Binary Mechanics

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ABSTRACT
Binary mechanics (BM) used a pair of relativistic Dirac equations of opposite handedness to guide quantization of space and time into binary bit loci in a cubic lattice restricted to zero or one states. The exact time development of this BM state vector is determined by the four bit operations -- unconditional, scalar, vector and strong -- applied sequentially, one each in a quantized time unit.

CONTENTS

INTRODUCTION

In the theory of binary mechanics to be presented, elementary particles are compositions of smaller entities, called binary units or **bits**. Fundamental physical constants, such as particle quantum numbers and masses, coupling constants, Planck's constant and the velocity of light, are seen in binary mechanics to result from a smaller set of more primary physical constants for energy, length and time. All known forces of nature including gravitation are unified by simple binary operations. In short, our universe is binary.

There are no continuous variables in binary mechanics. Zero and one are the only permissible bit states at any space-time location which may have only integer coordinate values. Thus, binary mechanics may be viewed as completing a historical trend culminating in the quantization of space and time.

The development of binary mechanics was guided by the representation of the relativistic Dirac equation by James Hughes (personal communication, 1993), who associated electron spinor components with neighboring, but distinct spatial loci in a cubic lattice. Quantum electrodynamic and chromodynamic dimensions beyond the four space-time dimensions are represented in binary mechanics as events occurring at neighboring spatial locations. For example, spinor and color components correspond to different bit locations.

Natural phenomena result from bit interactions over BM distance unit d. The basic equations of binary mechanics express the exact time-development of bit states in one binary unit of time, designated as a **tick**. Thus, in both principle and practice, using computer simulation technology, exact results may be obtained. The ability to completely and exactly catalog composition and life cycle of elementary particles (see "The central baryon bit cycle" and "Baryogensis") and their interactions is an example of the utility of binary mechanics. Conduct of the next generations of high energy particle physics experiments using simulation based on binary mechanics, before completion of multi-billion dollar apparatus, illustrates the possible economic utility of the theory.

This paper presents the postulates and equations of binary mechanics, the binary mechanical representation of elementary particles, such as leptons, quarks, baryons, photons and gluons, and the correspondence principles relating binary mechanics to quantum mechanical wave functions and operators and to classical mechanics, both in their relativistic forms.

THE THEORY OF BINARY MECHANICS

Binary mechanics will be presented in a representation which is convenient for expression of correspondence principles with quantum mechanical notions. The initial goal will be clarity of presentation of the basic postulates and equations of binary mechanics.

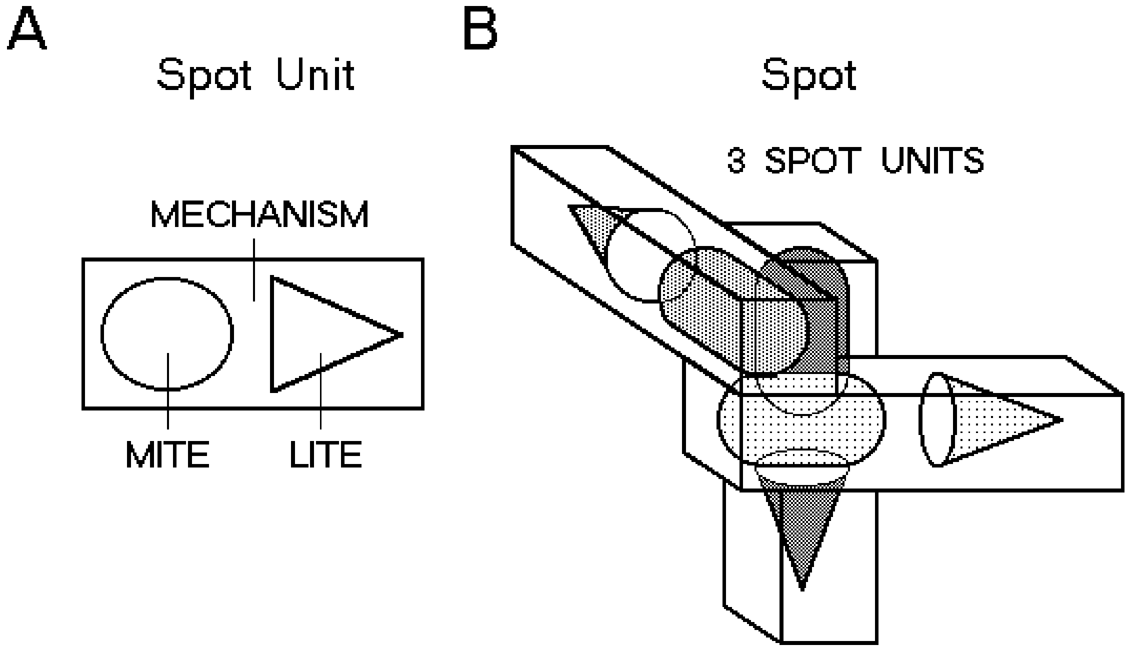
The Spot Unit

The two positive real components of the value of the complex wave function for one spatial dimension at an infinitesimal point in quantum mechanics correspond to a pair of bits residing at a location of finite dimension. The phrase **spot unit** will designate the spatial volume occupied by this bit pair in one dimension. The two bits in a spot unit, L and M, named the **lite** and the **mite** respectively, are restricted to the values or states of zero or one (Eq. 1).

$$L, M = 0, 1 \quad (1)$$

At this point, the reader may generally associate mites with "matter" and lites with "radiation," or more precisely, as constituents of spin one half and spin one particles respectively. The spot unit may be associated both with the location of the mite and lite and the mechanisms executing binary mechanical time development of bit states (Fig. 1A).

Figs. 1A and 1B



Legend: see "Physical interpretation of binary mechanical space".

[Notation: lower case is often used for alphabetical subscripts. Eg., Si]

A spatial frame, Si, i = 1, 2, 3, is chosen with position in S expressed by integer coordinates, Si, as in a cubic lattice. Spot unit bits, L and M, are oriented parallel to an axis of Si at each coordinate location $\{S_1, S_2, S_3\}$ called a **spot** (Fig. 1B). That is, a spot is a three-dimensional assembly of three spot units. The **bit state**, *B*, consists of these six bits -- the L and M bits in each of three spot units at a spot (Eq. 2).

$$Bi = Li, Mi = 0, 1; i = 1, 2, 3 \quad (2)$$

The bit state may include any number of spots and is a binary mechanical analog to the quantum mechanical state vector. A 1-state bit provides the fundamental energy unit.

Spot unit parity, P, for a spatial dimension i in S is Si modulo 2 (Eq. 3).

$$P(Si) = Si \text{ modulo } 2 = 0, 1; i = 1, 2, 3 \quad (3)$$

Reference frame S is further chosen to define **spot parity**, XYZ, in S as

$$X = P(S_1); Y = P(S_2); Z = P(S_3) \quad (4)$$

Mites and lites are characterized by three parities associated with each dimension i = 1,2,3 in S where I_i, J_i and K_i = (0,1) and are defined in the "Three Dimensional Spatial Format" section below.

Considering one dimension first, i = 1, omitting subscript i, the substrate for **electric and color charges** is a sign function of I parity in Si associated with mites (Eq. 5).

$$\text{sign}(M) = (-1)^I = +1, -1 \quad (5)$$

Mites associated with negative and positive signs are termed **nits** and **pits** respectively. From Eqs. 4 and 5, electric and color charge properties of mites depend on spot location. That is, nits occur in odd I parity spot units; pits occur in even I parity spot units.

Noting that ascending and descending values of spot coordinates, Si, are deemed to be right and left respectively, the substrate for **handedness** is lite sign and depends on K parity in Si (Eq. 6) where positive and negative lite sign indicates right and left handedness respectively.

$$\mathrm{sign}(L) = (-1)^K = +1, -1 \quad (6)$$

Lite sign is considered to represent the physical order of mite and lite bits in a spot unit, shown in Figs. 1 and 2A to 2C. For spot units with K = 0, the lite bit is to the right of the mite bit. With K = 1, lites are to the left of mites. The right or left lite bit position in a spot unit is said to point in the spot unit direction or lite direction.

Since M and L may not assume negative values, these mite and lite sign functions pertain to relative bit positions and associated physical properties. For each dimension i, four variations of spot units occur (Table 1, Fig. 2A to 2C): right or left, each with either nit or pit. The spatial arrangement of spot unit bits is listed in Table 1 in the rows labeled B(XYZ)x, B(XYZ)y and B(XYZ)z for the eight permutations of the three parity values XYZ, where x, y and z denote one of three spot units and B components are products of sign functions (Eqs. 5 and 6) with corresponding *B* bits (Eq. 2).

