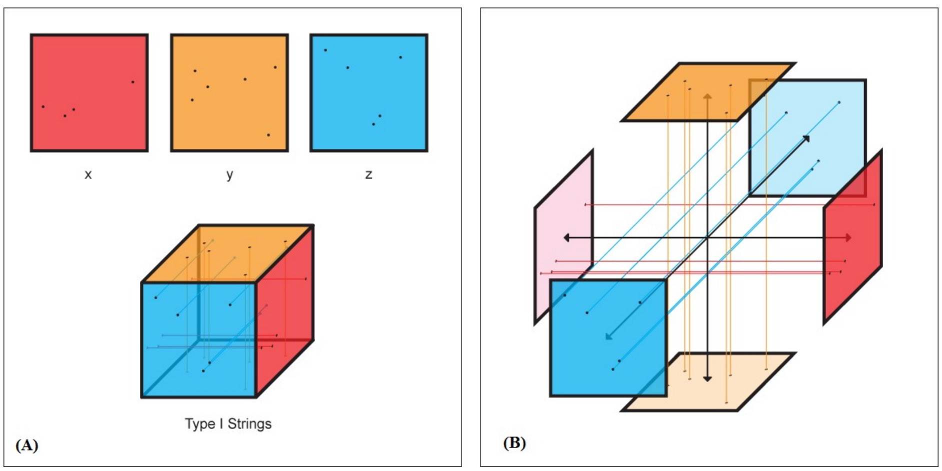

Figure 1. (A) Colored facets represent D-branes. (B) B-string exploded view, colored lines represent Type I strings.

2.3 The 10-dimensional and 11-dimensional Duality of the B-string

Type I strings constitute the three dimensions of the x, y, and z-axes. The author proffers that each of the D-branes occupying the six facets of the B-string are mathematically interpreted as distinct higher dimensions due to their attachment to the Type I string dimensions and the unique stereochemistry of each of the two-dimensional D-brane sheets. The arbitrary naming of the six D-branes on the B-string facets are: top, bottom, left, right, front, and back. The nomenclature of the 2-brane will be used to distinguish the higher dimensionality of the D-brane. The 10 dimensions of the B-string are:

1. x-axis Type I strings
2. y-axis Type I strings
3. z-axis Type I strings
4. top D-brane
5. bottom D-brane
6. left D-brane
7. right D-brane
8. front D-brane
9. back D-brane
10. time (spatial change)

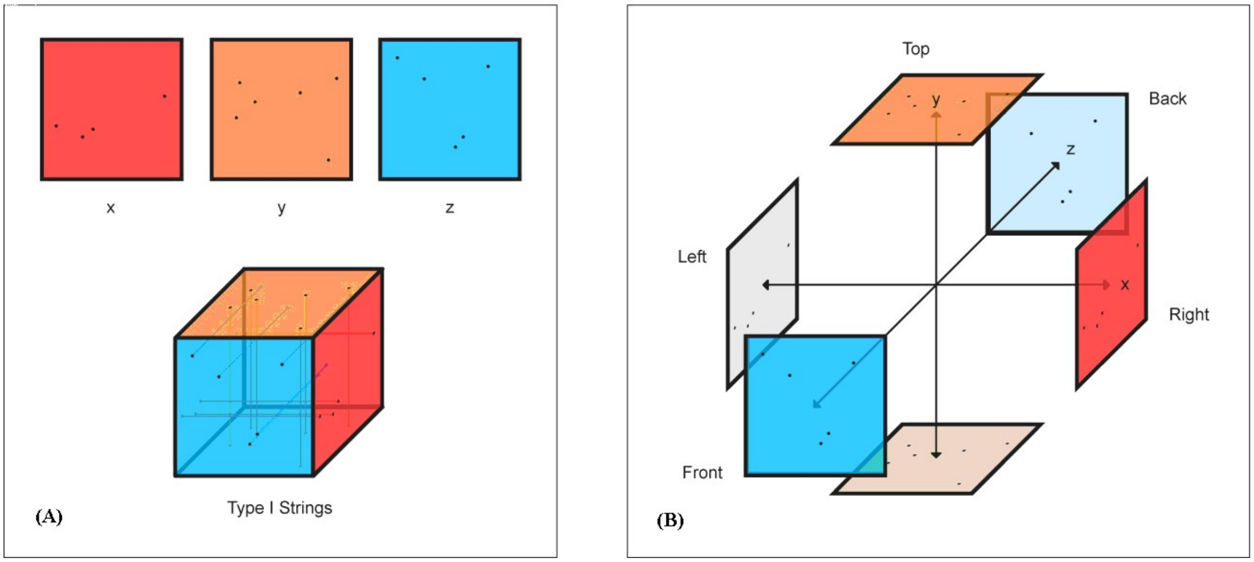

Figure 2 - The 10-dimensional B-string

Minkowski first proposed the linking of space and time as spacetime. [7] This paper defines a unit of time as the interval from initiation to completion of a geometric change in a quantum of spacetime, and this unit of time is equal to Planck's time and is invariant. Restated, since space and time are linked as spacetime, a change in the geometry of a B-string (space) is required for time to occur.

