Theory of Unit Space-Time and Displacements from Unit Space-Time: Material and Cosmic Photons, Subatoms, and Atoms

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Abstract

The Reciprocal System is in competition with Quantum Mechanics, the "Standard Model" of particle physics, and General Relativity. Whereas the Reciprocal System accepts Planck's quantum of radiation, Einstein's application to the photoelectric effect, and de Broglie's wave function for subatomic diffraction, it parts company with Quantum Mechanics in regards to the probabilistic wave function Ψ for atoms. The Reciprocal System rejects the concepts of the "Standard Model" of particle physics, including its 36 quarks and 8 gluons and other "gauge bosons." The Reciprocal System also rejects the non-Euclidean geometry of General Relativity and similar gravitational theories. This paper provides the concepts and mathematics of the Reciprocal System theory of space-time, photons, subatoms, and atoms, both *material* and *cosmic*. Space and time are the two *reciprocal* aspects of space-time and are perfectly *symmetrical*. Bare space-time represents unit speed, c. Photons, subatoms, and atoms are displacements up or down from unit speed. There are thus two major sectors of the universe: the *material* half, with speeds usually below that of c, and the *cosmic* half, with speeds usually above that of c--but in the cosmic sector the motion is in *time*, rather than in space, so the velocity equation is *inverted*. The cosmic particles are *inverse* to the material particles, not "anti-" to the material particles. There is no "missing anti-matter sector" of the universe; the cosmic sector is localized in time, not space, and therefore mostly invisible to us--except for the cosmic background radiation and the cosmic rays. The actions of entities depend on their *space-time concentrations* and their *space-time separations*; there are no "gauge bosons" exchanged between particles.

keywords: space-time, photons, subatoms, atoms, cosmic and material sectors, stellar energy generation

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Introduction and Literature Review

Dewey B. Larson, an engineer-scientist, originated the Reciprocal System of theory. His many physics books are listed in Ref. [1]-[8]. The present author summarized the Reciprocal System in Ref. [9] and has worked out many of the technical details in numerous papers--see Ref. [10]-[30]. This current paper updates some of the earlier work (mostly published in the ISUS journal *Reciprocity*) listed in Ref. [19]-[30]. The Reciprocal System is in competition with many of the theories of so-called "modern physics."

Numerous books exist touting "modern physics." Ref. [31] is useful for its examples and solved problems. An early work, though still of some value, is Ref. [32]. Prof. Penrose's work, Ref. [33], is 1099 pages long, the first 400 pages of which are the mathematics and the remaining 699 pages the physics, of practically every contemporary theory--except for the Reciprocal System. Prof. Bettini's work, Ref. [34], provides an up-to-date treatment of "elementary" particle physics; to his credit, he does recognize (p. 5) that mass is Lorentz-invariant--unlike what is stated in practically every other conventional physics book. A couple of earlier works on particle physics, Ref. [35] and Ref. [36], are still useful for their clarity.

Particle physics and astrophysics are intimately related. Ref. [37] tackles high energy astrophysics, including cosmic rays. Ref. [38] is a simple treatment of astronomy, with some solved problems. Prof. Lang is known for his numerous books on astronomy and astrophysics; Ref. [39] is his latest, at an intermediate level, whereas Ref. [40] is his advanced mathematical treatment. To his credit, Prof. Lang describes the "faint-young-Sun paradox" (Ref. [39], pp. 252-253), which shows that the Sun has actually moved *up* the Main Sequence (in accord with the Reciprocal System), whereas it should have remained essentially in the same location as when it formed (according to conventional theory). Prof. Lang also points out that Quantum Mechanical "tunneling" (pp. 220-224) is necessary to explain how the hydrogen ions overcome the Coulombic barrier to fuse, in order to generate (allegedly) the Sun's energy. (This is, of course, a "kludge.") Ref. [41], by Prof. Shu, is still a standard astrophysics work used in college, although it's been superceded to some extent by Ref. [42]. A couple of early works in astrophysics are still useful, Ref. [43] and Ref. [44]. Prof. Harwitt, author of Ref. [43], now has a fourth edition of this work available, but he asks essentially the same questions at the end of it (in the Epilogue) so it seems that nothing much has been achieved in conventional theory over the past few decades!

Handbooks and encyclopedias are indispensable to any working theoretical physicist. Ref. [45] has many tables of astrophysical data, arranged very nicely. Ref. [46] is an encyclopedia for astronomy and astrophysics. Ref. [47] is a recent physics handbook from Germany, very concise, yet very comprehensive, and nicely typeset. Ref. [48] is an old handbook, but it has a detailed treatment of cosmic rays. Ref. [49], a Russian compilation, has been extremely useful to the present author all throughout the work on his current set of theoretical physics papers; it has a very detailed table of all "elementary" particles. Ref. [50], the CRC Handbook, is the standard for American physical scientists. Ref. [51] is an online reference to the latest results from the particle accelerators. And Ref. [52] has a well-organized color insert displaying the basics of the "Standard Model" of particle physics.

Nomenclature

c = speed of light, usually expressed as m/sec

c_c = speed of light in cosmic sector, expressed as sec/m

c_m = speed of light in material sector (our sector), expressed as m/sec

$conv_{amu\_to\_u}$ = factor convert amu (atomic mass units based on O^{16}) to u (based on C^{12})

$conv_{J\_to\_MeV}$ = factor to convert joules (J) to MeV (million electron volts)

$conv_{u\_to\_kg}$ = factor to convert u (based on C^{12}) to kg

$conv_{u\_to\_MeV}$ = factor to convert u (based on C^{12}) to MeV

E = energy, expressed in ergs or J or MeV, depending on context

$E_{conv\_stellar\_energy\_gen}$ = stellar energy generated using H-to-He fusion (conventional theory), MeV

E_{H1_I} = energy of isotope 1 of neutral hydrogen, MeV

E_I = total ionization energy, MeV (subscript has element symbol)

$E_{stellar\_energy\_gen}$ = stellar energy generated according to Reciprocal System, MeV

G = gravitational constant in SI units; non-dimensional in Reciprocal System (see Ref. [15])

G_c = number of cosmic gravitational (or isotopic) charges (equal to 1 amu)

G_m = number of material gravitational (or isotopic) charges (equal to 1 amu) (when context is clear, the subscript may be dropped)

h = Planck's constant, erg-sec or erg-sec-cm or eV-sec (depending on context)

h = factor in Mercury's orbital equation

I_R = interregional ration (between time region and time-space region), 156.4444 (dimensionless)

K = kinetic energy, MeV

k = Boltzmann's Constant, joule/K

k_B = Botzmann's Constant, MeV/K

L_{S_MeV} = luminosity of Sun, MeV/sec

M = mass of star or planet, expressed as kg or g, depending on context

M_{c_A} = mass of cosmic element, u

$M_{c\_A\_MeV}$ = mass of cosmic element, MeV (or MeV/c^2, more exactly)

M_S = mass of Sun, kg

m = mass, kg or g, depending on context

N = RHS of Mercury's orbital equation

N_{v_frac} = fracton of atoms of an element (in a star or the Sun) that reach the thermal destructive velocity (and temperature)

n = rotational magnetic displacement of atom undergoing thermal destruction

n, m = Reciprocal System time region and time-space region thermal (translational) quantum numbers (dimensionless integers)

n_1, m_1 = Reciprocal System time region and time-space region thermal (translational) quantum numbers (dimensionless integers) before transition (emission or absorption of photon)

n_2, m_2 = Reciprocal System time region and time-space region thermal (translational) quantum numbers (dimensionless integers) after transition (emission or absorption of photon)

n_c, m_c = cosmic space region and space-time region thermal (translational) quantum numbers (dimensionless integers)

P = advance of perihelion of planet (such as Mercury), fraction of revolution per revolution or fraction of radian per radian

p = linear momentum (mass x velocity), kg x m/sec

Q, I, Spin, N, S, C, B, T, Y = quantum numbers of quarks (conventional theory)

R = Rydberg frequency hydrogen isotope 1, cycles/sec or rev/sec

R_0 = location of deflected photon from center of star, m

R_{div} = midpoint of radiation frequency which divides material and cosmic sectors, cycles/sec

R_S = stellar radius, m

s = space or distance between gravitating bodies, usually m or cm

s = inverse of mean radius of orbit of Mercury, m^{-1}

s_{clock} = clock space, usually m or cm

s_{coord} = coordinate space, usually m or cm

s_{u_cgs} = natural unit of space (time-space region), cm

T = temperature, K

$T_{destructive}$ = thermal temperature limit of element, K

T_u = natural unit of temperature for time-space region (gases), K

T_{V_u} = natural unit of temperature for vapor or condensed gas state, K

t = time, usually sec; total time (including both clock and coordinate) when using Lorentz transformations

t_1, t_2, t_3 = coordinate time components, sec

t_{coord} = coordinate time, sec

t_{clock} = clock time, sec

t_p = principal (or primargy) magnetic (two-dimensional) rotational time displacement (dimensionless)

t_u = natural unit of time, expressed in sec

U = factor in Maxwell's distribution to help compute fraction of atoms with velocity >= destructive velocity

V = velocity of star wrt observer, m/sec

V_r = radial velocity of star wrt observer, m/sec

V(x,y,z) = energy contribution from external field (Quantum Mechanics), erg or J or MeV depending on context

v = velocity of atom in star or Sun, m/sec

v_c = velocity of cosmic atom or subatom, sec/m or sec/cm

$v_{destructive}$ = destructive thermal velocity of element, m/sec

v_{c_max} = maximum velocity of cosmic atom or subatom in one dimenson of motion

v_{escape_Sun} = escape velocity from Sun, m/sec

v_m = velocity of material atom or subatom, m/sec or cm/sec

v_{m_max} = maximum velocity of material atom or subatom in one dimension of motion

$v_{mercury}$ = mean velocity of Mercury around Sun, m/sec

v_p = velocity of space-time progression (c), m/sec

x = space coordinate, m or cm

x, y, z = space coordinates

x_1, x_2, x_3 = coordinate space components, m or cm

x_{energy} = units of energy (t/s), natural units

x_{speed} = units of speed (s/t), natural units

Z = atomic number of matter element (dimensionless)

Z_c = atomic number of cosmic matter element (dimensionless)

z = red shift due to relative motion of star and observer (dimensionless)

z_g = gravitational red shift of radiation (dimensionless)

$\gamma =$ Lorentz factor (dimensionless)

γ = gravitational factor for red shift of photon from massive body

ε_0 = permittity of space-time, cm^2/sec or m^2/sec

$\theta =$ angle of deflected photon, rad

$\kappa_{spacetime}$ = curvature of space-time, m^{-2} (Ref. [43], p. 440)

λ = wavelength of radiation, cm or m or A

λ_{div} = wavelength of radiation at midpoint of division between material and cosmic sectors

μ_0 = magnetic permeability of space-time, sec^4/cm^3 or sec^4/m^3

ν = frequency of photon, cycles/sec

ν_1 = unit thermal vibration of atom in cgs units, 1 cycle/sec-cm

ν_{obs} = observed frequency of photon, cycles/sec

ν_L = line frequency of photon as originall emitted, cycles/sec

$\nu_{original}$ = original frequency of photon, cycles/sec, prior to red shift

ν_{red_shift} = frequency of photons, cycles/sec, after red shift

σ = Stefan-Boltzmann's constant, erg / cm^2-sec-K^4

τ_{n_calc} = mean lifetime of neutron, sec

ϕ = angle of Mercury in orbit around Sun, rad

Ψ = probabilistic wave function for subatoms and atoms (Quantum Mechanics)

A black square in the upper right of an equation means that the equation is disabled from running in *Mathcad*. This is done because not all variables in the equation have, as yet, been given numerical values. Because of the nature of this subject, it is necessary to use a mixture of SI, cgs, and natural units in the paper, but each individual equation utilizes just one set of units.

Unit Conversions and Physical Constants

$c := 2.997925 \cdot 10^{8}$ m/sec $c_m := c$ $c_c := \frac{1}{c}$ $s_{u\_cgs} := 4.558816 \cdot 10^{-6}$ cm

$l_R := \left[128 \cdot \left(1 + \frac{2}{9} \right) \right]$ $l_R = 156.444444$ $t_u := 1.520655 \cdot 10^{-16}$ sec

$T_u := 510.8$ K $conv_{amu\_to\_u} := .9996822$ $conv_{u\_to\_MeV} := 931.494061$ $conv_{J\_to\_MeV} := 6.242 \cdot 10^{12}$

$T_{V\_u} := 3.5978 \cdot 10^{9}$ K $M_S := 1.989 \cdot 10^{30}$ kg $R_S := 6.955 \cdot 10^{8}$ m $conv_{u\_to\_kg} := 1.66 \cdot 10^{-27}$

$G := 6.67259 \cdot 10^{-11}$ (SI) $k := 1.38065 \cdot 10^{-23}$ J/K $k_B := 1.3806505 \cdot 10^{-23} \cdot conv_{J\_to\_MeV}$ MeV/K

Note: when masses are stated in terms of "MeV", this should be interpreted as "MeV/c^2 multiplied through by c^2."

1. Space-Time

a. the natural reference system and the gravitationally-bound reference systems for motion

Most physical theories view time as one-dimensional and constituting a kind of quasi-space which joins with the three dimensions of space to form a four-dimensional space-time framework, within which physical objects move *one-dimensionally*. This view has been formulated to help explain some of the new phenomena discovered in the twentieth century, such as the very small, the very large, and the very fast. These phenomena exist outside of our normal everyday world, where Newton's laws predominate and where space seems to be totally separate from time. However, even with this modern framework, most of these phenomena remain mysteries, in whole or in part.

In contrast, the Reciprocal System of theory postulates that both space and time have three-dimensional aspects and join together to form one entity, space-time or motion, which itself is three-dimensional. Space and time are the two *reciprocal* aspects of motion and have no properties other than what they have in motion. Here, space-time or motion is theorized to be the *sole* component of the physical universe, not the framework or the background for particles of matter or "forces." Matter in the theory is itself a form of rotational motion and may move translationally in more than one-dimension *coincidentally*.

The Newtonian reference system is based on three dimensions of space and one of time. The space is considered to be stationary, and the time is considered to be flowing. Within this space, material objects move as a function of time in one dimension in a specific *vectorial* direction; the classical physics textbooks hardly every treat purely *scalar* motion. This one-dimension of motion may be resolved into three components, one along each of the three orthogonal axes of the reference system (usually denoted x, y, z or x_1, x_2, x_3 in Cartesian coordinates).

In the Reciprocal System, space and time each have the properties of the other. Time is *three-dimensional*, like space, and space *progresses*, like time. Of course, in the gravitationally-bound material environment, space *appears* to be stationary and three-dimensional and time *appears* to be one-dimensional and progressing, and so the Newtonian reference system works for this situation. In a gravitationally-bound cosmic (or inverse) environment, where space and time are *interchanged*, time would *appear* to be stationary and three-dimensional, and space would *appear* to be one-dimensional and progressing.

So, in the Reciprocal System, two types of gravitationally-bound reference systems exist: the first with three dimensions of space and one of time, and the second with three dimensions of time and one of space. The first is applicable to objects which are aggregated in *space* (as in our ordinary *material* sector), and the second is applicable to objects which are aggregated in *time* (as in the *cosmic* sector). Conventional physical science says that there are "anti-particles" and "anti-galaxies" but does not stipulate an "anti-reference system." Of course, in the Reciprocal System, "anti-particles" do *not* exist, just particles and *inverse* particles. Also, the supposed "dark matter" is simply ordinary or cosmic matter unilluminated, mostly between galaxies.

A common mistake of students of the Reciprocal System is to deduce from the above statements that there are thus six dimensions of the universe, three of space and three of time; some students even conclude that there are nine dimensions of the universe, three of space, three of time, and three of space-time. This is not correct, however. All that actually exists are three dimensions of *motion*, not three dimensions of space or three dimensions of time *separately*. Of course, where convenient, we can mentally *fix* one component, while allowing the other to *move*. This has the effect of concentrating on *one aspect* of each of the components while ignoring the others. But it's important not to forget that space and time do not exist separately; they are bound together in units of motion, which is the actual physical reality.

Outside of our gravitationally-bound region, what happens? It is observed in astronomy that distant galaxies are moving away from our galaxy (and all others) at speeds approaching that of light. The current explanation is that this is a result of a hypothetical "Big Bang" some 13.7 billion years ago. But even that explanation is not enough: the galaxies are *accelerating* away from each other, instead of slowing down, so now the conventional theorists are postulating some sort of "dark energy" to account for this, in addition to the "Big Bang." Of course, this is *not* the explanation of the Reciprocal System. Here, the cause is the *space-time progression*, which manifests itself when gravitation is attenuated. It is an effect brought about by the motion of the *natural* reference system relative to our conventional "stationary" spatial reference system.