Table 1: Spot Lattice Components in Binary Mechanics

Spot XYZ	000	001	010	100	011	101	110	111	Parity
B(XYZ)x	+ >	< +	+ >	- >	< +	< -	- >	< -	Symbols
B(XYZ)y	+ >	+ >	- >	< +	- >	< +	< -	< -	< = -L; > = L
B(XYZ)z	+ >	- >	< +	+ >	< -	- >	< +	< -	- = -M; + = +M
B(XYZ)x	L, M	-L, M	L, M	L,-M	-L, M	-L,-M	L,-M	-L,-M	Signed
B(XYZ)y	L, M	L, M	L,-M	-L, M	L,-M	-L, M	-L,-M	-L,-M	pairs
B(XYZ)z	L, M	L,-M	-L, M	L, M	-L,-M	L,-M	-L, M	-L,-M	L, M = 0, 1
B^C(XYZ)x	+L+iM	-L+iM	+iL+ M	+L-iM	-iL+ M	-L-iM	+iL- M	-iL- M	Signed
B^C(XYZ)y	+L+iM	+iL+ M	+L-iM	-L+iM	+iL- M	-iL+ M	-L-iM	-iL- M	complex
B^C(XYZ)z	+L+iM	+L-iM	-L+iM	+iL+ M	-L-iM	+iL- M	-iL+ M	-iL- M	L, M = 0, 1
Q	+1	+1/3	+1/3	+1/3	-1/3	-1/3	-1/3	-1	∑(sign(Mi)/3)
Handedness	+1	-1	-1	-1	+1	+1	+1	-1	∏(sign(Li))
C1H (red)	0	0	0	-1	+1	0	0	0	Spot Color
C2H (green)	0	0	-1	0	0	+1	0	0	+1 = color
C3H (blue)	0	-1	0	0	0	0	+1	0	-1 = anticolor
T3(XYZ)/4	0	0	+1/2	-1/2	+1/2	-1/2	0	0	(X-Y)/4
T8(XYZ)/4√3	0	+1	-1/2√3	-1/2√3	+1/2√3	+1/2√3	-1	0	(X+Y-2Z)/4√3
Particles	e+R lepton pos.	/dbL quark /blue	/dgL quark /green	/drL quark /red	drR quark red	dgR quark green	dbR quark blue	e-L lepton elec.	One Spot d = down / = anti
Lites X	photon R	gluon L /b>g	gluon R /g>b	photon R	photon L	gluon L g>/b	gluon R b>/g	photon L	L = -1; R = +1
Lites Y	photon R	gluon R /b>r	photon R	gluon L /r>b	gluon R r>/b	photon L	gluon L b>/r	photon L	
Lites Z	photon R	photon R	gluon L /g>r	gluon R /r>g	gluon L r>/g	gluon R g>/r	photon L	photon L	

Legend: X, Y and Z are spatial dimensions in spot lattice S.

Unconditional Bit Motion

The unconditional bit operation of the time-development equations of binary mechanics represents a bit shift in the spot unit directions (Fig. 2A) and may be expressed as

L(t=1) = M(t=0) = 0, 1 (7)

M(t=1) = Lx(t=0) = 0, 1 (8)

where t is the time tick and Lx is the adjacent lite in the preceding spot unit, with reference to lite direction, pointing to the M and L spot unit, allowing omission of position subscripts. In computer terminology, lite Lx is analogical to the "carry bit" from the bit shift in the preceding spot unit.

Fig. 2A: Mites and lites shift in lite direction

```
 Si coordinate  1     2     3     4     5     6     7     8
   I Parity     1     0     1     0     1     0     1     0
                -  >  +  >  -  >  +  >  -  >  +  >  -  >  +  >
J=1; K=0; t=0   0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 Scalar Φ = 0
                <  -  <  +  <  -  <  +  <  -  <  +  <  -  <  +
J=0; K=1; t=0   0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 Vector A = 0
                -  >  +  >  -  >  +  >  -  >  +  >  -  >  +  >
J=0; K=0; t=0   1  0  1  0  0  1  0  1  0  0  1  1  1  1  0  0 Sample data
                -  >  +  >  -  >  +  >  -  >  +  >  -  >  +  >
J=0; K=0; t=1   0  1  0  1  0  0  1  0  1  0  0  1  1  1  1  0 Shift right
```

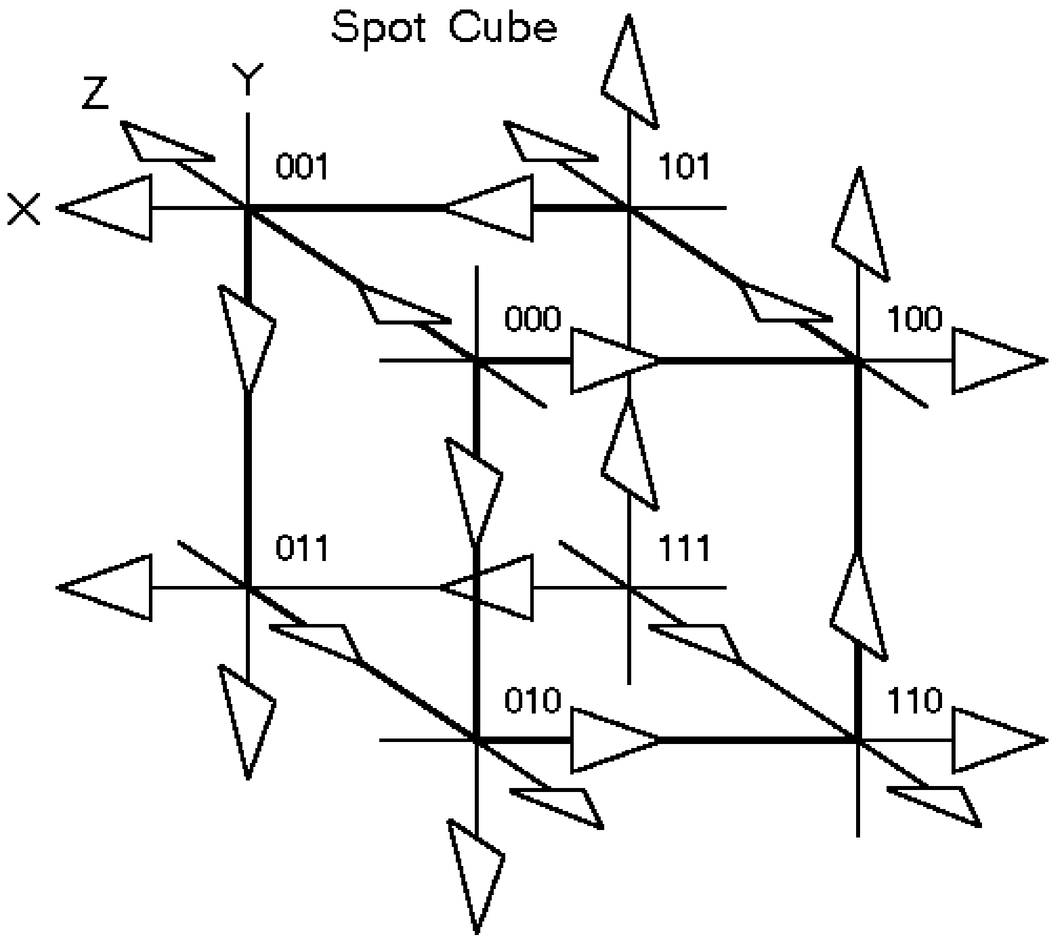
In one tick, mites produce lites within spot units and lites produce mites in the next spot units in the lite direction. In Eqs. 7 and 8, the lite and mite states at t = 1 do not depend on their t = 0 states. It may be said that in one tick, mites "radiate" lites and lites "materialize" as mites. These are general effects, since lites in Eq. 7 are constituents of photons or gluons (see Photons and Gluons).

At this level of fineness, the radiation-absorption coupling constants equal one, and hence, are not explicitly written in Eqs. 7 and 8. That is, the strength of different conventional forces, as expressed in values such as the alpha coupling constant is a function of the proportions of selected bit operations in a space volume per unit time, since each bit motion is exactly one unit of distance in one unit of time regardless of the potential (or bit operation) involved.

Electromagnetic Force

To add electromagnetic scalar and vector potential bit operations to the lite and mite Eqs. 7 and 8, it is convenient to define a **spot cube** as the eight spots (Table 1) in the cube with solid diagonal from spot XYZ = 000 to spot XYZ = 111 (Fig. 1C).