The dimensionality of the B-string is also 11-dimensional by presuming the following progression of dimensionality:

(1) The linear one-dimensional Type I strings are one level of dimensionality, i.e. 1-brane.
(2) The two-dimensional D-brane sheets are a secondary higher level of dimensionality, i.e. 2-brane.
(3) Then, a three-dimensional configuration of all six D-branes of a B-string projecting into space simultaneously results in a third higher level of dimensionality, i.e. 3-brane.

Therefore, the addition of a 3-brane dimension to the ten dimensions previously outlined results in an eleven dimensional B-string. Both ten and eleven-dimensional models express the same concept of the B-string in different ways, i.e. the models are a duality. The equivalency or duality of 10-dimensional and 11-dimensional string theory has been shown mathematically. [8][9]

The interpretation of 26-dimensional B-string is possible by analyzing the number of simultaneous combinations of **multiple** D-branes of the B-string, see list below. These combinations of D-branes provide 15 additional dimensions to the B-string, and when combined to the previously outlined existing 11 dimensions, results in the B-string having 26 dimensions. In compiling the D-brane combinations, there can be no mirror image combinations because mirror images are anti-matter and not matter. The numbering the B-string D-branes is analogous to the numbering of a dice cube, i.e. opposite sides of the cube should add up to 7. Defining matter and anti-matter is by arbitrarily designating the side #1 D-brane combinations as matter, and the mirror image side #6 D-brane combinations as anti-matter; each D-brane combination of matter must include the side #1 D-brane, and not include side #6 D-brane anti-matter. Utilizing multiple D-brane combinations an additional fifteen dimensions are constructed:

1. 1,2
2. 1,3
3. 1-4
4. 1-5
5. 1,2,3
6. 1,3,4
7. 1,4,5
8. 1,5,2
9. 1,2,4
10. 1,3,5
11. 1,2,3,4
12. 1,3,4,5
13. 1,4,5,2
14. 1,5,2,3
15. 1,2,3,4,5

D-branes and strings are contiguous; the strings being projections from the D-brane, i.e. strings are part of the D-branes. A loop model is possible by connecting any two strings of a B-string with contiguous D-branes and completing a loop. The author posits the different mathematical models of quantum mechanics dealing with multiple higher dimensions, strings, D-branes, quantum gravity, and loops are models that are different interpretations of the B-string.

2.4 Spacetime Conversion into Matter and Anti-matter

The B-string model presupposes that a B-string in the fully contracted state defines a quantum particle of matter. The author posits that the B-string quantum particles of matter are the smallest elementary building block of matter, and are the underlying components of quarks. Quarks were first predicted by Murray Gell-Mann [[10]], and George Zweig. [[11]][[12]]

A quantum particle of matter has the maximal potential energy content for a B-string. However, spacetime energy varies: the greater the contracted state, the greater the energy content of the spacetime B-string. Opposing D-branes on any one of the three axes of a B-string are mirror images of each other. A photon of sufficient energy, interacting and transferring its kinetic energy into potential energy of a spacetime B-string, will contract the spacetime B-string into a quantum particle of matter. Subsequently, if enough energy is present, each axis of the quantum particle of matter generates mirror image particle pairs (matter and antimatter) from the abutting spacetime B-strings, propagating to form three stereo-chemically distinct matter and antimatter quark pairs.

Paul Dirac developed his relativistic wave equation for the electron in 1928, [[13]] and this equation predicted that a photon of sufficient energy could produce an electron and a particle that is the same as the electron but with an opposite charge (anti-matter). [[14]] Carl Anderson is credited for discovering empirical evidence for the existence of anti-matter in a cloud chamber experiment in 1932. [[15]]

In the B-string model, matter and anti-matter differ in that each is the physical nonsuperposable mirror image enantiomer of the other, which is contrary to Dirac's statement that the particles are identical but differ only in charge sign. If paired enantiomers possess charge, the enantiomers will possess equal and opposite charges due to their mirror image geometry. Restated, what differentiates matter and anti-matter is the geometry of enantiomeric particle pairs, and not the sign of charge of the particle, e.g. a sub-atomic particle without charge such as a neutron still has an anti-matter partner.