The fundamental equation of motion in the Reciprocal System is not some fancy partial differential equation. Rather, it is the simplest possible equation relating space and time to speed or velocity. For the normal low-speed motion in the material sector, the equation is, of course

$$v_m := \frac{s_{coord}}{t_{clock}} \quad \text{m/sec} \quad |s_{coord}| << |t_{clock}| \qquad (1a)$$

For the normal low (inverse) speed motion in the cosmic sector,

$$v_c := \frac{t_{coord}}{s_{clock}} \quad \text{sec/m} \quad |t_{coord}| << |s_{clock}| \qquad (1b)$$

Equations (1a) and (1b) are for gravitationally-bound material and cosmic systems, respectively. The *natural reference system* is not gravitationally bound (because it exists *prior to matter)*, so the speed or velocity equation is

$$v_p := \frac{s_{clock}}{t_{clock}} \quad \text{and} \quad v_p := \frac{t_{clock}}{s_{clock}} \qquad (2a)$$

This immediately implies that, in natural units,

$$v_p := \frac{1}{1} \quad \text{so} \quad v_p := 1 \quad \text{or} \quad v_p := c \quad \text{(in conventional units like m/sec)} \qquad (2b)$$

The natural reference system moves at *unit speed*, which we can identify as the speed of light, c. See Ref. [11] for the dimensions of physical quantities in the Reciprocal System. The one-dimensional clock space of all space-time units *generates* the three-dimensional *coordinate space,* and the one-dimensional clock time of all space-time units generates the three-dimensional *coordinate time*.

Now consider a *collection* of space-time units moving outward from any point in our gravitationally-bound system. The equation in Cartesian coordinates is

$$\left(x_1^{\,2} + x_2^{\,2} + x_3^{\,2}\right)^{\frac{1}{2}} := c \cdot t \quad \text{m} \tag{3a}$$

Please note that because the motion is actually *scalarly outward* only, the imputation of a *specific* vectorial direction for a particular space-time unit is *arbitrary*. Similarly there is an outward motion of the natural reference system relative to a gravitationally-bound cosmic system. The equation is, by inspection,

$$\left(t_1^{\,2} + t_2^{\,2} + t_3^{\,2}\right)^{\frac{1}{2}} := \frac{x}{c} \quad \text{sec} \tag{3b}$$

Again, the assigned cosmic vectorial directions are arbitrary, since this is actually a scalar motion outward in all directions. Note that the space-time progression originates everywhere and is omnipresent; there is no "single point of an explosion." There was no "Big Bang" and there is no "dark energy." Also, note that both Eqs. (3a) and (3b) are Lorentz-invariant--the speed of light is the *same* relative to any other reference system (Ref. [31], p. 30).

The two major sectors of the universe, the material sector and the cosmic sector, each with their appropriate reference system, are stable. In between these two sectors is an unstable transition zone, which cannot be represented properly by *either* reference system. This is *where multi-dimensional* motions occur.

b. Lorentz transformations

Note that Eq. (1a) ignores coordinate time and Eq. (1b) ignores coordinate space. But at a substantial fraction of the speed of light or inverse speed of light, coordinate time and coordinate space cannot be ignored. Physicist H. A. Lorentz empirically derived his transformations in 1892; these were then adopted into Einstein's Special Theory of Relativity in 1905. Of course, they work as well in the Reciprocal System, although we do not accept the concept of "space contraction" for the material sector or "time contraction" for the cosmic sector--the entire correction to the usual velocity equations is due to coordinate time in our sector and coordinate space in the cosmic sector. (See Ref. [1], 2nd ed., pp. 100-104.) For the material sector:

$$v_m := \left(t^2 - t_{clock}^2\right)^{\frac{1}{2}} \cdot \frac{c_m}{t} \quad \text{m/sec} \quad t = \textit{total}\ \text{time},\ t > t_{clock} \quad c_m = c \qquad (4a)$$

$$t_{coord} := t - t_{clock} \quad \text{sec} \quad \text{"time dilation"} \qquad (4b)$$

For the cosmic sector:

$$c_c := \frac{1}{c_m} \quad \text{sec/m} \qquad (4c)$$

$$v_c := \left(s^2 - s_{clock}^2\right)^{\frac{1}{2}} \cdot \frac{c_c}{s} \quad \text{sec/m} \quad s = \textit{total}\ \text{space},\ s > s_{clock} \qquad (4d)$$

$$s_{coord} := s - s_{clock} \quad \text{m} \quad \text{"space dilation"} \qquad (4e)$$

The maximum *one-dimensional speed* of a material object in the material sector is

$$v_{m\_max} := c_m \quad \text{m/sec} \qquad (5a)$$

and the maximum *one-dimensional speed* of a cosmic object in the cosmic sector is

$$v_{c\_max} := c_c \quad \text{sec/m} \qquad (5b)$$

However, unlike other theories, the Reciprocal System allows motion coincidentally in *two or three dimensions*. The dimensions are, of course, orthogonal, so multi-dimensional motion is *not vectorial*--it is *scalar* only. The motions in the different dimensions are *added* together as scalars for some purposes and treated separately for others.

In the Reciprocal System, mass does *not* increase with translational motion--it is Lorentz-invariant. Mass depends *only* on the kind and quantity of the *rotational spin* of the atoms; see below. Therefore the *Lorentz factor* $\sqrt{1-\left(\frac{v_m}{c_m}\right)^2}$ should *not* be grouped with the mass--it should be grouped with the force (although the end numerical result doesn't change). For example, where there is a high relative speed of the masses involved, the gravitational equation is

$$F_G\cdot\sqrt{1-\left(\frac{v_m}{c_m}\right)^2} := \frac{m_1\cdot m_2}{\frac{1}{G}\cdot s^2} \quad \text{N} \qquad (6)$$

The Lorentz factors modifies the force, rather than dividing the mass. The high velocity kinetic energy equation should be written as

$$K := m\cdot c^2\cdot\left[\frac{1}{\sqrt{1-\left(\frac{v_m}{c_m}\right)^2}}-1\right] \quad \text{MeV if m is in MeV/c}^2 \qquad (7)$$

Thus there is no distinction between mass and "rest mass" in the Reciprocal System. Similar equations exist for the cosmic sector.

c. multi-dimensional motion

Motion exists only in *discrete units*, so the question arises: how can we have fractional units? The Reciprocal System starts with one unit of motion, *not* zero units of motion. This one one unit of motion is equal to one unit of energy, because of the reciprocal relation between space and time. To achieve effective translational speeds below unity we simply subtract the appropriate number of energy units from one. The equation in natural units is

$$v_m := 1 - \frac{1}{x_{energy}} \quad \text{(natural units)} \qquad (8a)$$

where x_{energy} is the number of one-dimensional energy units (with dimensions t/s, inverse of velocity). As x_{energy} is increased, the speed is increased, and in the limit reaches 1 (or c). In the time region, the region inside unit space, the numerical value of the energy term must be squared, for reasons given in Ref. [1], 1st ed., p. 19. So the equation actually is

$$v_m := 1 - \frac{1}{x_{energy}^2} \quad \text{(natural units)} \qquad (8b)$$

Suppose x_{energy} has the value *n* in the time region. Usually, for the motion of an atom, the energy is divided between the time region and the time-space region (the region outside unit space) with opposite vectorial directions; let *m* be the time-space region quantity. Then

$$v_m := \frac{1}{n^2} - \frac{1}{m^2} \quad \text{(natural units)} \qquad (8c)$$

This is, of course, the basic *spectroscopic* equation in terms of speed, rather than frequency. It does *not* represent the orbitals of any alleged electrons circling an alleged nucleus. Clearly, space-time is *not* a "continuum"--it is *discrete*. See Ref. [14] for a thorough treatment of spectroscopy in the Reciprocal System.

Because of the ability of adding or subtracting energy units to the three basic speed ranges (three dimensions of motion), we can have speeds of $1 - 1/x_{energy}$, $2 - 1/x_{energy}$, and $3 - 1/x_{energy}$. Larson denotes the speed range $1 - 1/x_{energy}$ "low speed"; the speed range $2 - 1/x_{energy}$, "intermediate speed"; and the speed range $3 - x_{energy}$, "ultra-high speed." Because of

the one-dimensional nature of energy, it is *not* possible to go from one speed range to the next by simply adding more energy. The only way to accomplish this is by *direct* addition of *units of speed*. And the only way that can be accomplished is by huge stellar or galactic *explosions*. Radiation from matter moving at intermediate and ulra-high speeds will be discussed in the radiation section of this paper.

By inspection, one can see that the corresponding motions in the cosmic sector can be expressed as follows:

$$v_c := 1 - \frac{1}{x_{speed}}\blacksquare \qquad \text{(natural units)} \qquad \text{(9a)}$$

$$v_c := 1 - \frac{1}{x_{speed}^{2}}\blacksquare \qquad \text{(natural units)} \qquad \text{(9b)}$$

$$v_c := \frac{1}{n_c^{2}} - \frac{1}{m_c^{2}}\blacksquare \qquad \text{(natural units)} \qquad \text{(9c)}$$

Speed ranges: $1 - 1/x_{speed}$, $2 - 1/x_{speed}$, and $3 - 1/x_{speed}$

If the motion of matter in our sector in dimension 1 exceeds c, the velocity equation *inverts* and so the motion is in *time* rather in space (because of the *one-dimensional speed limit of c*), although the object as a whole remains in the *same* time-space (macroscopic) location. A motion *outward in time* is equivalent to a motion *inward in space*, and so the object contracts--its atoms move *closer together in space*--in our ordinary spatial reference system. We can identify such astronomical objects as white dwarfs, pulsars, quasars, and galactic cores as objects with motion in the *second* dimension and therefore in *time*. If the motion extends to the *third* dimension, then the entire object moves *translationally in space*. This is the situation with pulsars and quasars; pulsars are white dwarf stars with translational motion away from the supernova explosion site, in the third dimension of motion.

Please note that there is no "collapse" of the atomic structure here; the size of the atom in the Reciprocal System is the same as that of the "nucleus" in conventional theory. Pulsars are not "neutron" stars; they have essentially the same atoms as any white dwarf. Same thing for the quasars and galactic cores. There is no "degenerate" matter. And there are no singularities or black holes.

Likewise, for the cosmic sector: if the motion of c-matter in dimension 1 exceeds c_c, the velocity equation *inverts* and so the motion is in space rather than in time (because of the *one-dimensional speed limit* of c_c), although the object as a whole remains in the *same* space-time (cosmic macroscopic) location. A motion *outward in space* is equivalent to a motion *inward in time*, so the object "contracts"--its c-atoms move *closer together in time*--in the ordinary c-temporal reference system. We can identify such astronomical objects as c-white dwarfs, c-pulsars, c-quasars, and c-galactic cores as objects with motion in the *second* dimension and therefore in *space*. If the motion extends to the *third* dimension, then the entire object moves *translationally in time*. This is the situation with c-pulsars and c-quasars; c-pulsars are c-white dwarfs with translational motion in time away from the c-supernovae explosion site. There is no cosmic degenerate matter. And there are no cosmic singularities or "cosmic black holes."

d. Euclidean vs. non-Euclidean space-time

In the Reciprocal System, space-time is isotropic, homogeneous, and Euclidean. The curvature is zero:

$$\kappa_{spacetime} := 0 \quad m^{-2} \tag{10}$$

General Relativity posits non-Euclidean space-time, and so the curvature is non-zero. Penrose, in Ref. [33], p. 1023, says that in some versions $\kappa_{spacetime} > 0$ and in other versions $\kappa_{spacetime} < 0$; Penrose himself seems to favor $\kappa_{spacetime} < 0$ (p. 1005). But Ref. [56] gives us a fairly definitive *observational* result:

"The shape of the universe is the local and global geometry of the universe, in terms of both curvature and topology (though, strictly speaking, it goes beyond both). Although the shape of the universe is still a matter of debate in physical cosmology, based on the recent Wilkenson Microwave Anisotropy Probe (WMAP) measurements 'We now know that the universe is flat with only a 0.4% margin of error,' according to NASA scientists." This *refutes* General Relativity and supports the Reciprocal System.

Other tests of General Relativity include the following (Ref. [47], p. 149): 1) light deflection in the gravitational field of the Sun; 2) rotation of the apse line (the line connecting aphelion and perihelion) of the inner planets, such as Mercury; 3) red shift of star light. The Reciprocal System can explain these situations just as well as General Relativity.

1) light deflection

A light ray passing a minimum distance R_0 from the center of a star of mass M will be deflected by the angle (Ref. [39], p. 95)

$$\theta := 2(1+\gamma)\cdot\frac{G\cdot M}{R_0\cdot c^2} \quad \text{radians} \qquad (11)$$

In General Relativity, $\gamma = 1$, whereas Newton's theory of gravitation implies $\gamma = 0$. Larson says (Ref. [8], p.36:

"The photon has no mass, and therefore no gravitational motion toward a massive aggregate, a star, for instance. But the gravitational motion of the star is distributed scalar motion, and this scalar motion of the star toward the photon (AB) is inherently nothing more than a decrease in the distance between the objects. It can equally well appear in the reference system as a motion of the photon toward the star (BA). On the basis of probability, the total motion is divided between the two alternatives. The total motion of the star toward the photon is distributed among so many mass units that the motion of each is unobservable, but the photon is a single unit, and it is deflected a small, but measurable, amount toward the star." Therefore, for the Reciprocal System, $\gamma = 1$ in Eq. (11), so the factor $2(1+\gamma) = 4$, which is twice what it would be for Newtonian gravity, simply because of how the reference system works. The deflection is not due to space-time curvature.

2) rotation of the apse line, e.g. of Mercury

From Ref. [19] and based on Eq. (6) above, the orbital motion of a planet around a star of mass M is given by

$$\left(\frac{d^2}{d\phi^2}s + s\right) := \frac{G\cdot M}{h^2\cdot\sqrt{1-\frac{h^2\cdot s^2}{c^2}}} \qquad (12)$$

where s = 1/r (i.e., 1/mean radial distance) and $h := \frac{\frac{d}{dt}\phi}{s^2}$ and ϕ is the angular displacement.

Let N(s) = the RHS of Eq. (12). For *any* gravitational theory, the advance of the perihelion of a planet is given, for small values, by

$$P := \frac{1}{2}\cdot\left(\frac{d}{ds}N(s)\right) \tag{13}$$

As the planet advances through ϕ radians, its perihelion advances though Pϕ radians. Now

$$\frac{d}{ds}N := \frac{G\cdot M}{c^2}\cdot\left(1-\frac{h^2\cdot s^2}{c^2}\right)^{\frac{-3}{2}}\cdot s \tag{14}$$

For Mercury,

$r := 5.79091\times 10^{10}$ m $\quad s := \frac{1}{r} \quad s = 1.726844\times 10^{-11}$ m^{-1}

$\frac{d}{dt}\phi := 8.266835\cdot 10^{-7}$ rad/sec $\quad h := \frac{8.266835\cdot 10^{-7}}{s^2} \quad h = 2.772253\times 10^{15}$

$$\left(1-\frac{h^2\cdot s^2}{c^2}\right)^{\frac{-3}{2}} = 1.00000004\times 10^{0} \tag{15}$$

For a circular orbit,

$$G \cdot M := \frac{v^2}{s} \blacksquare \tag{16}$$

Therefore,

$$\frac{d}{ds} N := \frac{v^2}{s \cdot c^2} \cdot 1.00000004 \cdot s \blacksquare \quad \text{or} \quad \frac{d}{ds} N := \frac{v^2}{c^2} \cdot 1.00000004 \blacksquare \tag{17}$$

Thus,

$$P \cdot \phi := \frac{1}{2} \cdot \left(\frac{v^2}{c^2} \cdot 1.00000004 \right) \cdot \phi \blacksquare \tag{18}$$

For one revolution, $\phi = 2\pi$, so

$$P \cdot 2 \cdot \pi := \left(\frac{v^2}{c^2} \cdot . \right) \cdot 1.00000004\pi \blacksquare \quad \text{fraction of a revolution per revolution} \tag{19}$$

$v_{Mercury} := 47872.5$ m/sec (Ref. [45], p. 294, mean value)

$$\frac{v_{Mercury}^{2}}{c^{2}} \cdot 1.00000004 \cdot \pi = 8.010886 \times 10^{-8}$$ fraction of a revolution per revolution, or

$$\frac{v_{Mercury}^{2}}{c^{2}} \cdot 1.00000004 \cdot \pi \cdot 60 \cdot 60 \cdot 360 = 0.103821$$ arc seconds per revolution

Mercury's sidereal period is .24084445 (Julian) years (Ref. [45], p. 294). Therefore, over a *century*:

$$\frac{100}{.24084445} \cdot .103821 = 43.107076$$ seconds of arc

Calculations with General Relativity (see Ref. [40], p. 579) give 43.11 +/- .45. From the standpoint of the Reciprocal System, the advance of the perihelion of Mercury is *not* due to a gravitational effect--it is due to the relatively *high velocity* of the planet and therefore due to *coordinate time*.