Fig. 1C



Each face of the spot cube includes **countercurrent** pairs of parallel spot units pointing in opposite directions. Each of these spot units also are adjacent to **concurrent** spot units pointing in the same direction in adjacent spot cubes (Fig. 1C). Concurrent spot units within a spot cube are not adjacent and therefore are not thought to interact per the scalar potential. Bits in concurrent and countercurrent spot unit pairs have inverse J and K parities respectively.

Lateral interactions between concurrent and countercurrent spot units mediate scalar potentials between spot cubes and vector potentials within spot cubes respectively (see "Electromagnetic bit operations revised").

SCALAR POTENTIAL. The classical scalar potential, Φ, is the presence of a concurrent mite, M_J, which has the attribute of electric charge,

$$\Phi = M_J = 0, 1 \quad (9)$$

where M_J is the mite in the adjacent concurrent spot unit in the same Si dimension with respect to M. That is, M_J is in spot unit I1K if M is in spot unit I0K, and vice versa.

Thus, the electric field is the mite distribution in a space volume.

Let e equal the absolute value of the electric charge of a mite. Interaction of mite electric charge and the classical scalar potential, eΦ, corresponds to the product of concurrent mites,

$$e\Phi = MM_J = 0, 1 \quad (10)$$

where J designates the mite in the concurrent spot unit. This mite-state product defines the force of the scalar potential in binary mechanics. The sign of the charges of M and M_J are always the same and thus can be disregarded in using the absolute value required to obtain zero or one values, since the physical result is always dispersion of like-signed charges.

In the scalar potential tick, this concurrent mite product (Eq. 10) at t = 0 results in mite motion to lite loci in the spot units if they were in the zero state (empty), as shown in Fig. 2B.

Fig. 2B: Scalar potential accelerates mites

```
 Si coordinate  1     2     3     4     5     6     7     8
   I Parity     1     0     1     0     1     0     1     0
                <  -  <  +  <  -  <  +  <  -  <  +  <  -  <  +
J=0; K=1; t=0   0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 Vector A = 0
                -  >  +  >  -  >  +  >  -  >  +  >  -  >  +  >
J=1; K=0; t=0   1  0  1  1  1  0  1  0  1  0  1  0  1  0  1  0 Scalar Φ = 1
                -  >  +  >  -  >  +  >  -  >  +  >  -  >  +  >
J=0; K=0; t=0   1  0  1  0  0  1  0  1  0  0  1  1  1  1  0  0 Sample data
                -  >  +  >  -  >  +  >  -  >  +  >  -  >  +  >
J=1; K=0; t=1   0  1  1  1  1  0  1  0  1  0  0  1  0  1  1  0 Mites move
                -  >  +  >  -  >  +  >  -  >  +  >  -  >  +  >
J=0; K=0; t=1   0  1  0  1  0  1  0  1  0  0  1  1  1  1  0  0 Mites move
```

The scalar potential Φ is revealed to consist of three spatial components, which is a new result of binary mechanics. For example, in the electron spot (Table 3), mites circulate rapidly among the three spatial dimensions which may explain why directionality of the scalar potential has not yet been observed experimentally.

VECTOR POTENTIAL. In the classical treatment, the vector potential is viewed as the direction of a magnetic field. In binary mechanical countercurrent spot units, the vector potential component A is

$$A = L_K = 0, 1 \quad (13)$$

omitting the dimensional subscript i for A and L, where K designates the lite bit in the adjacent countercurrent spot unit.

Hence, the magnetic field is the lite distribution in a space volume. These lites may exert force on an adjacent countercurrent mite (q)

$$qA = ML_K \quad (14)$$

Vector potential A results in mite motion to lite loci, if empty, as shown in Fig. 2C.

Fig. 2C: Vector potential accelerates mites

```
 Si coordinate  1     2     3     4     5     6     7     8
   I Parity     1     0     1     0     1     0     1     0
                -  >  +  >  -  >  +  >  -  >  +  >  -  >  +  >
J=1; K=0; t=0   0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 Scalar Φ = 0
                <  -  <  +  <  -  <  +  <  -  <  +  <  -  <  +
J=0; K=1; t=0   1  0  1  0  1  0  0  1  1  0  1  1  0  1  1  0 Vector A = 1
                -  >  +  >  -  >  +  >  -  >  +  >  -  >  +  >
J=0; K=0; t=0   1  0  1  0  0  1  1  1  0  0  0  1  1  1  0  0 Sample data
                <  -  <  +  <  -  <  +  <  -  <  +  <  -  <  +
J=0; K=1; t=1   1  0  1  0  1  0  1  0  1  0  1  1  1  0  1  0 Mites move
                -  >  +  >  -  >  +  >  -  >  +  >  -  >  +  >
J=0; K=0; t=1   0  1  0  1  0  1  1  1  0  0  0  1  1  1  0  0 Mites move
```

Table 2: Some Binary Mechanical Expressions

```
Quantity             Logical (True = 1)      Algebraic
```

Mite	M	M
Lite	L	L
Scalar Potential Φ	M_J	M_J
Vector Potential A	L_K	L_K
Strong Potential F	B_s and not B_d where s and d are source and destination bits.	$B_s(1 - B_d)$
Color Charge C_i	I_i xor I_n and not I_n xor I_p	$P(I_i + I_n)(1 - P(I_n + I_p))$
Neutrino v^M	not M	1 - M
Neutrino v^L	not L	1 - L

Gravitational Force

At present gravity is not considered to be fundamental force implemented by postulating an additional bit operation, but rather joins the electroweak and neutral weak forces as consequences of the primary forces (Table 4 below). Other reports (e.g., "Gravity looses primary force status" and "Gravity increased by surface temperature") argue with supporting data that gravity is a consequence of the four fundamental bit operations -- unconditional, scalar, vector and strong.

Energy Conservation

Annihilation and creation operations at the single bit level have not yet been defined. That is, each 1-state bit may be viewed as one unit of energy, which is conserved.

Three Dimensional Spatial Format

Spatial dimensions i = 1, 2, 3 are considered to be a cyclic ordered set. To generalize Eqs. 1 to 14 for each of three spatial dimensions, rotation matrix, R, a third root of unity, is used (Eqs. 19).

$$R = \begin{vmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{vmatrix}; \quad R^2 = \begin{vmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{vmatrix}; \quad R^3 = \begin{vmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{vmatrix} \quad (19)$$

Premultiplication of spot parity values XYZ (Eqs. 4) in S defines

$$\begin{vmatrix} I_2 \\ J_2 \\ K_2 \end{vmatrix} = R \begin{vmatrix} I_1 \\ J_1 \\ K_1 \end{vmatrix}, \text{ for } i=2; \quad \begin{vmatrix} I_3 \\ J_3 \\ K_3 \end{vmatrix} = R^2 \begin{vmatrix} I_1 \\ J_1 \\ K_1 \end{vmatrix}, \text{ for } i=3 \quad (20)$$

where $I_2J_2K_2$ and $I_3J_3K_3$ apply to spot units parallel to dimensions i = 2 and 3 respectively.

For example, mite and lite signs are obtained by substitution of I_2 and K_2 in Eqs. 5 and 6 for i = 2 and of I_3 and K_3 for i = 3. These results are listed in Table 1 in the rows labeled $B(XYZ)_y$ and $B(XYZ)_z$ for i = 2 and 3 respectively. J_1, J_2 and J_3 parities are used to identify location in S of concurrent mites with reference to any spot unit. In this text, XYZ = $I_1J_1K_1$.

Indeed, Eqs. 1 to 18 apply for all three spatial dimensions when the $I_iJ_iK_i$ parities applicable to spot unit alignment in S are used (Eqs. 4 and 20). This statement is equivalent to the stipulation that a rotation applied to reference frame S must also be applied to reference parities $I_1J_1K_1$ (XYZ in Eqs. 4) to maintain invariance of physical phenomena.

Thus far, bit transitions in one spatial dimension, including lateral interactions between parallel spot units in adjacent spots, have been described. Interactions between pairs of the three spot units within a single spot will now be presented.

Strong Potential

The strong force results from interactions between pairs of spatial dimensions at a spot locus (see "Strong operation disabled by inertia"). For a notation expressing the cyclic order of spatial dimensions i, let

$$n = 1 + (i \text{ modulo } 3);\ p = 1 + (n \text{ modulo } 3);\ n, p, i = 1, 2, 3 \quad (23)$$

so that n and p specify the next and the previous dimensions respectively for any dimension i in the cyclic ordered set.