The author suggests that the formation of matter and anti-matter occurs when a photon with sufficient kinetic vibrational energy interacts with a single unit of spacetime, increasing the potential energy of the spacetime B-string by contracting the D-branes and strings. Once the initial unit of spacetime has converted into a quantum particle of matter, the generation of additional quantum particle pair aggregates occurs from opposing mirror image D-branes of the initial quantum particle of matter. Einstein's equation for energy and mass equivalence [16] is shown in equation 2.1,

$$E = mc^2 \qquad (2.1)$$

Using the modern values for *G*, *h*, and *c* as listed in CODATA, [17] the values for Planck's natural units of length and time [18] are shown in equations 2.2 and 2.3.

$$l_p = \sqrt{\frac{Gh}{c^3}} = \sqrt{\frac{\left(6.6742\times10^{-8}\,cm^3g^{-1}s^{-2}\right)\left(6.6261\times10^{-27}\,g\cdot cm^2\cdot s^{-1}\right)}{\left(2.9979\times10^{10}\,cm\cdot s^{-1}\right)^3}} = 4.0513\times10^{-33}\,cm \qquad (2.2)$$

$$t_p = \sqrt{\frac{Gh}{c^5}} = \sqrt{\frac{\left(6.6742\times10^{-8}\,cm^3g^{-1}s^{-2}\right)\left(6.6261\times10^{-27}\,g\cdot cm^2\cdot s^{-1}\right)}{\left(2.9979\times10^{10}\,cm\cdot s^{-1}\right)^5}} = 1.3512\times10^{-43}\,s \qquad (2.1)$$

The transition of spacetime to matter occurs when the spacetime B-string dimensions along the x, y, or z-axes take the final quantum jump down to equal one Planck's length. One Planck's length is the smallest unit of distance because further sub-division of spacetime is not possible due to the quantization of spacetime. Therefore, the smallest possible wavelength of fully contracted spacetime also equals Planck's length. Since frequency multiplied by wavelength equals the speed of light, $c = \nu\lambda$, then $\nu = c/\lambda$, then the highest possible frequency can be expressed as

$$\nu_{\max} = \frac{c}{\lambda} = \frac{2.9979\times10^{10}\,cm\cdot s^{-1}}{4.0513\times10^{-33}\,cm} = 7.4000\times10^{42}\,s^{-1} \qquad (2.2)$$

The author posits that when a photon of *sufficient* electromagnetic energy interacts with a spacetime B-string, the B-string will convert into particle matter. It now must be determined whether an individual photon can possess sufficient EM energy for spacetime to quantum particle conversion to occur. The author chooses to use the hypothetically highest frequency photon because it contains the greatest energy for possibly transforming spacetime into matter. Equation 2.5 shows the relationship of energy as a function of EM frequency. Substituting the value from equation 2.4 into the equation for energy frequency, the calculation of the maximum possible EM energy of a spacetime photon is

$$E = hf = \left(6.6261\times10^{-27}\,g\cdot cm^2\cdot s^{-1}\right)\left(7.4000\times10^{42}\,s^{-1}\right) = 4.9033\times10^{16}\,g\cdot cm^2\cdot s^{-2} \qquad (2.3)$$

Substituting the energy value of a maximum frequency photon from equation 2.5 into equation 2.1 and solving for mass,

$$m = \frac{E}{c^2} = \frac{4.9033 \times 10^{16} g \cdot cm^2 \cdot s^{-2}}{\left(2.9979 \times 10^{10} cm \cdot s^{-1}\right)^2} = 5.4556 \times 10^{-5} g \qquad (2.4)$$

It is indeed apparent that one photon can possess enough EM energy to convert spacetime into matter. It is also interesting to note the value $5.4556x10^{-5}g$ *is equal to Planck's mass*, as calculated using currently accepted values for *G*, *h*, and *c* as listed in CODATA, [19] see equations 2.7 and 2.8,

$$m_p = \sqrt{\frac{hc}{G}} = 5.4556 \times 10^{-5} g \qquad (2.5)$$

$$m_p = \sqrt{\frac{\left(6.6261 \times 10^{-27} g \cdot cm^2 \cdot s^{-1}\right)\left(2.9979 \times 10^{10} cm \cdot s^{-1}\right)}{6.6742 \times 10^{-8} g \cdot cm^2 \cdot s^{-2}}} = 5.4556x10^{-5} g \qquad (2.6)$$

Therefore, Planck's mass is the amount of mass resulting from the conversion of spacetime by a maximal frequency photon, into equal quantities of matter and anti-matter, with the combined mass totaling $5.4556x10^{-5}g$.

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(2.2)
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[17] CODATA Committee on data for Science and Technology, page 63, Table XXVI (2005).

[18] H. Lorentz, "Electrodynamic Phenomena in a System Moving with any Velocity Less than that of Light," *Proceedings of the Academy of Science of Amsterdam* **IV**, 669-678 (1904).

[19] CODATA Committee on data for Science and Technology, page 63, Table XXVI (2005).