3) red shift of light coming from a large mass

According to General Relativity, energy is "spent" by light to leave the gravitational field of star or planet, so the frequency is reduced. But this effect is really due to *coordinate time*, like that of the advance of the perihelion of Mercury given above, except that we are not dealing with an orbit, so the orbital factor and π do not apply. This just leaves the half factor and v^2/c^2 . Here, v must be the *escape velocity* from the star or planet. The equation then is

$$\nu_{red\_shift} := \left(1 - \frac{1}{2}\frac{v_{escape}^{2}}{c^{2}}\right) \cdot \nu_{original} \blacksquare \qquad (20)$$

For the Sun,

$$v_{escape\_Sun} := 6.177 \cdot 10^5 \quad \text{m/sec} \quad \text{(Ref. [45], p. 340)}$$

Therefore,

$$\nu_{red\_shift} := \left(1 - \frac{1}{2}\frac{v_{escape\_Sun}^2}{c^2}\right) \cdot \nu_{original}$$

$$z_g := \frac{\nu_{original} - \nu_{red\_shift}}{\nu_{original}} \quad \text{or} \quad z_g := \left(\frac{1}{2}\frac{v_{escape\_Sun}^2}{c^2}\right) \qquad (21)$$

$$z_g := \frac{1}{2}\frac{v_{escape\_Sun}^2}{c^2} \qquad z_g = 2.122676 \times 10^{-6} \quad \text{(a very small effect)}$$

Ref. [40], p. 579 says the calculation from General Relativity is 2.17 x 10^{-6}. This same reference says "The gravitational red shift is not a definitive test of General Relativity, however, for the Newtonian theory of gravity predicts the same redshift...assuming that the photon energy is $h\nu$, and that the principle of equivalence and the law of conservation of energy hold." So the Reciprocal System and General Relativity and even the Newtonian theory are "tied" for this effect, and so it is no "proof" for General Relativity. Therefore, the proposition that the universe is Euclidean stands.

But General Relativity has other issues. It is in conflict with Quantum Mechanics, as Penrose points out over many pages in Ref. [33]. It's difficult to see how a quantized space-time could be consistent with a non-zero curvature. It's also difficult to see how mass can affect space-time in any manner; the theory provides no mechanism.

e. "gravitational lensing"

Astronomical objects like quasars often appear to be in *two different locations at the same time*. The conventional explanation of this phenomenon is "gravitational lensing." The Reciprocal System explanation (Ref. [3], p.301) is as follows (specifically in regards to quasars):

"Inasmuch as the outward motion of a quasar has a specific direction, as seen in the spatial reference system, the lateral motion is confined to one specific perpendicular line. As noted earlier, however, scalar motion does not distinguish between the direction AB and the direction BA. The lateral recession outward from point X is therefore divided equally between a direction XA and the opposite direction XB by the operation of probability. Matter moving translationally at upper range speeds thus appears in the reference system in two locations equidistant from the line of motion in the coincident dimension (the optical line of sight, in most cases), and separated by 33.8 seconds of arc."

See Ref. [3] for more details.

f. uniform rate or non-uniform rate of space-time

In the Reciprocal System, space-time flows at a *strictly constant rate*, c. A contemporary theory called "Inflation" says that shortly after the "Big Bang" there was a period of time in which space-time flowed *faster* than the speed of light. This is necessary in conventional theory, because the universe is reportedly *93 billion light years in diameter* (Ref. [57])! But there was actually no "Big Bang" and so the universe could be *vastly older* than currently estimated.

g. unit space-time and displacements from unit space-time; "vacuum" properties

Space-time cannot be physically changed in any manner. The existing physical displacements from unit space-time, such as photons, subatoms, and atoms therefore have the character of "postulates." If there were a creation of the universe, both unit space-time and the displacements from unit space-time were created together. The displacements cannot revert back to bare space-time: displacements are *conserved*. There are no "virtual particles" in the Reciprocal System. The acceleration due to the space-time progression outside unit space, and in opposition to gravitation, is 1.144×10^{-13} N/kg (Ref. [17]).

In contrast, Quantum Mechanics supposes that the "vacuum" is a very busy place, with all manner of "virtual particles" popping-in and popping-out of space-time. But these are "unobservable" (Ref. 42], p. 1239). On p. 1240 of this same reference, the authors boldly proclaim that the energy of the "vacuum" is, believe it or not, 10^{111} J/m^3! Obviously, this is utter nonsense.

h. Principle of Equivalence

Here the Reciprocal System and General Relativity agree: gravitational mass and inertial mass are perfectly *equal*. The reason for this in the Reciprocal System will be explained later in this paper, but it's obvious that gravitation *is* accelerated motion.

i. Special Relativity and paradoxes

As is well known, Special Relativity has the "clock paradox" and the "twin paradox" which can be resolved only by utilization of a "fixed" reference system (Ref. [1], 2nd ed, pp. 85-88). Therefore motion cannot be *purely* relative; it is, ultimately, *absolute*. See the discussion below on the Cosmic Microwave Background Radiation.

j. General Relativity and coordinates

Larson states, very clearly (Ref. [5], p. 94)

> "Here we have the real essence of General Relativity. Special Relativity accomplished its objective of providing a mathematical correction for the conceptual error in the conventional view of time by abandoning the idea that the magnitudes of time and space intervals measured with respect to coordinate systems of reference have fixed values, and introducing a fictitious variability in these magnitudes. To meet the additional problem of accelerated motion, Einstein simply prescribed a bigger dose of the same medicine. It took him seven years to figure out where the additional flexibility could be introduced, but finally he created more latitude for numerical variation by depriving the coordinates themselves of any meaning so far as mensuration is concerned."

Of course, in the Reciprocal System, coordinates have meaning!

k. simultaneity

Larson explains the reality of simultaneity in the Reciprocal System (Ref. [5], pp. 111-112):

"In earlier days when physical science dealt only with relatively low velocities, the contribution of the coordinate time to the total time interval in any physical process was negligible, and it was possible to carry out all calculations involving motion on the basis of clock time only. The advent of high velocity measurements, particularly those concerned with the velocity of light, showed that there was an error somewhere in the system, and it was a study of the background of this discrepancy that led Einstein to his conclusion that "There is no such thing as simultaneity of distant events." If we are referring to total time, this present study is in full accord with Einstein's conclusion, but for most purposes the useful definition of simultaneity is that which regards events as simultaneous if they occur at the same clock time; that is, at the same stage of the time progression, and this kind of simultaneity definitely does exist.

"Einstein and his colleagues accepted the 'operational' point of view in this instance and rejected the concept of an objectively real simultaneity because of its lack of an operational basis. As Moller explains, 'The concept of simultaneity between two events in different places obviously has no exact objective meaning at all, since we cannot give any experimental method by which this simultaneity could be ascertained.' The present work shows that this conclusion is in error; that simultaneity, defined as the same clock time, is something that *can* be ascertained by physical means, and this concept can therefore be legitimately employed in any connection in which it happens to be useful: a category that includes most of the applications in which the idea of simultaneity is normally employed. In this sense (the only sense that is of any particular importance to us) Einstein is wrong and there *is* such a thing as simultaneity of distant events."

l. summary

The conventional theorists need the "Big Bang," "Inflation," dark energy, and General Relativity, to explain the observations, whereas the Reciprocal System just needs the space-time progression and Newtonian gravitation (modified by coordinate time) to explain the observations, including the acceleration of the universe. See the appendix in Ref. [17] for the numerical calculation of this acceleration, which *increases with time*.

2. Photons and Radiation

a. space-time nature of photons and radiation; Maxwell relations

The space-time progression is *uniform translational motion*. The first kind of *displacement* from this is *linear vibration motion*. This linear vibration "knocks out" the space-time progression in the dimension of the vibration, leaving two dimensions available, one of which is used. This dimension is *perpendicular* to the progression. Therefore this object is a linear vibration moving at the speed of light in a perpendicular direction, resulting in a sine curve. Quite obviously, we can identify this combined motion as *radiation,* and we can identify the linear vibration as a *photon*. *Unit frequency* may be identified as the Rydberg frequency for H (isotope 1),

$$R := 3.28806 \cdot 10^{15} \quad \text{Hz}$$

Displacements above R are considered to be "high frequency," whereas displacements below R are considered "low frequency." The first displacement above R is 2R, whereas the first displacement below R is 1/2 R.

There is nothing "electromagnetic" about radiation. Maxwell (Ref. [55]) incorrectly deduced his theory of radiation as electromagnetic by his famous relation:

$$c := \frac{1}{\sqrt{\varepsilon_0 \cdot \mu_0}}$$

where ε_0 is the electric permittivity of space-time and μ_0 is the magnetic permeability of space-time. Of course, in the natural units of the Reciprocal System, these parameters have the value of *exactly* 1, as does c. The dimensions of ε_0 are s^2/t, and those of μ_0 are t^3/s^4 (see Ref. [11]), and so the dimension of c are s/t, of course. There is nothing electric or magnetic about space-time, and so there is nothing electrical or magnetic about radiation! The textbooks are all wrong.

Table I gives the spectrum of photon frequencies.

Name	Energy, eV	Frequency, Hz	Wavelength	Nat. Freq., based on R	Inverse Name
Radio Waves	10^{-14} - 10^{-3}	3 - 3 x 10^{11}	10^{14} - 10^{3} mm	9.1 x 10^{-16} - 9.1 x 10^{-5}	Gamma Rays
Extremely Low Freq.	10^{-14} - 10^{-13}	3 - 30	100000 km - 10000 km	9.1 x 10^{-16} - 9.1 x 10^{-15}	
Super Low Freq.	10^{-13} - 10^{-12}	30 - 300	10000 km - 1000 km	9.1 x 10^{-15} - 9.1 x 10^{-14}	
Ultra Low Freq.	10^{-12} - 10^{-11}	300 - 3000	1000 km - 100 km	9.1 x 10^{-14} - 9.1 x 10^{-13}	
Very Low Freq.	10^{-11} - 10^{-10}	3000 - 30000	100 km - 10 km	9.1 x 10^{-13} - 9.1 x 10^{-12}	
Low Freq.	10^{-10} - 10^{-9}	30000 - 300000	10 km - 1 km	9.1 x 10^{-12} - 9.1 x 10^{-11}	
Medium Freq.	10^{-9} - 10^{-8}	300000 - 3000000	1 km - 100 m	9.1 x 10^{-11} - 9.1 x 10^{-10}	
High Freq.	10^{-8} - 10^{-7}	3 x 10^{6} - 30 x 10^{6}	100 m - 10 m	9.1 x 10^{-10} - 9.1 x 10^{-9}	
Very High Freq.	10^{-7} - 10^{-6}	30 x 10^{6} to 300 x 10^{6}	10 m - 1 m	9.1 x 10^{-9} - 9.1 x 10^{-8}	
Ultra High Freq.	10^{-6} - 10^{-5}	300 x 10^{6} to 3000 x 10^{6}	100 cm - 10 cm	9.1 x 10^{-8} - 9.1 x 10^{-7}	
Super High Freq.	10^{-5} -10^{-4}	3 x 10^{9} - 30 x 10^{9}	10 cm - 1 cm	9.1 x 10^{-7} - 9.1 x 10^{-6}	
Extremely High Freq.	10^{-4} - 10^{-3}	30 x 10^{9} - 300 x 10^{9}	1 cm - .1 cm	9.1 x 10^{-6} - 9.1 x 10^{-5}	
Microwaves	10^{-6} - 10^{-3}	2.4 x 10^{11} - 3.00 x 10^{11}	.1 cm - 10^{3} mm	9.1 x 10^{-6} - 7.3 x 10^{-5}	X-Rays
Infrared Rays	10^{-3} - 1.299	2.4 x 10^{11} - 3.1 x 10^{14}	10^{3} mm - .77 mm	7.3 x 10^{-5} - .094	Ultraviolet Rays
Extreme	10^{-3} - .025	2.4 x 10^{11} - 6 x 10^{12}	1000 mm - 40 mm	7.3 x 10^{-5} - 1.8 x 10^{-3}	
Far	.025 - .167	6 x 10^{12} - 4.x 10^{13}	40 mm - 6 mm	1.8 x 10^{-3} - .012	
Medium	.167- .667	4 x 10^{13} - 1.6 x 10^{14}	6 mm - 1.5 mm	.012 -.049	
Near	.667 - 1.299	1.6 x 10^{14} - 3.1 x 10^{14}	1.5 mm - .77 mm	.049 -.094	
Visible Light	1.299 - 2.564	3.1 x 10^{14} - 8 x 10^{14}	.39 mm -77 mm	.094 - .243	Visible Light
Red	1.299 -1.608	3.1 x 10^{14} -3.9 x 10^{14}	.770 mm - .622 mm	.094 - .119	
Orange	1.608 -1.675	3.9 x 10^{14} - 4 x 10^{14}	.622 mm - .597 mm	.119 -.122	
Yellow	1.675 - 1.733	4 x 10^{14} - 4.2 x 10^{14}	.597 mm - .577 mm	.122 - .128	
Green	1.733 - 2.033	4.2 x 10^{14} - 4.9 x 10^{14}	.577 mm - .492 mm	0.128 - .149	
Blue	2.033 -2.198	4.9 x 10^{14} - 5.3 x 10^{14}	.492 mm - .455 mm	.149 - .161	
Violet	2.198 - 2.564	5.3 x 10^{14} - 6.193 x 10^{14}	.455 mm - .390 mm	.161 - .188	
Ultraviolet Rays	2.564- 100.000	6.193 x 10^{14} - 3 x 10^{16}	.39 mm - .01 mm	.188 - 7.3	Infrared Rays
Near	2.564 - 3.333	6.193 x 10^{14} - 8 x 10^{14}	.39 mm - .30 mm	.188 - .243	
Far	3.333 - 5.000	8 x 10^{14} - 1.2 x 10^{15}	.30 mm - 20 mm	.243 - .365	
Extreme	5.000 - 100.000	1.2 x 10^{15} -2.4 x 10^{16}	.20 mm - .1 mm	.365 - 7.3	
X-Rays	10^{2} - 1.2 x 10^{5}	2.4 x 10^{16} - 3 x 10^{19}	.1 mm - 10^{-5} mm	7.3- 9124	Microwaves
Soft	< 5000	2.4 x 10^{16} - 1.2 x 10^{18}	.1 mm - 2.5 x 10^{-4} mm	7.3 - 365	
Hard	> 5000	1.2 x 10^{18} -3 x 10^{19}	2.5 x 10^{-4} mm - 10^{-5} mm	365 - 9124	
Gamma Rays	> 1.2 x 10^{5}	> 3 x 10^{19}	< 10^{-5} mm	> 9124	Radio Waves

Table I. Photon Spectrum

b. Planck's quantum of radiation energy and calculation of Planck's constant

The Reciprocal System accepts, of course, Planck's concept of the quantum of radiation energy, the photon, and Planck's and Wien's radiation laws. The energy of a photon is a linear function of its frequency--the perpendicular translation of space-time contributes nothing to the energy.

$$E := h \cdot \nu \qquad (22)$$

None of the conventional references give a derivation of the value of Planck's constant, h. But we can derive this constant by means of the Reciprocal System. For convenience, cgs units will be used here.

1) Observers in our sector (the material or time-space sector) measure photon frequency in cycles per unit time, such as cycles/sec. In this sector, time appears to be one-dimensional and progressing.

2) Observers corresponding to us in the cosmic or space-time sector measure photon frequency in cycles per space unit, such as cycles/cm. In this inverse sector, space appears to be one-dimensional and progressing.

3) From statements 1) and 2), it follows that to have a definition covering both sectors we must combine the two equations and measure photon frequency in cycles per space-time unit, such as cycles/(cm-sec). In application to the time-space sector, the numerical value of the space factor in the general equation is set to unity; in application to the space-time sector, the numerical value of the time factor in the general equation is set to unity. But it's important to realize that the dimensions of these factors are still present.

4) In our sector, with energy in ergs, the dimensions of the energy equation are

$$erg := \frac{sec^2}{\frac{sec}{\frac{cm}{erg}}} \cdot \frac{1}{cm \cdot sec} \qquad (23a)$$

In the inverse sector, with energy in gres (inverse of ergs), the dimensions of the energy equation are

$$\text{gre} := \frac{\text{cm}^2}{\frac{\frac{\text{cm}}{\text{sec}}}{\text{gre}}} \cdot \frac{1}{\text{cm}\cdot\text{sec}} \qquad \text{(23b)}$$

From these two expressions, it follows that Planck's constant in our sector has the dimensions of erg-cm-sec and Planck's constant in the inverse sector has the dimensions gre-cm-sec. With the space factor unity in our sector, and treating the frequency here as cycles/sec, the units of Planck's constant become erg-sec. With the time factor unity in the inverse sector, and treating the frequency there as cycles/cm, the units of Planck's constant become gre-cm.

5) The ratios (sec/cm)/erg and (cm/sec)/gre in the equations above are simply conversion factors from the natural system to the cgs system and sgc system (the equivalent of the cgs system in the inverse sector). The ratio of sec/cm/erg is 2.236055×10^{-8} (Ref. [1], 2nd ed., p. 161).

6) The factor for sec^2 in the expression for our sector comes from the natural unit of time (expressed in seconds) squared. Similarly, the factor for cm^2 in the expression for the inverse sector comes from the natural unit of space (expressed in centimeters) squared. These terms are the keys to transforming the frequency to energy and must be included.

7) Finally, the interregional ratio (between the time region and time-space region or between the space region and the space-time region must be included because the oscillation of the photon takes place within a unit of space-time. So the result for h in our sector is

$$h := \frac{t_u^{\,2}}{l_R \cdot 2.236055 \cdot 10^{-8}} \qquad h = 6.610263 \times 10^{-27} \quad \text{erg-sec} \qquad \text{(24)}$$

with frequency given as cycles/sec, or as 6.610263 x 10^{-27} erg-cm-sec, with frequency given as cycles/(cm-sec). The resulting quantity of energy in ergs is identical in both cases. And, of course, there are similar values for the cosmic sector.