The strong potential F is a bit gradient within a spot from a source (s) bit in dimension i to a vacant destination (d) bit loci site in dimension n or p: $B_s(1 - B_d)$ (Table 2). Bit transitions from dimension i-to-p or from i-to-n depend on the presence of the strong potential F between the pairs of dimensions in their cyclic order within a tick interval and the absence of **inertia** in the source spot unit,

$$F_{ip} = B_i(1 - B_p)(1 - B_{i*}) = 0, 1 \quad (24)$$

$$F_{in} = B_i(1 - B_n)(1 - B_{i*}) = 0, 1 \quad (25)$$

where B_p is the bit in the previous dimension p and B_n is the bit in the next dimension n (Table 2). The first factor, B_i, assures the result equals one only when the source bit in the gradient is one. The second factor asserts that the destination bit must be zero, else there is no strong potential gradient. Finally, the third factor, where * denotes the other bit in the source spot unit, assures the the strong force can be one only in the absensce of a binary mechanical quantity called inertia which is the product of mite and lite bits in a spot unit. In short, if the source spot unit has inertia, the strong force and defining bit operation is disabled.

Strong interactions F_{ip} and F_{in} represent intraspot bit gradients between dimensions within a tick interval conditioned by inertia. For example, strong force F_{ip} equals one only if $B_i = 1$, $B_p = 0$ and $B_{i*} = 0$ (Eq. 24). In effect, F_{ip} implements a simple interdimensional bit transition, which is the mechanism of the strong force.

The i-to-p direction of bit motion (Eq. 24), x-to-z, z-to-y and y-to-x in space S, occurs in right-handed spots (Table 1). The i-to-n motion (Eq. 25), x-to-y, y-to-z and z-to-x, occurs in left-handed spots such as the electron. Together, this cyclic order of the dimensions in strong bit operations creates **chirality** associated with spot handedness and spin sign.

In sum, each force -- scalar, vector and strong, is the product of a potential and another factor, namely a mite for scalar and vector potentials and absent inertia $(1 - B_{i*})$ for strong potentials. As described below, $1 - B_{i*}$ may be viewed as a neutrino bit.

Bit State Time Development

Eqs. 24 and 25 complete the present time development representation of binary mechanics, which may be summarized in **bit function**

$$B[T=1] = f(s(u(v(B[T=0])))) \quad (26)$$

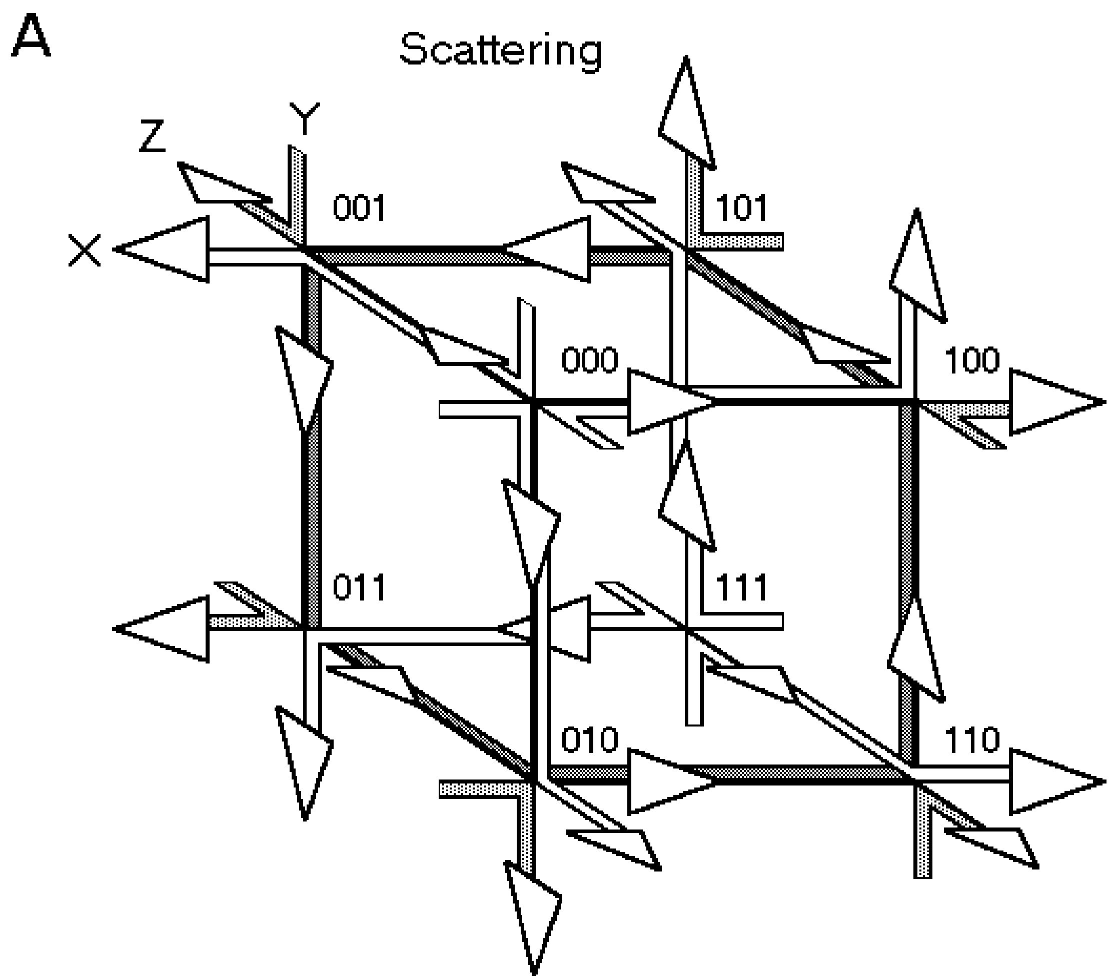
where B is the bit distribution (Eq. 2) at initial and final states (Tick 0 and 1), and f, v, s and u are the strong, vector, scalar and unconditional bit operations respectively, assuming each operation requires one sub-tick to implement. These sub-ticks may be viewed as the fundamental time unit. That is, sequential application of the four bit operations completes one operator cycle, which defines the Tick unit used in simulation software and in the following text (Tick with capital T). In contrast, the v and s operations are apparently simultaneous in Maxwell's equations and the Lorentz Force. At present, the correct order to apply the v, s and u bit operations is unsettled (see "Bit operations order").

More results of selected applications will now be presented, to further elaborate and justify the basics of binary mechanics. The fundamental justification would be, of course, that the equations provide exact results for all physical phenomena.

Scattering

The strong potential "scatters" bits. In subsequent Ticks, the scatter direction is the lite direction of the destination spot unit in the dimension to which the bit scatters (Fig. 3A).

Fig. 3A



Scattering will not occur and bits will move in one direction in a channel along a dimension as long as the strong potential F is zero or inertia equals one.

On the other hand, if the strong force equals one and unconditional bit motion is applied, bits will cycle through a series of spot units within or among spots as a result of intraspot bit transitions defining strong interactions (Fig. 3A). These sequences can result in bit cycling where a bit returns to its original loci, an important factor in the binding of bits into elementary particles, which occurs when such a particle is considered to be at rest.