The accepted value is 6.626 x 10^{-27} erg-sec, and this value has been used in most papers and books on the Reciprocal System (pending clarification of the small discrepancy). The ratio of the calculated to accepted value is .9976 or approx. 99.8%. The respected experimentalist physicist, R. Millikan, found h to be 6.57 x 10^{-27} erg-sec (Ref. [54]), somewhat lower than the accepted value of today.

c. calculation of Stephan-Boltzmann constant

The Reciprocal System accepts the Stephan-Boltzmann law and the thermodynamic calculation of the Stephan-Boltzmann constant (Ref. [56], pp. 194-198, pp. 254-257). The Stephan-Boltzmann law, radiation energy from a black body radiator, is

$$E := \sigma \cdot T^4 \qquad (25)$$

where σ is the constant. One unit of radiation leaves per unit of area per unit of time. Unit thermal vibration, expressed in cgs units, is

$$\nu_1 := 1 \quad \text{cycles/cm-sec} \qquad (26)$$

for reasons given in section b above. Unit area is the square of the natural unit of space, s_{u_cgs}, reduced by the interregional ratio, l_R. Thermal motion in the time region is effective only half the time (because the space-time progression acts *inward* here). Therefore, observing dimensional consistency, we obtain this value of σ:

$$\sigma := \left(\frac{1}{2}\right) \cdot \nu_1 \cdot \frac{1}{\left(\frac{s_{u\_cgs}}{l_R}\right)^2 \cdot \frac{2.236055 \cdot 10^{-8}}{t_u} \cdot T_u^{\,4}} \qquad \text{erg/(cm}^2\text{-sec-K}^4\text{)} \qquad (27)$$

$\sigma = 5.882079 \times 10^{-5}$ erg/(cm^2-sec-K^4)

The accepted value is 5.670400 x 10^{-5} (Ref. [50], p. 1-1), 3.7% lower than that calculated. Possibly any so-called black body may really have a "touch of gray"--thus the measured value may slightly underestimate the true value.

d. dividing line between atomic translational motion in space and motion in time

Although unit radiation frequency is R, this value is not necessarily the frequency which divides the emission/absorption of photons due to translational motion in space (material sector) and time (cosmic sector). Over all cubes of coordinate space and coordinate time the numbers of, and types of, photons from matter and photons from cosmic matter must *equal*. The standard references give a range of values for the energy of radiation per cubic centimeter; for our purposes here we can assume (roughly) .5 eV/cm^3 from matter starlight and .5 eV/cm^3 from cosmic matter starlight (i.e., the Cosmic Microwave Background Radiation). Incidentally, the energy from cosmic rays is estimated to be 1 eV/cm^3, so we can assume that the energy from matter rays (*to* the cosmic sector) is also 1 eV/cm^3, so the universe is in *balance*.

Because the cosmic sector is localized in coordinate time, rather than coordinate space, we cannot see cosmic stars and galaxies. But the photons from either sector *are* perceivable, though reduced by the proper distribution factor between the two sectors. Larson says (Ref. [3], p. 202) that this distribution factor is 128, meaning that R is reduced by 128, giving a wave length of 11.67 microns.

$$R_{div} := \frac{R}{128} \quad R_{div} = 2.568797 \times 10^{13} \quad \text{Hz} \qquad (28a)$$

$$\lambda_{div} := \frac{c}{R_{div}} \quad \lambda_{div} = 1.167054 \times 10^{-5} \quad \text{m} \qquad (28b)$$

Ref. [3], p. 204: "Our findings show that what is needed is a recognition of the existence of the unit boundary at 11.67 microns. Strong radiation in the far infrared, beyond 11.67 microns, comes from matter with speeds in the upper ranges, above the speed of light, not from relatively cool thermal sources like those that radiate weakly in the far infrared. As we will see in the pages that follow, strong infrared emission is one of the conspicuous features of the objects that we will identify as involving motion at upper range speeds: quasars, Seyfert galaxies, the cores of other large galaxies, exploding galaxies such as M 82, etc. The infrared radiation from the quasars is estimated to be 1000 times the radiation in the visible range. The association between infrared emission and radiation in the radio range (which we identify with upper range speeds) is another feature of these objects, which, like the infrared emission, is unexplained in current astronomical theory. The significance of the results of the surveys of the infrared sources within the Galaxy, such as the one reported by Neugebauer and Becklin, is that they demonstrate the existence of the line of demarcation between the far infrared of the upper range speeds and the near infrared of the speeds below unity."

Table I shows the names for the inverse values. Cosmic observers would see a shift to shorter wave lengths (higher frequencies), or R_{div} x 128.

e. origin of the 21.1 cm radio waves

21.1 cm radio waves are very useful for observing stars and galaxies because the radio waves are not absorbed by intervening dust. Conventional physicists say that this wave is generated by a "forbidden" transition: the intrinsic spins of the alleged electron and proton in H I (neutral hydrogen) *flip*. Of course, this is nonsense from the standpoint of the Reciprocal System. The Reciprocal System spectroscopic equations for an H transition are given by (see Ref. [14]):

$E_{H1\_I} := 13.61256 \quad eV$ (calculated ionization energy of H)

$h := 4.14 \cdot 10^{-15} \quad eV\text{-sec}$

$$\nu := \frac{E_{H1\_I}}{h} \cdot \left(\frac{1}{n_1^{\,2}} - \frac{1}{m_1^{\,2}} \right) - \left(\frac{1}{n_2^{\,2}} - \frac{1}{m_2^{\,2}} \right)$$

The Reciprocal System Database has a feature which enables the user to input an emitted or absorbed wave length such that the program will search over the space of all values of n_1, m_1, n_2, m_2 (usually from 1 to 99) to obtain that wave length or frequency. The result for the 21.1 cm line is

$n_1 := 62 \quad m_1 := 69 \quad n_2 := 76 \quad m_2 := 90$

$$\nu := \frac{E_{H1\_I}}{h} \cdot \left[\left(\frac{1}{n_1^2} - \frac{1}{m_1^2} \right) - \left(\frac{1}{n_2^2} - \frac{1}{m_2^2} \right) \right] \qquad \nu = 1.421658 \times 10^9 \quad \text{Hz}$$

$$\lambda := c \cdot \frac{100}{\nu} \qquad \lambda = 21.087521 \quad \text{cm} \quad \text{Q.E.D.}$$

This transition is not "forbidden" at all! Of course, with conventional theory, the orbitals would be too large! (Curiously, Ref. [47], p.854 refers to such atoms as "Rydberg atoms"--"highly excited hydrogen atoms or hydrogen-like atoms (principal quantum number n > 100). Their radii range up to approx. 5 x 10^{-7} m; this corresponds to the size of a virus.") But this is not a problem for the Reciprocal System because the spectra are due to changes in *thermal motion of the atom itself* (and ionization changes, if any).

A neutral H atom with $n_1 = 62$ and $m_1 = 69$ is at a temperature of 2.636 K. A neutral H atom with $n_2 = 76$ and $m_2 = 90$ is at a temperature of 2.613 K (from the Reciprocal System Database).

f. cosmic background radiation; absolute velocity of the Local Group

The Cosmic Microwave Background Radiation (CMBR) has been measured to be at a temperature of 2.725 K (Ref. [39], p. 531). According to the Reciprocal System, this radiation comes from the cosmic sector. Therefore, we can conclude that the CMBR contributes to the temperature of interstellar/intergalactic H I. So: the starlight coming from the cosmic sector slightly heats the H I of our sector. By the reciprocal postulate, starlight from the material sector appearing in the cosmic sector slightly heats the c-H I of that sector. The CMBR is not a "relic" of the alleged "Big Bang."

Larson says ([Ref. [3], p. 387):

"Because of the inversion of space and time at the unit level, the frequencies of the cosmic radiation are the inverse of those of the radiation in the material sector. Cosmic stars emit radiation mainly in the infrared, rather than mainly at optical frequencies, cosmic pulsars emit x-rays rather than radio frequency radiation, and so on. But these individual types of radiation are not recognized as such in the material sector because, as we found earlier, the atoms of matter that are aggregated in time to form cosmic stars, galaxies, etc., are widely separated in space. The radiation from all types of cosmic aggregates is received from these widely dispersed atoms as a uniform mixture of very low intensity that is isotropic in space."

Given that this radiation is isotropic, we can define a local reference frame at rest relative to the CMBR. Ref. [59] shows that the CMBR is *slightly blue-shifted* in one direction and *slightly red-shifted* in the other direction. The net result is that the Local Group is moving at a speed of 600 km/sec toward the Virgo cluster. Of course, the Relativists deny that there is any "preferred" coordinate system, but this is a logical candidate for one.

g. astronomical sources of radiation (based on Ref. [3])

1) radio waves

from matter moving at intermediate or ultra-high speeds; from early white dwarf product of Type I supernovae; from remnant of Type II supernovae

2) infrared waves

from infrared stars down to 1000 K; failed stars down to 300 K ; protostars; newly formed variable stars; intense infrared radiation comes from matter at ultra-high speed, such as quasars; low intensity is from matter at normal speeds

3) optical

from normal stars on the Main Sequence; from the low speed products of Type I and Type II supernovae

4) ultraviolet rays

from central region of Seyfert galaxies or any kind of "active galaxy"; from matter moving at intermediate or ultra-high speeds

5) x-rays

from atomic isotopic adjustments due to explosions of stars or galaxies; stage 4 of white dwarfs (which involves a return to the speed range below unity); from cataclysmic variables; from novae; from pulsars which failed to escape the galaxy and are coming back and reducing speed to below unity; from class M stars (x-rays leaking out because there is less thickness of overlying matter); leakage from the Sun's core which heats the corona

6) gamma rays

from atomic isotopic adjustments when matter drops below unit speed; from a cosmic stellar or galactic explosion--gamma ray bursts

Note: x-rays and gamma rays are *non-thermal*.

h. Doppler shift equations

Ref. [40], pp. 193-194, gives the usual expressions for the Doppler shift for both low and "relativistic" velocities as follows (but using our equation numbering):

"When line radiation of frequency, ν_L, is emitted from an object traveling at a velocity, V, with respect to an observer at rest, the observed frequency, ν_{obs}, is

$$\nu_{obs} := \nu_L \cdot \left(1 - \frac{V}{c} \cdot \cos(\theta)\right)^{-1} \cdot \left(1 - \frac{V^2}{c^2}\right)^{\frac{1}{2}} \quad (29a)$$

For V << c and θ << π/2: $$\nu_{obs} := \nu_L \cdot \left(1 - \frac{V_r}{c}\right) \quad (29b)$$

where θ is the angle between the velocity vector and the radiation wave vector. The radial velocity V_r = -V cos(θ) is positive when the radiating object is moving away from the observer. Consequently, when receding objects are observed at optical frequencies, the lines are shifted towards the red (toward longer wave lengths). The red shift, z, is defined as

$$z := \frac{\lambda_{obs} - \lambda_L}{\lambda_L} \qquad z := \frac{\nu_L - \nu_{obs}}{\nu_{obs}} \quad (30)$$

$$z := \frac{V_r}{c} \quad \text{(approximately)} \quad (31)$$

where λ_{obs} and λ_L denote, respectively, the wave lengths of the observed and emitted line radiation, ν_{obs} and ν_L denote, respectively, the frequencies of the observed and emitted line radiation, and V_r is the radial velocity. For large velocities the special relativistic Doppler effect is expressed by the equations:

$$z := \left(\frac{c + V_r}{c - V_r} \right)^{\frac{1}{2}} - 1 \qquad (32)$$

and

$$\frac{V_r}{c} := \frac{(z+1)^2 - 1}{(z+1)^2 + 1} \qquad (33)$$

Measured velocities are often corrected for the orbital motion of the earth about the Sun, and the Sun's motion with respect to the local group of stars."

However, the Reciprocal System *rejects* the use of Special Relativity in these equations because, as Eq. (30) shows, the *measured* value is used in the definition of z! So if z is calculated to be > 1 by Eq. (30), that means that the speed is, in fact, greater than c! Larson discusses this issue (Ref. [3], p. 307) as follows:

"Extension of the redshift range above 1.00 raised a question of interpretation. On the basis of the previous understanding of the origin of the Doppler shift, a recession redshift above 1.00 would indicate a relative speed greater than that of light. The general acceptance of Einstein's contention that the speed of light is an absolute limit made this interpretation unacceptable to the astronomers, and the relativity mathematics were invoked to resolve the problem. Our analysis in Volume I [*Nothing But Motion*] shows that this is a misapplication of these mathematical relations. In the situations to which those relations actually do apply, there are contradictions between values obtained by direct measurement and those obtained by indirect means, such as, for instance, arriving at a speed measurement by dividing coordinate distance by clock time. In these instances the relativity mathematics (the Lorentz equations) are applied to the indirect measurements to bring them into conformity with the direct measurements, which are accepted as correct. The Doppler shifts are direct measurements of speeds, and require no correction. A redshift of 2.00 indicates a relative outward motion with a scalar magnitude of twice the speed of light."

Note: the z value (for example, of a quasar) is a *combination* of the galactic recession plus any explosive velocity away from the associated galaxy. The high z values of quasars, for example, are *not* due to extreme distances.

i. Einstein-Podolsky-Rosen effect / quantum entanglement

Suppose that two photons originate at the *same event* and move in opposite directions. In the material sector, the motion appears to be *outward in space*; in the cosmic sector, the motion appears to be *outward in time*. In actuality, we are moving *inward in space* away from the photons, and the cosmic observers are moving *inward in time* away from the photons. We have no *independent* motion in coordinate time (at low vectorial speeds), and since the photons do not either, we are able to effect a change in both photons by a change in *one* of them. Likewise, the cosmic observers have no *independent* motion in coordinate space (at low vectorial inverse speeds), and since the photons do not either, the cosmic observers are able to effect a change in both photons by means of a change in *one* of them. Existents which are *contiguous* in *either* space or time may *both* be affected by application of a suitable *single* force.

Because photons are *stationary* in the natural reference system, they are not "lost" from either sector and are not "disappearing over the time or space horizon"; the universe is not "running down" toward a slow "heat death." The Second Law of thermodynamics applies to *kinetic energy only*, not to total energy, unlike the First Law.

j. plane polarization

By definition, if a stream of photons all have their linear vibrations in the *same plane* perpendicular to the direction of "propagation," the radiation is *plane-polarized*. Astronomical sources of polarized radiation come from matter moving at upper range speeds (intermediate and ultra). Quoting Larson (Ref. [3], p. 224):

"...according to our theoretical findings: (1) *all* radiation from objects with upper range speeds, except that generated by indirect processes...is non-thermal, and (2) *all* such radiation is polarized as emitted. Where a lower polarization is observed, this is due to depolarizing effects during travel of the radiation."

The reason for this is, of course, that this radiation originates from a *two-dimensional* space-time region. White dwarfs, pulsars, quasars, active galactic cores and jets all emit polarized radiation.

k. circular/elliptical polarization; rotational bases

So far we've covered uniform translational motion and linear vibrational motion. The next type of motion is *rotation*. A one-unit rotational displacement of a photon creates a *rotational base*. Two types of rotational base exist: the material rotational base, which has the rotational displacement in time (less than unit speed), and the cosmic rotational base, which has the rotational displacement in space (greater than unit speed). Penrose (Ref. [33], pp. 546-547) shows a diagram of circular polarization which is in agreement with the picture we get from the Reciprocal System; so, for once, the conventional theory and the Reciprocal System agree: circular polarization results from spinning photons about the direction of motion (the space-time progression). However, the spin is *scalar* in the Reciprocal System, whereas it is *vectorial* in conventional theory. Therefore "helicity" (direction of the spin) doesn't matter in the Reciprocal System, only the speed, and so $h/2\pi$ is *not* used as the unit of angular momentum.

By inspection, one can see that a photon (imagined as vertical) has *three rotational axes*: two horizontal, perpendicular axes through its midpoint, and one vertical axis along the linear vibration. The rotational spin can be represented in four different ways, all equivalent; the choice to use is a matter of convenience. The four ways are: rotational displacement, effective rotational displacement, rotational speed, and rotational frequency. For the material and cosmic rotational bases we have:

Circular Polarized Light	Photon Freq. (Ground)	Rot. Displ.	Eff. Rot. Displ.	Rot. Speed	Rot. Freq.
m-rotational base	2R	1-0-0	0-0-0	1/2-1-1	R/π-2R/π-2R/π
c-rotational base	1/2 R	(1)-0-0	0-0-0	2-1-1	4R/π-2R/π-2R/π

Table II. Rotational Bases

Here, "m" = material, "c" = cosmic, and "R" = Rydberg frequency, 3.2881 x 10^{15} cycles/sec or revolutions/sec. Rotational space displacements are enclosed by parentheses. The photon frequencies given in the table are for the "ground state"; obviously, non-ground-state material photons would have higher vibrational frequencies, and non-ground-state cosmic photons would have lower vibrational frequencies. The rotation of the rotational base is around the first horizontal axis of the photon, which is referred to as the "principal" axis (or sometimes the "primary" axis). The rotational base does not have a rotational displacement around the other two axes (which are termed the "subordinate" or "secondary", and the "electric"). However, keep in mind that we start with unity, not zero, in the Reciprocal System, so the rotational speed is not considered zero around these two other axes when there is no displacement, as is indicated under the column "Rot. Speed." Likewise, the rotational frequency is not considered as zero around these two other axes when there is no displacement; but the speed or frequency in the two non-displaced dimensions have *no physical effects*.