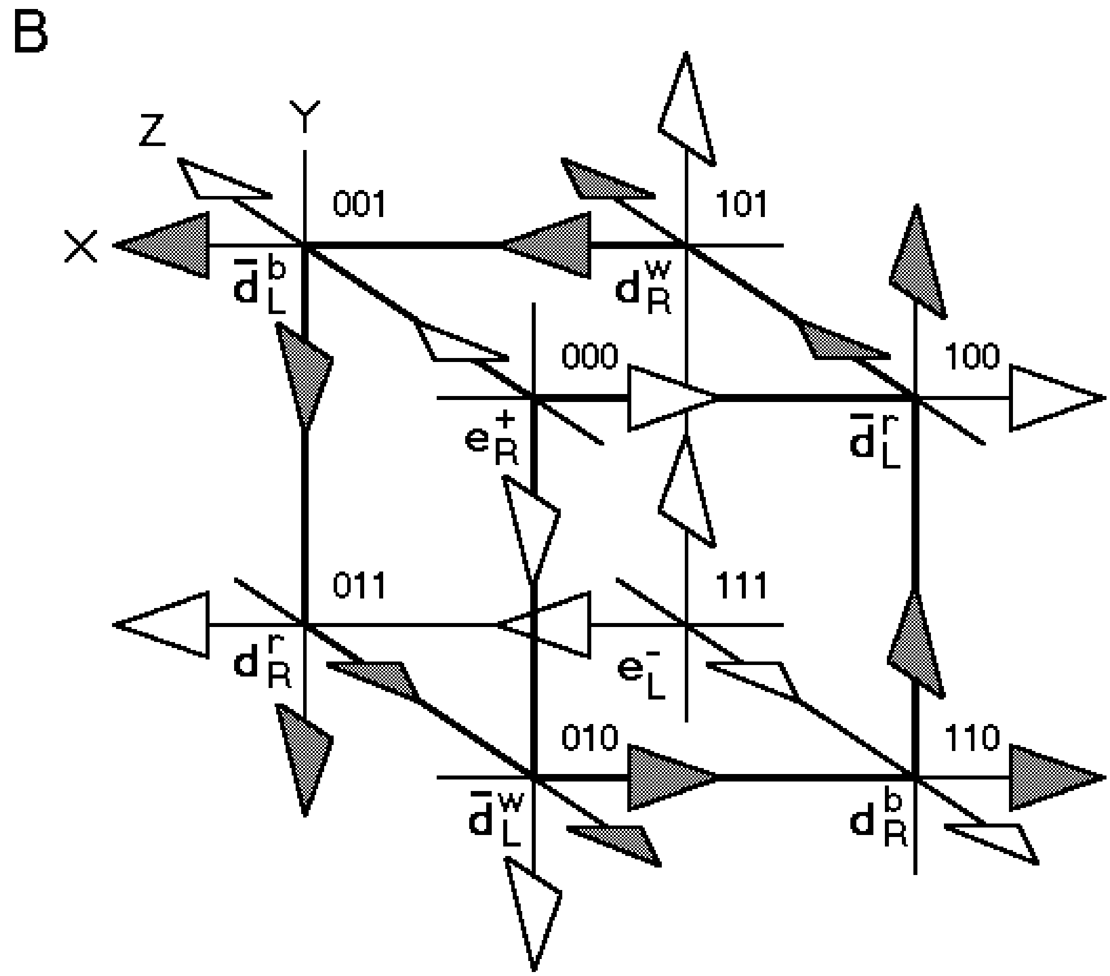
Mechanisms determining the form of the Yukawa potential are readily apparent. Let a number of bits be concentrated into a smaller volume, by, say, converging lite energy. The Yukawa potential and the average interbit distance will decrease, as the average binary mechanical strong potential decreases toward zero. As the strong potential decreases, bits will tend to disperse into a larger volume. When bit density decreases, the average strong potential increases toward maximum bit cycling, preventing further bit dispersion. In short, the Yukawa potential is a measure of bit cycling, which is an instance of strong potential scattering.

As described, all scattering occurs at fixed angles of 90 degrees in S, chosen to establish spatial symmetry. Thus, measured scattering angles distinguish among various interactions by their relation to the proportions of bits scattered in particular interactions over a particular distance and time interval. A complete analysis of scattering data would incorporate possible alterations in observed bit velocities due to scalar or vector potentials.

Electrons, Positrons and d Quarks and Antiquarks

The eight spots in a spot cube are associated with the electron, the positron and the six d flavor quarks (Table 1, Fig. 3B and Elementary Particles). These assignments should not be confused with the entirety of the particles themselves. Also, much "heavier" particles associated with very short half-lives can be defined to include spots in multiple spot cubes.

Fig. 3B



Legend: The white (w) color designation was changed to green in the Standard Model.

To obtain these results, three spot attributes are defined (Table 1): (1) spot electric charge, Q, (2) spot handedness and (3) spot color charge.

1. **Spot Electric Charge**

Spot electric charge, Q, is defined as the sum of mite signs at a spot, which depend on spot parities Ii (Eq. 5).

$$Q = (1/3) \sum \mathrm{sign}(Mi)$$
$$= (1/3) \sum (-1)^{Si}$$
$$= (1/3)((-1)^{I} + (-1)^{J} + (-1)^{K})$$
$$= \pm 1, \pm 1/3; i = 1, 2, 3 \quad (29)$$

Table 1 lists the binary mechanical results for spot electric charges, Q (Eq. 29), with Q = +1 and -1 for the positron and electron spots respectively and with Q = +1/3 and -1/3 for d antiquark and d quark spots respectively.

The signs of the spot electric charges and the ratios of pairs of spot electric charge values both agree with accepted values. Hence, each spot corresponds unambiguously with the lepton and d quark particle and antiparticle assignments in Table 1.

2. **Spot Handedness**

The handedness of one-spot particles corresponds to spot handedness, H, which is the product of spot lite signs (Eq. 30).

$$H = \mathrm{sign}(L1)\mathrm{sign}(L2)\mathrm{sign}(L3) = \prod \mathrm{sign}(Li) = +1, -1 \quad (30)$$

where H = +1 for right (R) and one-spot particles, and H = -1 for left (L) and one-spot antiparticles. Table 1 and Fig. 3B show results from Eq. 30 for spots XYZ in a spot cube.

3. **Spot Color Charge**

The exclusive-or logical function of pairs of spot unit parity values I, J and K, may be written as the parity (Eq. 3) of the sum of two parity values and used to define spot color charges.

$$r \text{ or } g = P(I + J);$$
$$g \text{ or } b = P(J + K);$$
$$b \text{ or } r = P(K + I); r, g, b = 0, 1 \quad (31)$$

where r, g and b are the red, green and blue color charges respectively and I, J and K are parities of position Xi in S (Eqs. 4). The color charges are the exclusive-or of the parities of a sequential pair of spatial dimensions in the cyclic ordered set (Eqs. 31).

Eqs. 31 may be combined to uniquely define color charges.

$$r = P(I + J)(1 - P(J + K));$$
$$g = P(J + K)(1 - P(K + I));$$
$$b = P(K + I)(1 - P(I + J)); r, g, b = 0, 1 \quad (32)$$

Using spot unit parities from Eqs. 20 with subscripts from Eqs. 23, Eqs. 32 may be summarized in one expression (Eq. 33).

$$Ci = P(Ii + In)(1 - P(In + Ip)) = 0, 1 \quad (33)$$

where i = 1 for red, 2 for green, 3 for blue. The logical form of this definition is given in Table 2.

Since I parity in each dimension i (Eqs. 20) defines mite sign (Eq. 5), Eq. 33 states that a non-zero color charge Ci occurs when mites Mi and Mn have opposite sign (Ii not equal to In) and Mn and Mp have the same sign (In equal to Ip). If mites Mi, Mn and Mp all have the same sign, as in the lepton spots, all three color charges, Ci, are zero.

The resulting Ci values in a spot cube consist of four mutually exclusive color charge states: red, green, blue and none. Each of the four color charge states, including the none state, is mapped to a pair of particle-antiparticle spots at solid diagonal loci in the spot cube (Fig. 3B). The parity functions in Eq. 33, then, map or project position Xi in S to position, Ci, in a "color" subspace of S, which is identical to one half of a spot cube consisting of antiparticle spots.

Table 1 and Fig. 3B show these results, which correctly assign non-zero color charges to d quarks and zero color charge to electrons and positrons. The product of color charge, Ci, and handedness, H, is displayed in Table 1, for the conventional association of anticolor charges with antiparticles.

Substitution of Eqs. 4 in Eq. 33 emphasizes this definite relation between color charges, Ci, i = 1, 2, 3, for red, green and blue respectively, and spatial dimensions i in S. If i = 1,

$$C1 = P(P(X1) + P(X2))(1 - P(P(X2) + P(X3))) = 0, 1 \quad (34)$$

the red color charge, C1, is clearly a function of the parities of spot position, Xi, in the three spatial dimensions.

SU(3) Symmetry Matrices

The conventional values of the two components of color charge at each spot may be obtained from binary mechanical variables by the dot products of mite signs i (Eq. 5) and the diagonal elements i of SU(3) symmetry matrices T_3 or T_8,

$$T_3(XYZ) = \mathrm{diag}(T_3)_i \mathrm{sign}(M_i XYZ)$$

$$T_8(XYZ) = \mathrm{diag}(T_8)_i \mathrm{sign}(M_i XYZ) \quad (35)$$

where $\mathrm{sign}(M_i XYZ)$ are the three mite signs at a spot XYZ. Substituting the T_3 and T_8 diagonal values in Eqs. 35,

$$T_3(XYZ) = \mathrm{sign}(M_1 XYZ) - \mathrm{sign}(M_2 XYZ)$$

$$T_8(XYZ) = \mathrm{sign}(M_1 XYZ) + \mathrm{sign}(M_2 XYZ) - 2\mathrm{sign}(M_3 XYZ) \quad (36)$$

Table 1 lists the resulting values of $T_3(XYZ)$ and $T_8(XYZ)$ from Eqs. 35, with conventional normalization by using factors of (1/4) and $(1/4\sqrt{3})$ respectively. The consistency in spot color charge results from Eqs. 33 and 35 supports the binary mechanical definition of color charges.

To summarize, spot electric charge Q, color charges Ci and handedness H unambiguously associate each spot with a distinct particle class. Table 1 presents these results. Binary mechanics unifies electric and color charges, which are both based on mite signs defined by Ii parities.

Because the strong potential can occur in any spot, it functions to bind the bit constituents of d quarks as well as of the electron and positron. The role of the strong force in the internal binding of these leptons is a new result of binary mechanics.

Number of d Quark Spots

Table 3 lists particles which can be defined considering only one spot cube, including quarks, leptons and mesons by the number of d quark spot components of each. Quarks and mesons are distinguished by odd and even numbers of d quark spots respectively. The sum of the products of spot color charge (Eq. 33), C(XYZ), and spot handedness (Eq. 30), H(XYZ), modulo 3, equals +1 or -1 for quarks and antiquarks respectively, and equals zero for the leptons and mesons, in agreement with accepted conventions.

Table 3: Quarks, Leptons and Mesons by Number of d Quark Spots

	Spot XYZ	000	001	010	100	011	101	110	111	Q
ZERO-d	Leptons									
	e+R	X								+1
	e-L								X	-1
ONE-d	d Quarks									
	/drL				X					+1/3
	/dwL			X						+1/3
	/dbL		X							+1/3
	drR					X				-1/3
	dwR						X			-1/3
	dbR							X		-1/3
	u Quarks									
	urL	X				X				+2/3
	uwL	X					X			+2/3
	ubL	X						X		+2/3
	/urR				X				X	-2/3
	/uwR			X					X	-2/3
	/ubR		X						X	-2/3
TWO-d	Leptons									
	μ+	X			X	X				+1
		X		X			X			
		X	X					X		
	μ-				X	X			X	-1
				X			X		X	
			X					X	X	
	Light Mesons									
	π0 (/dd)				X	X				0
				X			X			
			X					X		
	π+ (/du)	X			E	E				+1
		X		E			E			
		X	E					E		
	π- (/ud)				E	E			X	-1
				E			E		X	
			E					E	X	
	π0 (/uu)	X			X	X			X	0
		X		X			X		X	
		X	X					X	X	
THREE-d	s Quarks									
	/srL			X	X		X			+1/3
			X		X			X		
	/swL			X	X	X				+1/3
			X	X				X		
	/sbL		X		X	X				+1/3
			X	X			X			
	srR			X		X	X			-1/3
			X			X		X		
	swR				X	X	X			-1/3
			X				X	X		
	sbR				X	X		X		-1/3
				X			X	X		
	c Quarks									
	crR	X		X		X	X			+2/3
		X	X			X		X		
	cwR	X			X	X	X			+2/3
		X	X				X	X		
	cbR	X			X	X		X		+2/3
		X		X			X	X		
	/crL			X	X		X		X	-2/3
			X		X			X	X	
	/cwL			X	X	X			X	-2/3

			X	X				X	X	
	/cbL		X		X	X			X	-2/3
			X	X			X		X	
	Leptons									
	τ+		X	X	X					+1
	τ-					X	X	X		-1
	Nonstrange Baryons									
	p (uud)	X				X	X	X		+1
	/p (/u/u/d)		X	X	X				X	-1
	n (udd)	X				X	X	X	X	0
	/n (/u/d/d)	X	X	X	X				X	0
FOUR-d	Strange Mesons									
	K0			X	X	X	X			0
	(d/s=/ds)		X		X	X		X		
			X	X			X	X		
	K+ (u/s)	X		X	X	X	X			+1
		X	X		X	X		X		
		X	X	X			X	X		
	K- (/us)			X	X	X	X		X	-1
			X		X	X		X	X	
			X	X			X	X	X	
	K0	X		X	X	X	X		X	0
		X	X		X	X		X	X	
		X	X	X			X	X	X	
	Charmed Mesons									
	D0	X		X	X	X	X		X	0
	(u/c=/uc)	X	X		X	X		X	X	
		X	X	X			X	X	X	
	D+ (/dc)	X		X	X	X	X			+1
		X	X		X	X		X		
		X	X	X			X	X		
	D- (d/c)			X	X	X	X		X	-1
			X		X	X		X	X	
			X	X			X	X	X	
FIVE-d	b Quarks									
	/brL		X	X	X		X	X		+1/3
	/bwL		X	X	X	X		X		+1/3
	/bbL		X	X	X	X	X			+1/3
	brR		X	X		X	X	X		-1/3
	bwR		X		X	X	X	X		-1/3
	bbR			X	X	X	X	X		-1/3
	t Quarks									
	trR	X	X	X		X	X	X		+2/3
	twR	X	X		X	X	X	X		+2/3
	tbR	X		X	X	X	X	X		+2/3
	/trL		X	X	X		X	X	X	-2/3
	/twL		X	X	X	X		X	X	-2/3
	/tbL		X	X	X	X	X		X	-2/3
SIX-d	Top/Bottom Mesons									
	B0		X	X	X	X	X	X		0
	B0	X	X	X	X	X	X	X	X	0
	B+	X	X	X	X	X	X	X		+1
	B-		X	X	X	X	X	X	X	-1

Note: A reader has pointed out that Table 3 is incomplete. Please note this paper was written in 1994 and may have contained errors then, not to mention now -- some 16 years later. Please update Table 3 and I'll cite your work. The point of Table 3 is simply that binary mechanics predicts all possible "particles" and is generally backward-compatible with the Standard Model.

One, three and five d quark components correspond to the three pairs -- d and u, s and c, and b and t respectively -- of quark **flavors**. The flavor classification is completed by adding positron or electron spots for quarks with +2/3 and -2/3 electric charge, Q, in each of the three rest mass categories. In general, the electric charge, Q, of a particle corresponds to the sum of Q (Eq. 29) over its spot components XYZ.

Leptons are represented similarly. The electron and positron have zero d quark components, while the muon, $\mu^{\pm}$, and tau, $\tau^{\pm}$, add the even numbers of two and four d quark spots respectively. For this purpose, neutrinos (Eqs. 37 below) are not listed.

In brief, the analysis thus far has provided a qualitative accounting for the progression of increased rest masses in the three varieties of both quarks and leptons. Further, the basis of the larger quark rest masses, compared especially with the electron and positron masses, is no doubt attributable to the d quark bit cycle described above.

The spot components of particles in Table 3 are one-Tick states. If these components define particle composition in an odd or even Tick, then most, if not all, other mite patterns in the alternate parity Tick, such as those shown in Table 3, could presumably occur, with the only constraints being Eqs. 26 and 28. Thus, during multi-Tick intervals, spot cubes may contain representations of two particles from the lepton, quark or meson set, accounting for observed "resonance" states. Further analysis might identify baryon and other states as examples of this sort of multi-Tick resonance and of more complex intercube patterns. For example, the muon, $\mu^{\pm}$, and charged pion, $\pi^{\pm}$, states are distinguished by assigning the pion d quark components to adjacent extracubic spots (E in Table 3), which in the next two Ticks, would converge on a lepton spot, consistent with observed probable decay products of charged pions.

In summary, it appears that a complete listing of quarks, leptons and mesons (Table 3) may be based on spot components in a spot cube or adjacent spot cubes.

Photons and Gluons

Table 1 and Fig. 3B also categorize lites within and between spot cubes. For any line of spot units extending within and between spot cubes, which may be called a channel, all lites are either gluon or photon bits.

Interactions between sequential spot units along any dimension i, requiring, of course, a two Tick interval, are called **direct interactions**. **Indirect interactions** are sequences of direct interactions over four or more Ticks. **Intracube** and **intercube** interactions will refer to interactions within and between spot cubes respectively.

All direct interactions involve spot unit pairs of the same handedness linking spots of opposite handedness.

Lites from electron and positron spots -- photon constituents -- may only participate in intracube direct interactions, since the respective lite directions are confined to the spot cube. Further, these photonic lites from lepton spots can only mediate direct interactions between spots associated with either particles or antiparticles, never both. All intracube photonic lites mediate direct interactions linking lepton spots with d quark spots. Finally, all intercube photonic lites originate from d quark spots in one cube and transfer to electron or positron spots in another cube, where the direct interaction links spots of the same particle-antiparticle class.

There are no direct interactions among pairs of electron and positron lepton spots. All interactions between electrons and positrons are intercubic, since there is no intracube lite path linking electron and positron spots, and are indirect, as evident by inspection of Fig. 3 imagining two adjacent spot cubes. Indirect interactions between electron spots or between positron spots are mediated by one d quark spot over four Ticks. Indirect interactions between electron and positron spots require two d quark spots over six Ticks.

Lites of d quark spots are identified as gluonic or photonic on the basis of the direct interactions mediated.