The one-displacement of rotational motion is not "effective" in stopping or reversing the space-time progression--the two rotational bases still move *at the speed of light*. Hence, they both have the designation 0-0-0 under the column "Eff. Rot. Displ." This form of the spin representation is useful for expressing combinations of particles, which we will see in the section of this paper devoted to subatoms.

As the references [1]-[10] show, the sequence of additions of displacements alternate between space and time. Material particles are rotational displacements in time built on photons with space displacement; cosmic particles are rotational displacement in space built on photons with time displacement.

3. Subatoms

a. de Broglie diffraction and wave functions; probability function Ψ

In the Reciprocal System, all subatoms and atoms are rotating photons. The spins of the atoms, which will be discussed in a later section of this paper, "hide" or "shield" or "screen" their photons, so that the wave aspects of atoms and c-atoms can usually be neglected. This is not the case with electrons, positrons, or neutrons, which do not "hide" or "screen" or "shield" their photon substrate; these subatoms therefore undergo *diffraction* in crystals. We therefore *do* accept de Broglie's hypothesis that these particles can act as "waves." However, atoms, such as alpha particles, *scatter*; here, the scattering is a function of the *rotational displacements* of the alpha particles and the target (such as gold atoms). Therefore, the Reciprocal System usually works with the *spin numbers* of atoms and subatoms, rather than with "wave functions." This contrasts with Quantum Mechanics, in which Ref [31], p. 80 says "...a particle is described by associating with it a wave packet formed from the superposition of an *infinite* number of plane waves. Each plane wave moves with a phase velocity which may *exceed the velocity of light*....The individual phase velocities are *not observable*. The quantity that is observable is the velocity of the localized disturbance, or group velocity, which...is equal to the velocity one normally associates with a particle and less than the speed of light." (Italics added.)

But an "infinity" in a physical theory is a red flag; it's a *disproof* of a theory. Furthermore, conventional theory says that the square of the wave function Ψ "gives the probability of finding [a particle] at a given place. In order to reconcile the wave and particle pictures of matter, we must *give up the idea that the location of a single material particle can be specified exactly*. Instead, we can talk only of the probability of finding a particle at a particular location at a particular time" (Ref. [31], p. 88). This is not so in the Reciprocal System; space-time and all motions are, ultimately, absolute, and so, yes, we can specify the *exact location of a particle at an exact time*. There is no "Heisenberg Uncertainty Principle" in the Reciprocal System.

The de Broglie wave equation is simply

$$\lambda := \frac{h}{p}$$

where λ is the wave length, h is Planck's constant, and p is the linear momentum of of the particle. Ref. [31], pp. 82-87 gives many examples of the use of this equation; the Reciprocal System is in full agreement here with de Broglie.

Ref. [33], p. 499 gives "the Schrödinger equation for a single particle of mass m, moving in an external field whose energy contribution is V = V(x,y,z)":

$$i \cdot \frac{h}{2\pi} \cdot \left(\frac{\partial}{\partial t} \Psi \right) := \frac{-\left(\frac{h}{2 \cdot \pi} \right)^2}{2 \cdot m} \cdot \left(\nabla_{xyz} \right)^2 \Psi + V \cdot \Psi$$

where i is the imaginary number. This equation is very difficult to apply; the textbooks and handbooks give only the most trivial solutions (e.g., see Ref. [47], pp. 835-841). The Quantum Mechanics literature is full of approximate solutions, but these are still worthless for practical application by engineers (and they all disagree with one another). Larson (Ref. [6], p. 8) quotes de Broglie as saying, "What seemed to me to be eminently desirable was...a return to precise space-time representations which could give a clear picture of what they were supposed to portray." In other words, de Broglie himself did *not* accept Schrodinger's wave equation, and neither do we!

Penrose (Ref. [33], p. 528) discusses the puzzling feature of the "collapse of the wave function"--wherein a jump is made to a "state reduction" whenever a *measurement* is deemed to take place. The Reciprocal System has no such issue.

b. spin numbers in the Reciprocal System vs. that in Quantum Mechanics and the "Standard Model"

The three spin numbers in the Reciprocal System represent displacements or speeds around three perpendicular axes of one photon (subatoms) or two photons (atoms). The *one* spin number of Quantum Mechanics represents an angular momentum (in units of h/2π) about an *ill-defined axis*...of what? One needs to specify a "sub-nuclear" theory to explain *what* is rotating in Quantum Mechanics.

Side note on the "Standard Model": According to the so-called "Standard Model" of particle physics, the "fermions" are matter constituents, and have a spin = 1/2, 3/2, 5/2, ...; there are two type of fermions: leptons (electrons and neutrinos) and "quarks" (18 types). The "gauge bosons" are "force carriers" and have spin 0, 1, 2, ... These include the photon, the W particle, the Z particle, the Higgs boson, the "graviton," and the "gluon" (8 types)--which allegedly holds the quarks together. (Isn't it curious that the "Standard Model" needs two bosons to explain mass and gravitation?) The fermionic hadrons include the proton and anti-proton, and the neutron, etc. The bosonic hadrons include the pion, the kaon, etc., which are supposedly comprised of quarks and anti-quarks. See Ref. [33], Ref. [34], Ref. [35], Ref. [36], Ref. [40], and Ref. [49] for the details. The so-called quarks which are supposedly contained within many of the subatomic particles and mesons do not have a *fixed* mass; see Ref. [34], p. 389 for a table of quark masses--for instance the supposed "d" quark has a mass which ranges from "3-7 Mev." But this is nonsense; it would mean that particles built up from quarks do not have a fixed mass, which they certainly do have. They are also said to be "point particles" and have a speed close to that of light (Ref. [34]). A complete table of subatoms and mesons is given in Ref. [40], pp. 1182-1202. Quarks need the following quantum numbers (Ref. [33], [34], etc. above): Q, I, Spin, N, S, C, B, T, Y.

As an example of the complexity of representing the properties of a particle in the "Standard Model", consider the proton, p. This supposedly has three quarks: u u d. The "u" quark has these properties: Q = 2/3, I = 1/2, I3 = 1/2, Spin = 1/2. N = 1/2, S = 0, C = 0 , B = 0, T = 0 , Y = 1/3. The mass of the "u" quark is 1.5 - 3 MeV. The "d" quark has these properties: Q = -1/3, I = 1/2, I3 = -1/2, Spin = 1/2, N = 1/3, S = 0, C = 0, B = 0, T = 0, Y = 1/3. The mass of the "d" quark is said to be 3 - 7 MeV. The spin of the proton itself is supposedly 1/2 and its J value is 1/2. The mass of the proton is 938.27 MeV, but the masses of the internal quarks don't sum to this at all! Besides, the quark particles are just "points," so how could they combine to make a particle with *extent*?

In contrast, the Reciprocal System represents the spins of the material and cosmic protons as follows:

Particle	Photon Freq. (Ground)	Rot. Displ.	Eff. Rot. Displ.	Rot. Speed	Rot. Freq.
m-proton	2R	2-1-(1)	1-1-(1)	1/2-1/2-2	2R/3π-R/π-4R/π
c-proton	1/2 R	(2)-(1)-1	(1)-(1)-1	2-2-1/2	4R/π-4R/π-R/π

Table III. m-proton and c-proton

where 2R/π is the natural unit of rotational frequency. Note that these are for chargeless particles. For the normally-charged m-proton, we add a "+" sign to the spin representation, either before or after it, like: 2-1-(1)+. For the normally-charged c-proton: (2)-(1)-1-. In working out the details of the rotational spin about each of the three axes of the photon of a subatom, eccentricity must be minimized, so for instance, we don't have a particle with displacements 2-0-0. The complete table for subatomic particles follows, by inspection, together with their identifications. Note: an *intermediate particle* (like the compound neutron and H^1) is one that has *two* rotational systems, one of which is massless.

Particle	Photon Freq. (Ground)	Rot. Displ.	Eff. Rot. Displ.	Rot. Speed	Rot. Freq.	Calc. Mass, u
massless m-electron:	2R	1-0-(1)	0-0-(1)	1/2-1-2	R/π-2R/π-4R/π	0
charged m-electron:	2R	1-0-(1)-	0-0-(1)-	1/2-1-2	R/π-2R/π-4R/π	.000548567
massless c-electron:	1/2 R	(1)-0-1	0-0-1	2-1-1/2	4R/π-2R/π-R/π	0
charged c-electron:	1/2 R	(1)-0-1+	0-0-1+	2-1-1/2	4R/π-2R/π-R/π	.000548567
massless m-positron:	2R	1-0-1	0-0-1	1/2-1-1/2	R/π-2R/π-R/π	0
charged m-positron:	2R	1-0-(1)+	0-0-(1)+	1/2-1-1/2	R/π-2R/π-R/π	.000548567
massless c-positron:	1/2 R	(1)-0-(1)	0-0-(1)	2-1-2	4R/π-2R/π-4R/π	0
charged c-positron:	1/2 R	(1)-0-(1)-	0-0-(1)-	2-1-2	4R/π-2R/π-4R/π	0

Particle	Photon Freq. (Ground)	Rot. Displ.	Eff. Rot. Displ.	Rot. Speed	Rot. Freq.	Calc. Mass, u
massless m-neutrino:	2R	1-1-(1)	1/2-1/2-(1)	1/2-1/2-2	R/π-R/π-4R/π	0
massless c-neutrino:	1/2 R	(1)-(1)-1	(1/2)-(1/2)-1	2-2-1/2	4R/π-4R/π-R/π	0
massless m-neutron:	2R	1-1-0	1/2-1/2-0	1/2-1/2-1	R/π-R/π-2R/π	0
massless c-neutron:	1/2 R	(1)-(1)-0	(1/2)-(1/2)-0	2-2-1	4R/π-4R/π-2R/π	0
chargeless m-proton:	2R	2-1-(1)	1-1-(1)	1/2-1/2-2	R/3π-R/π-4R/π	1.007229255
charged m-proton:	2R	2-1-(1)+/-	1-1-(1)	1/2-1/2-2	2R/3π-R/π-4R/π	1.007274185
chargeless c-proton	1/2 R	(2)-(1)-1	(1)-(1)-1	2-2-1/2	4R/π-4R/π-R/π	1.007229255
charged c-proton:	1/2 R	(2)-(1)-1-/+	(1)-(1)-1	2-2-1/2	4R/π-4R/π-R/π	1.007274185
m-compound neutron:	2R	2-1-(1)	1-1-(1)	1/3-1/2-2	2R/3π-R/π-4R	1.008675555
	1/2 R	(1)-(1)-1	(1/2)-(1/2)-1	2-2-1/2	4R/π-4R/π-R/π	0
c-compound neutron:	1/2 R	(2)-(1)-1	(1)-(1)-1	3-2-1/2	6R/π-4R/π-R/π	1.0086675555
	2R	1-1-(1)	1/2-1/2-(1)	1/2-1/2-2	R/π-R/π-4R/π	0
m-hydrogen (H^1):	2R	2-1-(1)	1-1-(1)	1/3-1/2-2	2R/3π-R/π-4R/π	1.007807775
	2R	1-1-(1)	1/2-1/2-(1)	1/2-1/2-2	R/π-R/π-4R/π	0
c-hydrogen (c-H^1):	1/2 R	(2)-(1)-1	(1)-(1)-1	3-2-1/2	6R/π-4R/π-R/π	1.007807775
	1/2 R	(1)-(1)-1	(1/2)-(1/2)-1	2-2-1/2	4R/π-4R/π-R/π	0

Table IV. Subatomic and Intermediate Particles

Note on electric charge: An electric charge in the Reciprocal System is a *one-dimensional rotational vibration*; the natural unit value is R/π--the rotation *reverses* at the end of each revolution (therefore the cycle takes twice as long as a uniform rotation). A negative charge (in time) therefore has the frequency R/2π; a positive charge (in space) has the frequency 2R/π. An electric rotational displacement in time can take a rotational vibrational displacement in space (positive charge); an electric rotational vibrational displacement in space can take a rotational vibrational displacement in time (negative charge).

A material atom of atomic number Z (equivalent to Z electric time displacements) can take Z positive charges (space displacements), regardless of its actual number or type of electric displacements; a cosmic atom of atomic number Z (equivalent to Z electric space displacements) can take Z negative charges (time displacements), regardless of its actual number or type of electric displacements.

A material proton has one net electric time displacement due to the magnetic displacement, so it can take one positive charge; but it also has one electric space displacement, so it can also take a negative charge! Similarly for the cosmic proton--this proton has one net electric space displacement due to its magnetic displacement, so it can take one negative charge; but it also has one electric time displacement, so it can take a positive charge! The observed negatively-charged "anti-proton" can therefore either be a negatively-charged material proton or a negatively-charged cosmic proton. Given the energy requirements in accelerators, it is likely, however, that the observed "anti-proton" is a negatively-charged cosmic proton.

Also note that the material positron is not an "anti-particle" of the electron or a cosmic particle. Likewise, the cosmic positron is not an "anti-particle" for the cosmic electron or a material particle.

Note on mass: The mass calculation for the material particles is given in detail in Ref. [13]. The corresponding *subatomic* and *intermediate* particles in the cosmic sector have the *exact same masses*. The first *real* atoms are deuterium and c-deuterium:

Particle	Photon Freq. (Ground)	Rot. Displ.	Eff. Rot. Displ.	Rot. Speed	Rot. Freq.	Calc. Mass, u
m-deuterium	2R	2-1-(1)	1-1-(1)	1/2-1/2-2	2R/3π-R/π-4R/π	2.014169251
	2R	2-1-(1)	1-1-(1)	1/2-1/2-2	2R/3π-R/π-4R/π	
c-deuterium	1/2 R	(2)-(1)-1	(1)-(1)-1	2-2-1/2	6R/π-4R/π-R/π	2.014169251
	1/2 R	(2)-(1)-1	(1)-(1)-1	2-2-1/2	6R/π-4R/π-R/π	

Table IV. m-deuterium and c-deuterium

For convenience, the spin representations for atoms and c-atoms are reduced to just giving *one* set, rather than two, because they are identical. So, for instance, m-deuterium can be specified simply as 2-1-(1) and c-deuterium can be specified simply as (2)-(1)-1. Each rotational system is equal to unity, so the m-D and c-D must have the same mass.

c. magnetic moments of electron, proton, and neutron

In the Reciprocal System, *none* of the subatoms have *intrinsic* magnetic moments or charges. But, similar to diamagnetic and paramagnetic matter, a magnetic charge (two-dimensional rotational vibration) may be temporarily *induced* in them. Normally electropositive elements (those with electric time displacement) are paramagnetic (positive), whereas electronegative elements (those with electric space displacement) are diamagnetic (negative). The proton has an electric space displacement and usually takes a rotational vibration in space (a positive charge) (over the net electric time displacement). Apparently, the net electric time displacement dominates here so the proton acts as a paramagnet: a *positive* magnetic moment can be induced in it. The electron also has an electric space displacement but takes a rotational vibration in time (a negative charge). Here, the electric space displacement seems to dominate, therefore a negative magnetic moment can be induced in it. The compound neutron has both electric space and electric time displacements and is therefore unstable. The electric space displacement (from the proton rotation) dominates, so a negative magnetic moment can be induced in it. Further work, including quantitative calculation, needs to be done here.

d. neutrino mass and energy; "flavor changes"

The m-neutrino can be identified as the "electron neutrino" and the c-neutrino can be identified as the "anti-electron neutrino"; the massless m-neutron can be identified as the "muon neutrino" and the massless c-neutron can be identified as the "anti-muon neutrino"; there are no other neutrinos, so it's probable that the "tau neutrino" is really just the m-neutrino, and the "anti-tau neutrino" is really just the c-neutrino.

Neutrinos in the Reciprocal System have zero mass, which contrasts with conventional theory which says that they have a small mass, which is necessary to explain the "oscillation between flavors." According to Ref. [36], published in 1973, the mass of the "electron neutrino" is < 60 eV and the mass of the "muon neutrino" is < 1.6 eV. According to Ref. [34], published in 2008, the mass of the "electron neutrino" is between 0 and 200 meV; the mass of the "muon neutrino" is between 9 and 200 meV, and the mass of the "tau neutrino" is between 0 and 200 meV. So the estimates have come down considerably over the period from 1973 to 2008.