1. **Gluonic lites** -- gluon constituents -- link d quark spots and mediate intracube and intercube direct interactions only between particle and antiparticle d spot pairs. Color charge transfer is mediated by gluon lite bits in direct interactions between d quark spots as shown in Table 1 and Fig. 3. Intracube gluonic lites form a cyclic path through all of the d quark spots in a spot cube (Fig. 3), utilized in the bit cycling phenomena described above. Intercube gluonic lites may scatter in the next Tick out of the destination cube (Fig. 3).

2. **Photonic lites** from d quark mites mediate intercube direct interactions with the lepton spots, as stated above.

Lite Scattering Interactions

Bits never collide. Collisions occur between bits and spots. Combination of spot scattering angles (Fig. 3A) and particle identifications (Fig. 3B) define four categories of lite scattering interactions over two Tick intervals.

1. **Intracube gluon scattering** follows the intracube d quark lite path and consists of gluon-to-gluon interactions at d quark spots, resulting in the intracube bit cycling described above.

2. **Intracube photon scattering** may convert lepton spot lites to centrifugal d quark lites. That is, d quark spots may scatter intracube photonic lites to gluonic lites exiting a cube.

3. **Intercube gluon scattering** may convert d quark lites (gluons) entering a cube to a d quark spot into centrifugal d quark lites (photons) exiting the cube.

4. **Intercube photon scattering** may convert d quark lites (photons) entering a cube to a lepton spot into intracube lepton lites (photons).

Neutrinos

Neutrino constituents are bits in the zero state (Eqs. 37),

$$v^M = /M = 1 - M; v^L = /L = 1 - L; v^M, v^L = 0, 1 \quad (37)$$

where v^M, v^L = 1 are neutrino bits in mite and lite spot unit loci respectively, and would have zero electric charge. The binary neutrino field, [v^M, v^L], then, is the bit complement of mites and lites. Neutrino bits refer to M = 0 or L = 0. In short, an **absolute vacuum** (see "Vacuum thresholds") is entirely filled with neurtrinos.

Eq. 37 defines one-bit neutrinos. However, any number of n-bit neutrinos may be defined as convenient to study physical phenomena forming desired groups or flavors. For example, the neutrino equivalent for the absence of an electron might consist of a number of zero-state bits located in an electron spot.

Can neutrinos have mass? Yes, in binary mechanics, since mass is an expression of the underlying mechanism related to motion, namely, the difficulty in moving the object, whatever its bit pattern may be.

Eqs. 24 and 25 state that neutrino bits will move along any axis of S or channel as long as the strong potential F is zero at each spot unit.

At any spot, a neutrino bit will experience absence of strong potential F only when the source bit of F is also in the neutrino zero state. Thus, neutrinos do not display interdimensional, i.e., intraspot, interactions with other neutrinos. On the other hand, if the source bit is present, and hence, strong potential F as well, the neutrino bit will be replaced by a bit in the one state in the strong interaction transition. But the neutrino bit is not annihilated, since it replaces the one-state source bit. In brief, strong potentials F may scatter neutrino bits between dimensions in the opposition direction as the non-zero, non-neutrino bit.

By definition (Eqs. 24, 25 and 37), a strong potential may occur only when a neutrino bit is present. Since resulting strong interactions may occur at electron, positron and d quark spots, neutrino bits affect time development of these leptons and quarks in an identical manner at the spot level of analysis. In particular, observations described as a neutral weak force supposed to be mediated by a Z^0 particle, then, correspond to this coupled scattering of electron or positron bits and neutrino bits, which is in fact a strong interaction (Table 4).

Table 4: Binary Mechanical Bit Operations

Primary Forces		A Conventional Classification of Forces				
Transitions	Equations	Electro Weak	Electro-magnetic	Gravity	Strong	Neutral Weak
Unconditional	7, 8	X		X		
Scalar	10		X	X		
Vector	14		X	X		
Strong	24, 25			X	X	X

Note: Conventional forces are listed (X) by their binary mechanism(s).

Eq. 37 means that neutrino bit interactions with photonic or gluonic lites cannot occur at a single lite locus in a spot unit. However, the scalar force eΦ (Eq. 10) and vector force qA (Eq. 14) both depend on the presence of a neutrino bit, else the mite-to-lite motion is disabled. That is, v^L neutrino bits are always required in electromagnetic interactions.

The requirement for neutrino bits in interactions due to the strong or electromagnetic potentials is in general agreement with experiment. Also, by definition, the binary mechanical scalar and vector forces both require the absence of neutrino bits, but the resulting bit motions require v^L neutrino bits.

Electroweak Force

Electroweak interactions, purported to be mediated by the $W^{\pm}$ particles, are already encompassed in Eqs. 24 and 25. This postulate may be illustrated with several examples, which require only unconditional bit motion (Eqs. 7 and 8).

Photonic lites simultaneously emitted by d quark spots in up to three different cubes can converge toward an electron spot in a fourth cube. Meanwhile, if the originating d quarks receive incoming neutrino v^L bits during the same Tick, the d quarks would tend to vanish. In the next Tick, the one to three lites become mites at the electron spot. If at this time, the cube containing the electron mites also has d quark mites in at least one spot, then the result is by definition a two-spot u quark particle constituent (Table 3). In sum, the W^- constituents are lites in the first Tick and become u quark mites in the second Tick. Hence, given the conditions specified, the W^- lites are simply intercube photonic lites mediating a direct intercube interaction.

On the other hand, if there are no d quark mites in the electron spot cube at the second Tick, the electron mites may be distributed to the d quark spots in the same cube after two more Ticks. Depending on the presence of mites in various other spots in this cube at that time, one or more resulting u quark states might occur. Thus, in a four Tick weak interaction, the W particle may consist of photonic lites, then electron mites and finally electron lites. The weak interaction may be completed when the electron lites become d quark mites. Then there are two possibilities. First, two d quark spots can define a resonant state of two d quarks with Q = -2/3. Second, the d quark mites with a positron spot defines a u quark with Q of +2/3; and the W particle would be classed as W^+.

Conversely, photonic lites mediating electroweak interactions by convergence on positron spots would be classed as W^+ and $W^\pm$ for direct (two Ticks) and indirect (four Ticks) interactions respectively.

In the four-Tick weak interactions, the W particles have the mass of their mite components. This treatment of electroweak interactions reveals that the neutrino bit is most necessarily related to zeroing the initial d quark state. Also, it is not required to postulate neutrino bits traveling backwards in time.

Grand Unification

Table 4 tabulates four primary forces of nature. Hence, binary mechanics encompasses a grand unification.

A primary force of nature was defined above as a distinct type of binary mechanical bit transition. In other words, four primary forces of nature exist arising from the unconditional, scalar, vector and strong bit operations. This categorization is mutually exclusive and thereby permits attainment of increased clarity in analysis of physical phenomena.

A conventional listing of five forces of nature is cross referenced with the four primary forces of binary mechanics in Table 4, which may clarify underlying mechanisms of the conventional forces presented. But measurements and data analysis keyed to some of the listed conventional forces are best viewed as composites of all four primary bit operations, until further analysis clarifies this situation.

As evident in the presentation above and in Table 4, there is not always a one-to-one correspondence between the primary and conventional force classifications. For example, the electromagnetic force consists of two primary forces, which by definition may independently cause bit transitions. Gravitation appears to be a consequence of a combination of primary forces. The neutral weak force is a particular instance of the strong force in binary mechanics as described above.

The electroweak force may be explained by unconditional bit shifts alone (Eqs. 7 and 8). It is arguable whether the electroweak bit transitions should be classed as a force at all, since the bit transitions are unconditional. In this view, favored by the author, there are only three primary forces defined as independent bit transitions modifying unconditional bit shifts. This is only a semantic issue. Time will tell.

The conciseness of binary mechanics provides a means to determine whether a newly observed phenomenon meets the criteria for a new primary force or is merely a pattern of bit states over space and time that had not been previously noted.

The binary mechanical criterion for a primary force may help prevent a proliferation of conventional forces, considering that a single spot cube may alone assume up to 248 distinct states, not to mention purpoted particles with multi-cube components. In short, binary mechanics may facilitate increased discipline in theoretical physics.

Finally, the theory of binary mechanics allows for the addition of new primary forces should they be discovered. One need only note that the primary forces described thus far do not encompass all possible local bit interactions. Hence, a new primary force might be added, with the expectation that it would not overlap with, or otherwise violate, the presently described primary forces, defined in terms of specific bit operations.

Pauli Spin Matrices

After transforming the binary mechanical bit function (Eq. 2) to a suitable form, quantum mechanical and electrodynamic operators may be obtained from the postulates and equations of binary mechanics.

The **bit function**, Bi, expressed in Eq. 26, is a binary mechanical analog to the quantum mechanical wave function. Projecting the components, L and M, of B to a complex plane for each spatial dimension i, defines a complex bit function, B^C,

$$B^C(000)i = \Omega(000)B(000)i = Li + iMi;\ L, M = 0, 1 \quad (38)$$

where subscript i denotes matrix columns. Both Ω, the projection matrix with diagonal elements [1, *i*], and the positive lite and mite signs in Eq. 38 correspond to positron spot XYZ = 000 (Table 1).

In general, the complex bit function B^C for each spot XYZ is

$$B^C(XYZ)i = \Omega(IiJiKi)B(XYZ)i \quad (39)$$

where the i subscripts specify Ii, Ji and Ki from Eqs. 4 and 20 and Bi from Eq. 2. The eight projection matrices, Ω, are obtained by premultiplication of Ω(000) by one or more of the Pauli spin matrices, σ_x, σ_y and σ_z, as follows.

First, σ_z inverts Ii parity along any spot unit axis i in S,

$$\Omega(0JK)i = \sigma_z\Omega(1JK)i;\ \Omega(1JK)i = \sigma_z\Omega(0JK)i \quad (40)$$

Thus, σ_z alternates mite sign over odd and even spot units.

Second, σ_x inverts Ji parity in spatial dimensions i,

$$\Omega(I0K)i = \sigma_x\Omega(I1K)i;\ \Omega(I1K)i = \sigma_x\Omega(I0K)i \quad (41)$$

and therefore identifies concurrent spot units as defined by equal lite signs and equal mite signs. The projection matrices Ω in Eq. 41 swap the real and imaginary components in the complex bit function.

Third, σ_y inverts Ki parity in spatial dimensions i,

$$\Omega(IJ0)i = \sigma_y\Omega(IJ1)i;\ \Omega(IJ1)i = \sigma_y\Omega(IJ0)i \quad (42)$$

thereby identifying countercurrent spot units which have opposite lite signs and by definition, opposite lite directions.

Table 1 presents B^C values resulting from Eqs. 39 to 42. The parallel pairs of both concurrent and countercurrent spot units are seen to consist of real and imaginary pairs of both mites and lites. In addition, the mite and lite signs of B^C match those of B in Table 1. In this regard, then, the Pauli spin matrices produce identical results as the binary mechanical sign functions (Eq. 5 and 6).

By a similar analysis, the four Dirac spinor components may be uniquely mapped to solid diagonal pairs of spots in the spot cube (James Hughes, personal communication, 1993). These are the same pairs, as shown above, which represent four color states -- red, green, blue and none, and which each include a particle and an antiparticle spot. The spot cube, then, corresponds to two Dirac spinor equations, one for each spot handedness -- right and left. From the perspective of binary mechanics, the improved description of the behavior of the electron achieved by the Dirac spinor components is based on their representation of d quark spots.

When its six components are normalized to unit length, the complex bit function, B^C, corresponds to a quantum mechanical amplitude, integrated over the volume of a spot.

Four-Momentum Operator

The four-momentum operator for time development of the state vector, which has the status of a postulate in quantum mechanics, results from unconditional bit motion (Eqs. 7 and 8).

If the complex bit function (Eq. 39) does, indeed, correspond to an amplitude, then the four-momentum operator may be obtained from binary mechanics by simply rewriting the bit shift equations for the complex form, B^C, of the bit function, *B*.

For the dB^C/dt operator on the rest mass component, -*i*,

$$L^C(t=1) = -iHM^C(t=0);\ M^C(t=1) = -iHL^C(t=1) \quad (43)$$

where the superscript C specifies positive or negative, real or imaginary lite and mite components of B^C, and the H coefficients (Eq. 30) represent spot handedness which is identical to the spot particle or antiparticle attribute, as described above. Table 5 illustrates the results for dimension i = 1, listing the initial states $B^C(XYZ)x$ and the -*i*H component of dB^C/dt. In brief, the -*i*H component of the four-momentum operator sets the lite component and clears the mite component, if a mite is present at t = 0. Thus, the -*i*H operator shifts bits within spot units in the lite direction according to spot handedness.

Table 5: Correspondence With Quantum Mechanic Operators

Spot XYZ	000	001	010	100	011	101	110	111	Comments
Symbols	+ >	< +	+ >	- >	< +	< -	- >	< -	
$B^C(XYZ)x$	+L+iM	-L+iM	+iL+ M	+L-iM	-iL+ M	-L-iM	+iL- M	-iL- M	L,M = 0,1
H	1	-1	-1	-1	1	1	1	-1	Handedness
dB^C/dt									
-iH	+1-i	-1-i	+i-1	+1+i	-i-1	-1+i	+i+1	-i+1	
+ieΦ	+1-i	-1-i	+i-1	+1+i	-i-1	-1+i	+i+1	-i+1	
+iH	-1+i	+1+i	-i+1	-1-i	+i+1	+1-i	-i-1	+i-1	
-eAH	-1+i	+1+i	-i+1	-1-i	+i+1	+1-i	-i-1	+i-1	

To complete the complex representation of unconditional bit motion, the *i*d/dx momentum components correspond to the required shift of bits between successive spot units along a channel,

$$L^C(t=1) = iHM^C_x(t=1);\ M^C(t=1) = iHL^C_x(t=0) \quad (44)$$

where the I parity subscripts (x) in $M^C_x(t=1)$ and $L^C_x(t=0)$ specify the next and preceding spot units respectively. In Table 5, the results from the +*i*H operator in dB^C/dt for one dimension, $B^C(XYZ)_x$, show the addition of a mite bit from $L^C_x(t=0)$ at the preceding spot unit and the negation of a lite bit due to its shift to $M^C_x(t=1)$ in the next spot unit in the lite direction.

Handedness, H, in Eqs. 43 and 44 is required because the eight spots in a cube correspond to two sets of Dirac equations.

Electromagnetic Four-Potential

Table 5 lists results where the sign of charge e equals -1. Given the concurrent mite product representation of $e\Phi$ (Eq. 10),

$$e\Phi = -1;\ ie\Phi = -i;\ \text{if } M = 1 \text{ and } M_J = 1 \quad (45)$$

Hence, the scalar force in dB^C/dt moves mites to lite loci similar to the momentum operator $-i$

$$L^C(t{=}1) = +ie\Phi L^C(t{=}0);\ M^C(t{=}1) = +ie\Phi M^C(t{=}0) \quad (46)$$

For clarity, Table 5 lists the dB^C/dt results for the $+ie\Phi$ operator when the scalar potential is present (Eqs. 45 and 46), where the $-iH$ and $+ie\Phi$ rows in Table 5 are identical.

The $-eA$ operator in the relativistic forms of the Dirac equations for each handedness, H, must be $+i$ since e equals -1 and one of the two multiplicands is imaginary:

$$-eAH = -(-i)H = +iH \quad (47)$$

In brief, the $+iH$ and $-eAH$ rows in Table 5 are identical.

Finally, $B^C(t{=}1)$ equals $B^C(t{=}0)$ plus dB^C/dt, where

$$dB^C/dt = -iHB^C + ie\Phi B^C + iHB^C_x - eAHB^C_x$$

$$= -i(H - e\Phi)B^C + H(i - eA)B^C_x \quad (49)$$

Substitute H = 1 in Eq. 49 for an approximate analog of the conventional relativistic Dirac spinor equation for the electron in an electromagnetic field.

Intrinsic Limitations of the Wave Function

Several features of Eqs. 49 may be noteworthy. First, the operators obtained from binary mechanics are essentially identical to the postulated quantum electrodynamic operators. Second, the strong potential operators may be readily written for the complex representation B^C of the bit function.

Finally, the described differences in the state vectors -- the binary mechanical bit function and the quantum mechanical wave function, pinpoint why quantum mechanical formalism cannot, in principle, provide exact results. Namely, it assumes that bits at different physical locations are positioned at one point. This defect remains even if quantum mechanical calculations are conducted at the same fine scale of binary mechanics, based on the primary constants presented below.

This oversimplification intrinsic to the quantum mechanical wave function limits the accuracy of calculations at reduced distances and time durations. It also leads to qualitative paradoxes and discrepancies with experimental observation, similar in nature to those found when classical mechanics is applied at an atomic scale.

On the other hand, binary mechanical calculations of physical quantities are, in principle, exact. Therefore, the precision of any calculation of an observable is limited only by the degree of precision, available at the time, of measurements used to set the primary constants of binary mechanics. Thus, the intrinsic limitations of the wave function may be easily remedied by usage of the bit function.