The different transformations (termed "flavor changes") are as follows, using *effective displacements*:

m-neutrino + massless m-electron = massless m-neutron

1/2-1/2-1 + 0-0-(1) = 1/2-1/2-0 (34)

c-neutrino + massless c-electron = massless c-neutron

(1/2)-(1/2)-(1) + 0-0-1 = (1/2)-(1/2)-0 (35)

massless m-neutron + massless m-positron = m-neutrino

1/2-1/2-0 + 0-0-1 = 1/2-1/2-1 (36)

massless c-neutron + massless c-positron = c-neutrino

(1/2)-(1/2)-0 + 0-0-(1) = (1/2)-(1/2)-(1) (37)

All of these massless particles are carried at the speed of light by the space-time progression, but are *refracted* when moving through matter or c-matter. There is essentially a *constant flux* of these particles throughout the universe, similar to the flux of photons. Therefore, the combinations above happen on a regular basis. So, for example, an m-neutrino created from solar energy generation can combine with a massless m-electron on its way to the Earth and become a massless m-neutron, etc.

The Reciprocal System can also explain the variation of neutrino energy levels: the ground state photon frequency for the material neutrino and massless neutron of 2R can be *increased to practically any frequency*. According to Ref. [46], p. 487, neutrinos from Supernova 1987A had individual energies of 10 MeV! This means they were essentially rotating gamma photons. But the reference says these are are "anti-neutrinos", which is quite unlikely--they were actually the normal "electron neutrinos." Conventional theory has a difficult time explaining the energy of the neutrinos whether they have zero mass or very small mass.

e. calculation of average lifetime of the compound neutron

Ref. [13] gives the Reciprocal System equations for calculating the average lifetime and half-lives of heavy radioactive isotopes. Here, an alpha particle is ejected. In the case of neutron decay, a proton is ejected, together with a cosmic neutrino, and an electron; the neutron completely decomposes The charges are created in the *process*. The mean lifetime depends on the natural unit of time, together with an exponential function, as with the radioactive elements, but the natural units are different. For the neutron, the natural unit of energy to use is equal to one electric time displacement, equal to two atomic mass units, expressed in terms of MeV. Therefore,

$Z := .5$ (*effective* atomic number for H^1, p, and n)

$$\tau_{n\_calc} := t_u \cdot e^{\left(\frac{2 \cdot Z}{\left(\frac{1}{2 \cdot conv_{amu\_to\_u} \cdot conv_{u\_to\_MeV}}\right)^{\frac{1}{2}}}\right)} \qquad \tau_{n\_calc} = 839.886486 \quad \text{sec} \qquad (38)$$

The "1" in the second numerator means 1 MeV. This calculation is, unfortunately, a "one-off," because there is no other case similar to this for material particles, so it's not possible to provide additional confirmation.

Ref. [34], p. 22, and Ref. [50], p. 11-42, say the mean lifetime of the the neutron is 886 sec. Ref. [49], p.1337, says it's 877- 926 sec. Ref. [48], p. 9-131, says it's 1010 sec. Ref. [36], p. 237, and Ref. [45], p. 45, say it's 932 sec. Ref. [41], p. 109, says it's 865 sec. Ref. [47], p. 909, says it's 889 sec. Ref. [40], p. 330, says it's 935 sec. In general, the newer references give *lower* values.

Isn't it odd that, according to conventional physics, stable atoms can contain unstable neutrons, and stable stars--like "neutron stars"--can be constructed out of unstable neutrons? Prof. Shu gives the conventional answer (Ref. [41], p. 111):

"Because of Pauli's exclusion principle. Protons and neutrons in the nucleus of an atom are arranged in discrete energy levels, much as the electrons in the shells of an atom are. The guiding principle in both cases is Pauli's exclusion principle, which forbids two identical fermions to occupy the same same quantum state." But: why should neutrons or protons or electrons "obey" Pauli's exclusion principle? These subatoms don't "know" Pauli! The *observed* "free" protons, neutrons, and electrons can have the *same* energy levels as their brethren.

4. Atoms

a. periodic table of elements and c-elements

The periodic tables are given in the appendix. The figure after the matter table shows the rotational axes of an m-atom; the figure after the c-matter table shows the rotational axes of a c-atom. The alternation of magnetic and electric displacements is very logical, and one can clearly see the symmetry between the matter table and the c-matter table. The Reciprocal System periodic table for matter first appeared in the author's book, Ref. [9], pp. 42-43.

b. masses of the elements and c-elements

Ref. [13] gives the equations for the calculation of the isotopes of all matter elements. To get the corresponding masses for the isotopes of the cosmic sector, we simply invert the Eqs. (25) given there:

$$M_{c\_A} := \frac{4}{\left(1.994857253 \cdot Z_c + 1.009267224 \cdot G_c\right)} \blacksquare \quad u \qquad Z_c \geq 10 \qquad (39a)$$

$$M_{c\_A} := \frac{4}{2.001294586 \cdot Z_c + 1.006072216 \cdot G_c} \blacksquare \quad u \qquad 1 < Z_c < 10 \qquad (39b)$$

where Z_c is the cosmic atomic number and G_c is the number of cosmic gravitational charges. The inverse is based on the equivalent *atomic number*, not the equivalent *atomic weight,* hence the 4 in the numerators. These equations *do* take into account the *mass defect*, so they are *more exact* than previous such equations (as in Ref. [22]). $Z_c = 1$, for deuterium, is a special case, and the mass is simply 2.014169251 u by symmetry. Table V follows.

Element	Z	A	G	Z x m_D	c-M_A_calc_u	c-M_A_calc_MeV
c-D	1	2	0	2.014170	2.014169	1876.186461
c-He	2	4	0	4.028340	0.999353	930.891501
c-Li	3	6	0	6.042510	0.666235	620.594334
	3	7	1	6.042510	0.570617	531.526340
c-Be	4	9	1	8.056680	0.443890	413.480484
c-B	5	10	0	10.070850	0.399741	372.356601
	5	11	1	10.070850	0.363222	338.339248
c-C	6	12	0	12.085020	0.333118	310.297167
	6	13	1	12.085020	0.307365	286.308754
c-N	7	14	0	14.099190	0.285529	265.969000
	7	15	1	14.099190	0.266398	248.148046
c-O	8	16	0	16.113360	0.249838	232.722875
	8	17	1	16.113360	0.235067	218.963466
	8	18	2	16.113360	0.221945	206.740242
c-F	9	19	1	18.127530	0.210330	195.921255
c-Ne	10	20	0	20.141700	0.200516	186.779091
	10	21	1	20.141700	0.190859	177.784366
	10	22	2	20.141700	0.182090	169.616156
c-Na	11	23	1	22.155870	0.174271	162.332829
c-Mg	12	24	0	24.170040	0.167096	155.649243
	12	25	1	24.170040	0.160336	149.352366
	12	26	2	24.170040	0.154102	143.545166
c-Al	13	27	1	26.184210	0.148465	138.294089
c-Si	14	28	0	28.198380	0.143225	133.413636
	14	29	1	28.198380	0.138230	128.760467
	14	30	2	28.198380	0.133571	124.420943
c-P	15	31	1	30.212550	0.129315	120.456520
c-S	16	32	0	32.226720	0.125322	116.736932
	16	33	1	32.226720	0.121481	113.158749
	16	34	2	32.226720	0.117868	109.793398
	16	36	4	32.226720	0.111251	103.629496
c-Cl	17	35	1	34.240890	0.114542	106.694727
	17	37	3	34.240890	0.108283	100.864603
c-Ar	18	36	0	36.255060	0.111398	103.766162
	18	38	2	36.255060	0.105469	98.243413
	18	40	4	36.255060	0.100139	93.278832
c-K	19	39	1	38.269230	0.102797	95.755008
	19	40	2	38.269230	0.100198	93.334156
	19	41	3	38.269230	0.097728	91.032692

c-Ca	20	40	0	40.283400	0.100258	93.389546
	20	42	2	40.283400	0.095430	88.892183
	20	43	3	40.283400	0.093186	86.802117
	20	44	4	40.283400	0.091045	84.808078
	20	46	6	40.283400	0.087046	81.082772
	20	48	8	40.283400	0.083383	77.670974
c-Sc	21	45	3	42.297570	0.089048	82.947295
c-Ti	22	46	2	44.311740	0.087136	81.166415
	22	47	3	44.311740	0.085261	79.420295
	22	48	4	44.311740	0.083466	77.747722
	22	49	5	44.311740	0.081744	76.144143
	22	50	6	44.311740	0.080092	74.605376
c-V	23	50	4	46.325910	0.080130	74.640763
	23	51	5	46.325910	0.078542	73.161569
c-Cr	24	50	2	48.340080	0.080168	74.676183
	24	52	4	48.340080	0.077051	71.772583
	24	53	5	48.340080	0.075582	70.403843
	24	54	6	48.340080	0.074167	69.086331
c-Mn	25	55	5	50.354250	0.072836	67.846462
c-Fe	26	54	2	52.368420	0.074232	69.147044
	26	56	4	52.368420	0.071552	66.650312
	26	57	5	52.368420	0.070283	65.468361
	26	58	6	52.368420	0.069059	64.327599
c-Co	27	59	5	54.382590	0.067903	63.251324
c-Ni	28	58	2	56.396760	0.069115	64.380234
	28	60	4	56.396760	0.066786	62.210471
	28	61	5	56.396760	0.065679	61.179526
	28	62	6	56.396760	0.064608	60.182193
	28	64	8	56.396760	0.062568	58.281996
c-Cu	29	63	5	58.410930	0.063596	59.239147
	29	65	7	58.410930	0.061618	57.397124
c-Zn	30	64	4	60.425100	0.062615	58.325199
	30	66	6	60.425100	0.060697	56.538719
	30	67	7	60.425100	0.059781	55.685899
	30	68	8	60.425100	0.058893	54.858424
	30	70	10	60.425100	0.057193	53.275122
c-Ga	31	69	7	62.439270	0.058051	54.073756
	31	71	9	62.439270	0.056398	52.534788
c-Ge	32	70	6	64.453440	0.057232	53.311218
	32	72	8	64.453440	0.055625	51.814748

	32	73	9	64.453440	0.054856	51.097582
	32	74	10	64.453440	0.054107	50.399997
	32	76	12	64.453440	0.052669	49.060450
c-As	33	75	9	66.467610	0.053395	49.736918
c-Se	34	74	6	68.481780	0.054141	50.432301
	34	76	8	68.481780	0.052701	49.091059
	34	77	9	68.481780	0.052010	48.446839
	34	78	10	68.481780	0.051336	47.819309
	34	80	12	68.481780	0.050040	46.611787
	34	82	14	68.481780	0.048807	45.463747
c-Br	35	79	9	70.495950	0.050695	47.221993
	35	81	11	70.495950	0.049430	46.044078
c-Kr	36	78	6	72.510120	0.051367	47.848389
	36	80	8	72.510120	0.050069	46.639416
	36	82	10	72.510120	0.048836	45.490031
	36	83	11	72.510120	0.048241	44.936324
	36	84	12	72.510120	0.047661	44.395935
	36	86	14	72.510120	0.046542	43.353232
c-Rb	37	85	11	74.524290	0.047108	43.880621
	37	87	13	74.524290	0.046014	42.861705
c-Sr	38	84	8	76.538460	0.047688	44.420999
	38	86	10	76.538460	0.046567	43.377132
	38	87	11	76.538460	0.046026	42.873382
	38	88	12	76.538460	0.045498	42.381199
c-Y	39	89	11	78.552630	0.044994	41.911347
c-Zr	40	90	10	80.566800	0.044500	41.451798
	40	91	11	80.566800	0.044006	40.991538
	40	92	12	80.566800	0.043523	40.541386
	40	94	14	80.566800	0.042588	39.670106
	40	96	16	80.566800	0.041692	38.835487
c-Nb	41	93	11	82.580970	0.043061	40.111235
c-Mo	42	92	8	84.595140	0.043545	40.562286
	42	94	10	84.595140	0.042609	39.690117
	42	95	11	84.595140	0.042156	39.267947
	42	96	12	84.595140	0.041712	38.854664
	42	97	13	84.595140	0.041278	38.449990
	42	98	14	84.595140	0.040852	38.053659
	42	100	16	84.595140	0.040027	37.285012
c-Tc	43	97	11	86.609310	0.041288	38.459387
	43	98	12	86.609310	0.040862	38.062863

	43	99	13	86.609310	0.040445	37.674431
c-Ru	44	96	8	88.623480	0.041733	38.873861
	44	98	10	88.623480	0.040872	38.072071
	44	99	11	88.623480	0.040455	37.683453
	44	100	12	88.623480	0.040046	37.302688
	44	101	13	88.623480	0.039645	36.929541
	44	102	14	88.623480	0.039253	36.563785
	44	104	16	88.623480	0.038490	35.853587
c-Rh	45	103	13	90.637650	0.038877	36.213535
c-Pd	46	102	10	92.651820	0.039271	36.580784
	46	104	12	92.651820	0.038508	35.869932
	46	105	13	92.651820	0.038137	35.524766
	46	106	14	92.651820	0.037774	35.186179
	46	108	16	92.651820	0.037067	34.528007
	46	110	18	92.651820	0.036387	33.894005
c-Ag	47	107	13	94.665990	0.037426	34.861708
	47	109	15	94.665990	0.036732	34.215506
c-Cd	48	106	10	96.680160	0.037791	35.201921
	48	108	12	96.680160	0.037084	34.543165
	48	110	14	96.680160	0.036402	33.908612
	48	111	15	96.680160	0.036071	33.599998
	48	112	16	96.680160	0.035746	33.296951
	48	113	17	96.680160	0.035426	32.999322
	48	114	18	96.680160	0.035112	32.706966
	48	116	20	96.680160	0.034501	32.137525
c-In	49	113	15	98.694330	0.035434	33.006243
	49	115	17	98.694330	0.034811	32.426426
c-Sn	50	112	12	100.708500	0.035761	33.311048
	50	114	14	100.708500	0.035127	32.720568
	50	115	15	100.708500	0.034818	32.433109
	50	116	16	100.708500	0.034515	32.150657
	50	117	17	100.708500	0.034217	31.873082
	50	118	18	100.708500	0.033924	31.600259
	50	119	19	100.708500	0.033636	31.332067
	50	120	20	100.708500	0.033353	31.068389
	50	122	22	100.708500	0.032801	30.554127
	50	124	24	100.708500	0.032267	30.056612
c-Sb	51	121	19	102.722670	0.033081	30.815145
	51	123	21	102.722670	0.032538	30.309164

c-Te	52	120	16	104.736840	0.033366	31.080662
	52	122	18	104.736840	0.032814	30.565997
	52	123	19	104.736840	0.032544	30.315003
	52	124	20	104.736840	0.032279	30.068098
	52	125	21	104.736840	0.032019	29.825183
	52	126	22	104.736840	0.031762	29.586161
	52	128	24	104.736840	0.031261	29.119429
	52	130	26	104.736840	0.030775	28.667194
c-I	53	127	21	106.751010	0.031515	29.356415
c-Xe	54	124	16	108.765180	0.032292	30.079593
	54	126	18	108.765180	0.031774	29.597290
	54	128	20	108.765180	0.031273	29.130210
	54	129	21	108.765180	0.031028	28.902154
	54	130	22	108.765180	0.030787	28.677642
	54	131	23	108.765180	0.030549	28.456591
	54	132	24	108.765180	0.030316	28.238922
	54	134	26	108.765180	0.029859	27.813423
	54	136	28	108.765180	0.029416	27.400556
c-Cs	55	133	23	110.779350	0.030091	28.029549
c-Ba	56	130	18	112.793520	0.030798	28.688098
	56	132	20	112.793520	0.030327	28.249061
	56	134	22	112.793520	0.029869	27.823258
	56	135	23	112.793520	0.029646	27.615135
	56	136	24	112.793520	0.029426	27.410102
	56	137	25	112.793520	0.029209	27.208091
	56	138	26	112.793520	0.028995	27.009036
c-La	57	138	24	114.807690	0.029000	27.013672
	57	139	25	114.807690	0.028790	26.817441
c-Ce	58	136	20	116.821860	0.029436	27.419654
	58	138	22	116.821860	0.029005	27.018310
	58	140	24	116.821860	0.028587	26.628546
	58	142	26	116.821860	0.028180	26.249868
c-Pr	59	141	23	118.836030	0.028387	26.442293
c-Nd	60	142	22	120.850200	0.028190	26.258628
	60	143	23	120.850200	0.027991	26.073176
	60	144	24	120.850200	0.027794	25.890325
	60	145	25	120.850200	0.027601	25.710020
	60	146	26	120.850200	0.027410	25.532210
	60	148	28	120.850200	0.027036	25.183867
	60	150	30	120.850200	0.026672	24.844901

c-Pm	61	145	23	122.864370	0.027605	25.714221
	61	146	24	122.864370	0.027414	25.536353
	61	147	25	122.864370	0.027226	25.360929
c-Sm	62	144	20	124.878540	0.027804	25.898846
	62	147	23	124.878540	0.027230	25.365017
	62	148	24	124.878540	0.027045	25.191930
	62	149	25	124.878540	0.026861	25.021190
	62	150	26	124.878540	0.026681	24.852749
	62	152	28	124.878540	0.026326	24.522580
	62	154	30	124.878540	0.025981	24.201068
c-Eu	63	151	25	126.892710	0.026506	24.690434
	63	153	27	126.892710	0.026156	24.364535
c-Gd	64	152	24	128.906880	0.026334	24.530225
	64	154	26	128.906880	0.025989	24.208514
	64	155	27	128.906880	0.025820	24.050802
	64	156	28	128.906880	0.025652	23.895132
	64	158	30	128.906880	0.025325	23.589760
	64	160	32	128.906880	0.025005	23.292095
c-Tb	65	159	29	130.921050	0.025168	23.443475
c-Dy	66	156	24	132.935220	0.025660	23.902391
	66	158	26	132.935220	0.025332	23.596835
	66	160	28	132.935220	0.025012	23.298992
	66	161	29	132.935220	0.024856	23.152873
	66	162	30	132.935220	0.024701	23.008575
	66	163	31	132.935220	0.024548	22.866064
	66	164	32	132.935220	0.024397	22.725308
c-Ho	67	165	31	134.949390	0.024251	22.589516
c-Er	68	162	26	136.963560	0.024708	23.015305
	68	164	28	136.963560	0.024404	22.731873
	68	166	30	136.963560	0.024107	22.455338
	68	167	31	136.963560	0.023961	22.319578
	68	168	32	136.963560	0.023817	22.185450
	68	170	34	136.963560	0.023534	21.921972
c-Tm	69	169	31	138.977730	0.023678	22.056015
c-Yb	70	168	28	140.991900	0.023824	22.191707
	70	170	30	140.991900	0.023541	21.928081
	70	171	31	140.991900	0.023402	21.798603
	70	172	32	140.991900	0.023264	21.670646
	70	173	33	140.991900	0.023129	21.544181
	70	174	34	140.991900	0.022994	21.419185
	70	176	36	140.991900	0.022731	21.173492

c-Lu	71	175	33	143.006070	0.022865	21.298512
	71	176	34	143.006070	0.022734	21.176342
c-Hf	72	174	30	145.020240	0.023001	21.425017
	72	176	32	145.020240	0.022737	21.179192
	72	177	33	145.020240	0.022607	21.058382
	72	178	34	145.020240	0.022479	20.938943
	72	179	35	145.020240	0.022352	20.820852
	72	180	36	145.020240	0.022227	20.704084
c-Ta	73	180	34	147.034410	0.022230	20.706809
	73	181	35	147.034410	0.022106	20.591314
c-W	74	180	32	149.048580	0.022233	20.709534
	74	182	34	149.048580	0.021986	20.479765
	74	183	35	149.048580	0.021865	20.366782
	74	184	36	149.048580	0.021745	20.255038
	74	186	38	149.048580	0.021509	20.035190
c-Re	75	185	35	151.062750	0.021629	20.147094
	75	187	37	151.062750	0.021395	19.929570
c-Os	76	184	32	153.076920	0.021750	20.260254
	76	186	34	153.076920	0.021514	20.040293
	76	187	35	153.076920	0.021398	19.932094
	76	188	36	153.076920	0.021283	19.825057
	76	189	37	153.076920	0.021169	19.719164
	76	190	38	153.076920	0.021057	19.614396
	76	192	40	153.076920	0.020836	19.408164
c-Ir	77	191	37	155.091090	0.020948	19.513154
	77	193	39	155.091090	0.020729	19.309035
c-Pt	78	190	34	157.105260	0.021062	19.619287
	78	192	36	157.105260	0.020841	19.412953
	78	194	38	157.105260	0.020624	19.210913
	78	195	39	157.105260	0.020517	19.111463
	78	196	40	157.105260	0.020411	19.013036
	78	198	42	157.105260	0.020203	18.819194
c-Au	79	197	39	159.119430	0.020309	18.917892
c-Hg	80	196	36	161.133600	0.020416	19.017632
	80	198	38	161.133600	0.020208	18.823696
	80	199	39	161.133600	0.020106	18.728204
	80	200	40	161.133600	0.020004	18.633676
	80	201	41	161.133600	0.019904	18.540097
	80	202	42	161.133600	0.019804	18.447454
	80	204	44	161.133600	0.019608	18.264917

c-Tl	81	203	41	163.147770	0.019708	18.357873
	81	205	43	163.147770	0.019514	18.177096
c-Pb	82	204	40	165.161940	0.019613	18.269158
	82	206	42	165.161940	0.019421	18.090116
	82	207	43	165.161940	0.019326	18.001904
	82	208	44	165.161940	0.019232	17.914549
c-Bi	83	209	43	167.176110	0.019141	17.830057
c-Po	84	208	40	169.190280	0.019236	17.918628
	84	209	41	169.190280	0.019144	17.832077
c-At	85	210	40	171.204450	0.019054	17.748360
c-Rn	86	211	39	173.218620	0.018965	17.665425
c-Fr	87	212	38	175.232790	0.018876	17.583261
	87	222	48	175.232790	0.018018	16.783873
	87	223	49	175.232790	0.017937	16.707914
c-Ra	88	226	50	177.246960	0.017698	16.485833
	88	228	52	177.246960	0.017542	16.339899
c-Ac	89	227	49	179.261130	0.017621	16.414253
c-Th	90	232	52	181.275300	0.017240	16.058924
c-Pa	91	231	49	183.289470	0.017317	16.130738
	91	233	51	183.289470	0.017167	15.990996
c-U	92	234	50	185.303640	0.017095	15.923640
	92	235	51	185.303640	0.017021	15.855252
	92	238	54	185.303640	0.016805	15.653567
c-Np	93	236	50	187.317810	0.016950	15.789033
	93	237	51	187.317810	0.016878	15.721793
c-Pu	94	238	50	189.331980	0.016808	15.656682
	94	239	51	189.331980	0.016737	15.590563
	94	240	52	189.331980	0.016667	15.525000
	94	241	53	189.331980	0.016597	15.459986
	94	242	54	189.331980	0.016528	15.395514
	94	244	56	189.331980	0.016391	15.268170
c-Am	95	241	51	191.346150	0.016599	15.461505
	95	243	53	191.346150	0.016461	15.333071
c-Cm	96	240	48	193.360320	0.016670	15.528063
	96	242	50	193.360320	0.016531	15.398527
	96	243	51	193.360320	0.016462	15.334566
	96	244	52	193.360320	0.016394	15.271133
	96	245	53	193.360320	0.016327	15.208224
	96	246	54	193.360320	0.016260	15.145831
	96	247	55	193.360320	0.016193	15.083947

	96	248	56	193.360320	0.016127	15.022568
	96	249	57	193.360320	0.016062	14.961685
	96	250	58	193.360320	0.015997	14.901295
c-Bk	97	247	53	195.374490	0.016195	15.085393
	97	249	55	195.374490	0.016064	14.963108
c-Cf	98	248	52	197.388660	0.016130	15.025436
	98	249	53	197.388660	0.016065	14.964531
	98	250	54	197.388660	0.016000	14.904117
	98	251	55	197.388660	0.015936	14.844189
	98	253	57	197.388660	0.015809	14.725768
c-Es	99	252	54	199.402830	0.015874	14.786131
	99	254	56	199.402830	0.015747	14.668630
c-Fm	100	252	52	201.417000	0.015875	14.787520
	100	254	54	201.417000	0.015749	14.669997
	100	257	57	201.417000	0.015563	14.497175

Table V. Cosmic Isotopes (most probable*)

*This table is based on the matter table in Ref. [13], assuming a "magnetic ionization level" of 1, the same flux of neutrinos observed in our sector at the current epoch.

The column on the right is the value of the mass in terms of "MeV":

$$M_{c\_A\_MeV} := \frac{4 \cdot conv_{u\_to\_MeV}}{\left(1.994857253 \cdot Z_c + 1.009267224 \cdot G_c\right)} \blacksquare \qquad Z_c \geq 10 \qquad (39c)$$

$$M_{c\_A\_MeV} := \frac{4 \cdot conv_{u\_to\_MeV}}{2.001294586 \cdot Z_c + 1.006072216 \cdot G_c} \blacksquare \qquad 1 < Z_c < 10 \qquad (39d)$$

In the material environment, cosmic isotopes can pick up material gravitational charges. This is often the case with experiments in accelerators. Eqs. (39c and 39d) are then modified to

$$M_{c\_A\_MeV} := \frac{4 \cdot conv_{u\_to\_MeV}}{\left(1.994857253 \cdot Z_c + 1.009267224 \cdot G_c\right)} + G_m \cdot conv_{amu\_to\_u} \cdot conv_{u\_to\_MeV} \qquad Z_c \geq 10 \qquad (39e)$$

$$M_{c\_A\_MeV} := \frac{4 \cdot conv_{u\_to\_MeV}}{2.001294586 \cdot Z_c + 1.006072216 \cdot G_c} + G_m \cdot conv_{amu\_to\_u} \cdot conv_{u\_to\_MeV} \qquad 1 < Z_c < 10 \qquad (39f)$$

where G_m is a small integer: $G_m \leq 2 \cdot t_p$ (t_p is the number of principal magnetic rotational displacements)

Usually, though not necessarily, $G_c = 0$ when G_m is not. Some sample calculations follow, together with particle identifications.

In functional format, the Eqs. above are

$$M_{c\_A\_MeV}\left(Z_c, G_c, G_m\right) := \begin{cases} 1876.186695 + G_m \cdot conv_{amu\_to\_u} \cdot conv_{u\_to\_MeV} & \text{if } Z_c = 1 \\ \left[\dfrac{4 \cdot conv_{u\_to\_MeV}}{\left(1.994857253 \cdot Z_c + 1.009267224 \cdot G_c\right)} + G_m \cdot conv_{amu\_to\_u} \cdot conv_{u\_to\_MeV}\right] & \text{if } Z_c \geq 10 \\ \dfrac{4 \cdot conv_{u\_to\_MeV}}{2.001294586 \cdot Z_c + 1.006072216 \cdot G_c} + G_m \cdot conv_{amu\_to\_u} \cdot conv_{u\_to\_MeV} & \end{cases}$$

Identification			observed values (from Ref. [49]) MeV
c-D	ψ	$M_{c\_A\_MeV}(1,0,2) = 3724.179067$	3769
c-He^3	ψ	$M_{c\_A\_MeV}(2,-1,2) = 3105.831793$	3096.93
c-He^5	N	$M_{c\_A\_MeV}(2,1,2) = 2606.30266$	2600
c-Li^5	Ω	$M_{c\_A\_MeV}(3,-1,1) = 1676.71959$	1672
c-Be^7	N	$M_{c\_A\_MeV}(4,-1,1) = 1463.548332$	1430-1470
c-Be^7	η	$M_{c\_A\_MeV}(4,-1,0) = 532.3503$	547.45
c-B^{10}	Ξ	$M_{c\_A\_MeV}(5,0,1) = 1303.554633$	1314.9
c-C^{12}	Δ	$M_{c\_A\_MeV}(6,0,1) = 1241.495199$	1234
c-N^{14}	Σ	$M_{c\_A\_MeV}(7,0,1) = 1197.167033$	1197.43
c-Ne^{20}	Λ	$M_{c\_A\_MeV}(10,0,1) = 1117.376332$	1115.63
c-Si^{27}	π	$M_{c\_A\_MeV}(14,0,0) = 132.9845$	134.9743
c-Ar^{35}	μ	$M_{c\_A\_MeV}(18,-1,0) = 106.404082$	105.658389
c-Kr^{72}	?	$M_{c\_A\_MeV}(36,0,0) = 51.716195$	?
c-Kr^{72}	K	$M_{c\_A\_MeV}(36,0,1.5) = 1448.513243$	1430
c-Kr^{72}	K	$.5 \cdot M_{c\_A\_MeV}(36,0,1) = 491.457113$	493.646 (the usual kaon)

Table VI. Important Cosmic Isotopes and "Decay" Sequence

There are hundreds of possible cosmic isotopes. The Reciprocal System Database makes it easy to to enter them, by providing ranges. One then can input the number of material gravitational charges to obtain the total mass in u or MeV. Or, one can input the observed mass and determine the most likely values of G_c and G_m for the cosmic element.

Note on isotopes: When the neutron was discovered in 1932, the scientific community assumed that it was a constituent of the nucleus of the atom and was the explanation for isotopes and atom-building. However, in the decades since, it's been determined that neutron addition plays only a minor role in atom building. There is no major flux of neutrons. But there is a remarkably high flux of neutrinos. The Reciprocal System asserts that neutrinos can obtain a magnetic charge, a two-dimensional rotational vibration in space, and thus become trapped in matter. The two-dimensional rotational vibration in *space* induces a two-dimensional rotational vibration in *time*, a "gravitational charge" in the associated atom. This is equal to 1 amu. Atom-building thus takes place by neutrino addition *everywhere* in the material sector, not by supernovae, as assumed by conventional theory. The recent discovery of Fe in intergalactic space proves this. The Davis neutrino detector made use of the following reaction:

$$Cl^{37}_{17} + \nu_e \text{ --> } Ar^{37}_{18} + e^- \qquad (40)$$

This shows, in effect, how neutrinos are the source for isotopes and atom-building, not neutrons. See below for more details (it usually takes two magnetically-charged neutrinos to move up the periodic table).

Table V lists many cosmic isotopes with masses less than that of the muon. These should be considered as predictions by the Reciprocal System. They will have to be assiduously looked for the aftermath of proton/"anti-proton" collisions in accelerators.

Some miscellaneous cosmic elements: Larson gives tables for the "baryon resonances" and "meson resonances" in Ref. [1], 2nd ed., pp. 205-208. The "Sigma Series", "Lambda Series", "Xi Series", "N Series", "Delta Series" are there.

Recently, many heavier particles have been discovered. The maximum number of gravitational charges = 2 x 5 = 10, giving

$$10 \cdot conv_{amu\_to\_u} \cdot conv_{u\_to\_MeV} = 9311.980322 \ \ MeV$$

plus the small inverse mass. If the observed particle has greater than this mass, then it cannot be a cosmic isotope.

The kaon, or K-meson, plays a prominent role in particle physics. Larson explains this particle as follows (Ref. [1], 2nd ed, p. 199):

"The standard technique in the production of transient particles therefore is to use protons, or hydrogen atoms which fragment to protons, as the raw material for cosmic atom building. In the high energy environment that is created in the production apparatus, the particle accelerators, the proton, m 1-1-(1), ejects an electron, m 0-0-(1), [using effective displacements] and then separates into two massless neutrons, m 1/2-1/2-0, each of which converts to a half c-Kr atom (that is, one of the rotating systems of that atom) by directional inversion. These half c-Kr atoms cannot add displacement and become muons because they are unable to dispose of the proton mass, which persists as a gravitational charge (half of the normal size, as the proton has only one rotating system). They remain as particles of a distinct type, each with half of the c-Kr mass (52 MeV), and half of the 931 MeV mass of a normal gravitational charge, the total being 492 MeV. They can be identified as K mesons, or kaons, the observed mass of which is 494 MeV. As can be seen from the foregoing, the initial production of transient (cosmic) particles in the accelerators is always accompanied by a copious production of kaons."

Note on electric charge of cosmic elements: The charged pions (plus and minus) have 4.59358 MeV more mass than the neutral pion. This is 110 times the mass contribution of the positive charge of a proton to the proton's mass. Further research is needed here to explain this charge effect of some cosmic elements.

c. true identity of the W, Z, and Higgs bosons, and the τ "lepton"

1) W boson

The observed mass is 80.403 GeV (Ref. [50], p. 11-1).

$$\frac{80.403 \cdot 1000}{conv_{u\_to\_MeV}} = 86.31617 \quad u$$

Using the Reciprocal System Database for material isotopes, one can see that this particle could be Kr (with $G_m = 15$), Rb (with $G_m = 13$), Sr (with $G_m = 11$), Y (with $G_m = 9$), Zr (with $G_m = 7$), Nb (with $G_m = 5$), Mo (with $G_m = 3$), or Tc (with $G_m = 1$). Smaller numbers would be favored in accelerators, so most likely the W boson is Tc.

2) Z boson

The observed mass is 91.1875 GeV (Ref. [50], p. 11-1).

$$\frac{91.1875 \cdot 1000}{conv_{u\_to\_MeV}} = 97.893807 \quad u$$

Using the Reciprocal System Database for material isotopes, one can see that this particle could be many of the elements in Row 3B of the periodic table. However, most likely it is In, with $G_m = 0$.

3) Higgs bosons

Rather than just one, two "Higgs bosons" have been discovered, with masses given as 123.5 GeV = 132.582703 u and 126.6 GeV = 135.910689 u. These particles are most likely Cs, with $G_m = 23$ or 26. Prediction: because there are many isotopes of Cs, there could be many more supposed "Higgs bosons" to be "found." Elements to the right of Cs (from Ba to Eu) in the periodic table are "rare earth" elements--these could be created in accelerators (and match the mass specs of the "Higgs bosons"), but Cs is a much more common element.

4) tau "lepton"

The observed mass is 1784.1 MeV (Ref. [49], p. 1182), which is 1.91531 u. This is close to the mass of c-D, 2.0012 u. However, the tau particle does not change to m-D; rather it decays into muons, pions, kaons, etc. So a more likely possibility is that it is c-He^5 with 1 cosmic gravitational charge and one material gravitational charge, giving a mass of 1675 MeV. More research is needed here.

d. alpha and beta radioactivity (material atoms)

The general equation for alpha radioactivity is:

$$ {}^{A}_{Z}X_{N} \rightarrow {}^{A-4}_{Z-2}X_{N-2} + {}^{4}_{2}\alpha_{2} \qquad (41) $$

In Reciprocal System notation, with the first number being rotational mass (2Z) and the second number being rotational vibrational mass (gravitational charges), the general equation is:

$$ 2Z+G_m \rightarrow (2Z-4) + G_m + 4+0 \qquad (42) $$

where, for clarity, a plus sign is used, rather than a hyphen.

The general equation for beta radioactivity is:

$$ {}^{A}_{Z}X_{N} \rightarrow {}^{A}_{Z+/-1}X_{N-/+1} + e^{-/+} + (\nu_e \text{ or } \bar{\nu}_e) \qquad (43) $$

The electrons and positrons, with their charges, are created in the process. The neutrinos were originally present! If a cosmic neutrino comes out, this means that it had originally created a *negative* gravitational charge in the isotope, so the mass would be less than 2Z. In radioactive decay, say from U^{238} to Pb^{206}, the process proceeds by both alpha and beta decay. "The loss of this rotational mass necessitates beta emission to restore the equilibrium between rotational and vibrational mass." (Ref. [2], p. 270).

e. cosmic atom buildup process in accelerators

The sequence is as follows (based on Ref. [1], 2nd ed., p. 203).

Atomic Number	G_c	Element	Atomic Mass (MeV)
3	-1	c-Li^5	745
3	0	c-Li^6	621
4	-1	c-Be^7	532
4	0	c-Be^8	466
4	1	c-B^9	414
5	-1	c-B^{10}	372
6	0	c-C^{12}	310
7	0	c-N	266
8	0	c-O	232
9	0	c-F	207
10	0	c-Ne	186
12	0	c-Mg	155
18	0	c-A	103
36	0	c-Kr	52

Table VII. Cosmic Atom Building Sequence in Accelerators

Ref. [1], 2nd ed., pp.202-203: "In the atom building process in a high energy environment the necessary energy is readily available, and the essential task is to provide the required mass. This is supplied in the form of c-Kr atoms, mass 51.73 [MeV] each. The full sequence of cosmic atoms in the building process therefore consists of a series of elements, the successive members of which differ by 52 MeV." The table shows this to be at least approximately true.

f. cosmic ray decay and material atom building

1) original rays

The original rays come from the cosmic sector by means of gigantic cosmic galactic explosions, commonly observed as Gamma Ray Bursts (Ref. [3], p. 386). The cosmic atoms are ejected above the inverse speed of light (1 to 3 c_c), which means they're at or below the speed of light here, c_m (in our usual one dimension of observation). The cosmic sector is not localized in space, so the distribution of the cosmic rays in the material sector is *isotropic*, as observed. All of the cosmic atoms are fully ionized--with *negative* charges. The abundance of the various elements is not too different from that of late stage material matter (as determined by the number of charges), but there is the usual cutoff above Fe. The charges are transferred to massless, chargeless electrons when the original rays strike the top of the Earth's atmosphere.

2) primary rays and secondary rays

These mostly consist of c-H, c-He, and c-p; other subatomic particles are absent (because they cannot be accelerated above c), except for those charged electrons created in the collision *processes* in the atmosphere. Apparently, the cosmic protons and cosmic hydrogen atoms (assuming they do *not* have gravitational charges) simply *invert* their rotations to convert to their material equivalents, because 1 u of cosmic mass = 1 u of material mass, and 2 u of cosmic mass = 2 u of material mass. Cosmic atoms above c-Kr *fragment* to c-Kr or below. These then shed material mass (gain cosmic mass) until they reach c-Kr, at which point the rotations can invert to form two massless neutrons. Starting with c-D with two material gravitational charges and reading down to c-Kr with 0 material gravitational charges, Table VI above gives the *normal* decay sequence. Of course, any cosmic element in between is possible, depending on the circumstances. Also, mass and energy *conservation* must be observed in these transformations.

c-Kr (3)-(3)-0
||
$2n_0$ 2 x 1/2-1/2-0

Recall that 3 magnetic displacement units in space (double rotations) equal 1 magnetic displacement unit in time (4-3 = 1); see Ref. [1], 2nd. ed., p.187. The massless neutrons then undergo further transformations in our sector.

3) massless neutron transformations (using effective displacements)

massless m-neutron - massless m-positron = m-neutrino

1/2-1/2-0 - 0-0-1 = 1/2-1/2-(1) (44)

massless m-neutron + massless electron = m-neutrino

1/2-1/2-0 + 0-0-(1) = 1/2-1/2-(1) (45)

massless m-neutron + m-neutrino + unit mass = proton

1/2-1/2-0 + 1/2-1/2-(1) + unit mass = 2-1-(1) (46)

The unit momentum of the massless m-neutron, t^2/s^2, provides the energy, t/s, which is converted to mass, t^3/s^3, when the particle comes to rest in a gravitationally-bound system. Recall that the massless m-neutron and the m-neutrino have potential mass (see Ref. [13]). The sum is .00057852 u + 1.00665074 u = 1.00722926 u (chargeless proton).

4) hydrogen isotope 1

The (chargeless) proton created above combines with a material neutrino to create H^1:

2-1
\
(1) (using a combination of single displacements here to form a double rotating system) (47)
/
1-1

5) hydrogen isotope 2 (D)

Two (chargeless) protons can combine to form deuterium, D or H^2.

2-1
\
/ (1) (the first real atom in the material periodic table). This notation can be simplified to 2-1-(1). (48)
2-1

However, gravitation is reversed within the time region, becoming a force of repulsion, so that a direct combination of two protons is rather improbable, even if they are uncharged.

6) atom building beyond H^1

Neutrinos can acquire magnetic charges by interaction with matter or photons. As stated above, in the section on isotopes, this magnetic charge of the neutrino can induce a gravitational charge in an associated atom, adding 1 amu to the total atomic weight. If this puts the isotopic weight of the atom outside the zone of stability, some of the vibrational mass is converted to rotational mass, thus moving the atom to a *higher* position in the periodic table. This is, in a sense, somewhat like *reverse beta radioactivity*.

$$2Z+G_m + 2 \times \nu_{e\_M} \rightarrow (2Z) + (G_m + 2) \quad (49a)$$

$$(2Z) + (G_m + 2) \rightarrow 2 \times (Z+1) + G_m \quad (49b)$$

$${}^{A}_{Z}X + 2 \times \nu_{e\_M} \rightarrow {}^{A+2}_{Z+1}X \quad \text{(overall)} \quad (49c)$$

where ν_{e_M} is the magnetically-charged neutrino.

7) speed and location of atom building

In Ref. [2], pp. 282-283, Larson says, "Atom building in intergalactic space is slow because of the low density of matter, but the amount of time spent in this state is so long that there is sufficient opportunity for production of a finite quantity of all of the 117 possible elements [plus the unstable 118], in proportions determined by the relative probabilities. After this initial period, the existing matter is increasingly concentrated into larger aggregates. This speeds up the atom building, but meanwhile there are processes in operation [in the interior of stars] that destroy some of the heavier elements." The atom-building takes place *everywhere*, because the cosmic rays are everywhere! The heavy elements are *not* created by supernovae; the outward-moving debris consists mostly of lighter elements.

8) abundance of elements and even/odd atomic numbers

As Larson points out (Ref. [2], p. 285), "Evidently a single addition to the atomic rotation introduces a degree of asymmetry that decreases stability, as the even-numbered elements are generally more abundant than the odd-numbered ones. For instance, the ten most abundant elements beyond hydrogen in the earth's crust include seven even-numbered elements, and only three with odd atomic numbers. The zone of isotopic stability is likewise wider in the even-numbered than in the odd-numbered elements, as would be expected if they are inherently more stable. Many of the odd-numbered group have only one stable isotope, and there are five within the 117 element range of the terrestrial environment that have no stable isotope at all (in that environment). On the other hand, no even-numbered element, other than beryllium, has less than two stable isotopes."

g. mass, gravitation, inertia

The rotational spins of each atom and subatom with mass are the *cause* of that mass and its inertia. The resultant translational motion is in opposition to the space-time progression and thus causes the atoms (and subatoms with mass) to move inward toward each other, outside unit space. This *is* gravitation. There are no gravitational waves, gravitons, or Higgs bosons. See Ref. [17] for a detailed treatment of the interplay between gravitation and the space-time progression.

h. matter properties

The properties of matter depend on the rotational displacements of the atoms, and numbers derived from these displacements, not from "wave functions." For an isotope like U^{238} the Quantum Mechanics theorist has to work with 92 protons, 92 electrons, and 146 neutrons, each of which has a "wave function." In contrast, the Reciprocal System theorist works with the rotational displacements 4-4-6, plus 54 gravitational charges. This represents a vast reduction of complexity and therefore makes possible the *ab initio* calculation of all the properties of matter; no longer can a theorist say that although he can solve the problem "in principle" he cannot "in fact" because of the mathematical complexity.

In the author's current series of papers (such as Ref. [9]-[18]), many properties have been calculated and the resultant equations put into the Reciprocal System Database. A number of chapters in Larson's works, Ref. [2] and Ref. [1], 2nd ed., are sufficiently detailed so that the present author could directly code the properties into the Reciprocal System Database. These chapters include the following:

Basic Properties of Matter

1. Solid Cohesion
2. Inter-atomic Distances
3. Distances in Compounds
4. Compressibility
5. Heat
6. Specific Heat Patterns
7. Temperature Relations
8. Thermal Expansion

Nothing But Motion

18. Simple Compounds
19. Complex Compounds
20. Chain Compounds
21. Ring Compounds

The other chapters, dealing with electric and magnetic phenomena, particle physics, radioactivity, matter states, etc., have been translated into the language of mathematical physics in the author's papers, including this one, making it easier to code the programs in the Database.

5. Atomic Transformations in Stellar Energy Generation

a. concepts

The most important atomic transformation in the universe is that which generates stellar energy. The Reciprocal System rejects the "Standard Solar Model"; see Ref. [1]-Ref.[10]. Larson explains the Reciprocal System alternative as follows (Ref. [3], p. 41):

"From theoretical considerations we deduce that at some point after the interior of a contracting cloud of dust and gas has been raised to a high temperature by gravitational energy, a relatively rapid rise in the temperature of the entire aggregate occurs when the destructive limit of the heaviest element present is reached in the central regions, and conversion of mass to energy begins. As explained in Volume II, both the thermal energy of the matter in the star and its ionization energy are space displacements, and when the total of these space displacements reaches equality with one of the rotational time displacements of an atom, the opposite displacements neutralize each other, and the rotation reverts to the linear basis. In other words, both the ionization and a portion of the matter of the atoms are converted into kinetic energy. Inasmuch as all atoms are fully ionized before the temperature limit is reached, and the heavier atoms are capable of acquiring a greater degree of ionization than the lighter ones, the amount of thermal energy required to bring the total space displacement up to the limit is less for the heavier elements. The limiting temperature is therefore inversely related to the atomic mass."

Translating these concepts into mathematical physics has not proven to be easy. Ref. [60] and Ref. [61] give the previous attempts, which concluded that the thermal destructive temperatures are in the range of 10^{13} to 10^{14} K--which is patently ludicrous. Transforming potential gravitational energy, at the rim of a star, to kinetic energy, at the core of star, brings the temperature of a heavy element up to approx. 10^{9} K. The thermal destructive limit can therefore not be much higher than this. Also, the relevant *natural temperature unit* to use is *not* the usual time-space gas temperature, 7.2042×10^{12} K, but rather the vapor and condensed gas temperature unit, 3.5978×10^{9} K: stars contain "condensed gas," not "perfect gas." (See Ref. [2], p. 60, and Ref. [3], p. 107.)

b. calculation of destructive temperature

A magnetic rotational displacement (two-dimensional), n, is equivalent to 2 x n^2 electric rotational displacements (one-dimensional). Translating the above concepts to mathematical physics, we obtain the relationship between these rotational displacements and the destructive thermal limit:

$$2 \cdot n^2 = Z \cdot \left(1 - \frac{T_{V\_u}}{T_{destructive}} \right) + \frac{E_I}{2 \cdot conv_{amu\_to\_u} \cdot conv_{u\_to\_MeV}} \qquad (50a)$$

where T_{V_u} is the natural temperature unit for the vapor (condensed gas) state, E_I is the total ionization energy of the element in MeV, and Z is the atomic number. Solving for $T_{destructive}$, we obtain

$$T_{destructive} := \frac{T_{V\_u}}{\frac{\frac{E_I}{2 \cdot conv_{amu\_to\_u} \cdot conv_{u\_to\_MeV}} - 2 \cdot n^2}{Z} + 1} \qquad (50b)$$

The value of n to use is the principal value - 1 (because the first displacement is ineffective) or the secondary value, whichever is greater. Neglecting E_I, for the moment, we can plot $T_{destructive}$ as a function of Z as follows:

$$T_{destructive}(ZZ) := \left| \begin{array}{l} n \leftarrow 4 \\ n \leftarrow 3 \quad \text{if} \quad ZZ < 69 \\ -\frac{T_{V\_u}}{\frac{2 \cdot n^2}{ZZ} - 1} \end{array} \right.$$

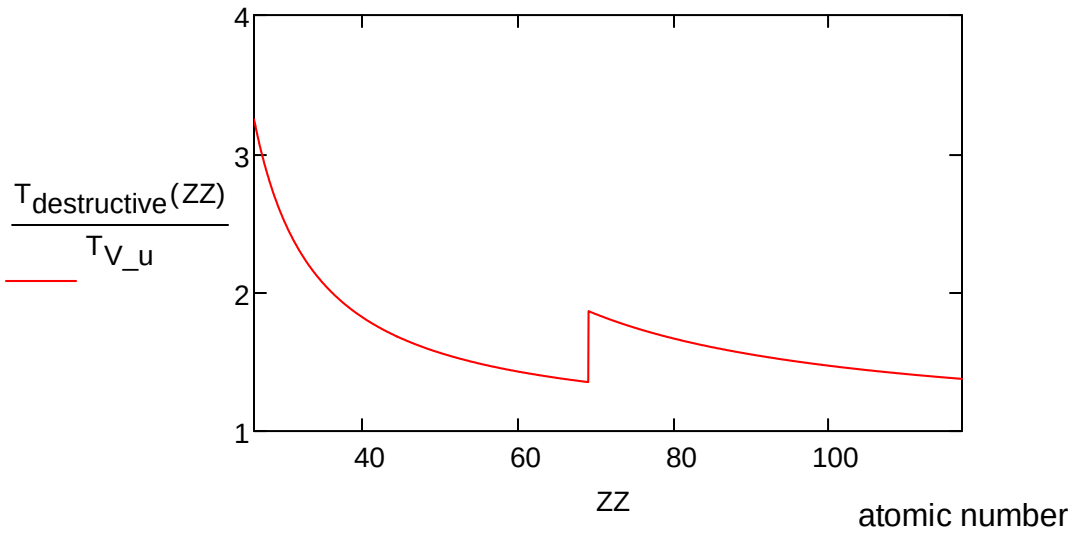

Figure 1. Destructive Thermal Limit

What's interesting about this graph, is that for elements from Z = 69 down to Z = 66 the destructive thermal limit is lower than that for Z = 117. From Z = 66 downward and Z = 117 downward, *both* curve segments are in play.

Example calculation for Th: $Z := 90$ $n := 4$ $E_{I\_Th} := .68836$ MeV (from Reciprocal System Database)

$$T_{destructive\_Th} := \frac{T_{V\_u}}{\frac{\frac{E_{I\_Th}}{2 \cdot conv_{amu\_to\_u} \cdot conv_{u\_to\_MeV}} - 2 \cdot n^2}{Z} + 1} \qquad T_{destructive\_Th} = 5.582758 \times 10^9$$

Leaving out E_{I_th}, we obtain:

$$T_{destructive\_Th} := \frac{T_{V\_u}}{1 - \frac{2 \cdot n^2}{Z}} \qquad T_{destructive\_Th} = 5.582793 \times 10^9$$

Including the ionization energy lowers the destructive thermal limit by just a little bit.

c. gravitational energy at rim of star and kinetic energy at core of star

Continuing with Th, but without isotopic charges, let's consider what happens as an atom of this element makes its way from the rim of the star to the core. By the First Law of thermodynamics, the gravitational potential energy of this atom at the rim (neglecting the small kinetic energy) changes to kinetic energy at the core, and these values must be equal:

$m_{Th\_MeV} := 2 \cdot Z \cdot conv_{amu\_to\_u} \cdot conv_{u\_to\_MeV}$ $\quad m_{Th\_MeV} = 1.676156 \times 10^{5}$ MeV

$m_{Th\_kg} := 2 \cdot Z \cdot conv_{amu\_to\_u} \cdot conv_{u\_to\_kg}$ $\quad m_{Th\_kg} = 2.98705 \times 10^{-25}$ kg

$$\frac{m_{Th\_MeV}}{\sqrt{1 - \frac{v^2}{c^2}}} - m_{Th\_MeV} = \frac{G \cdot m_{Th\_kg} \cdot M_S}{R_S} \cdot conv_{J\_to\_MeV} \qquad (51a)$$

where the relativistic form for the kinetic energy is used on the LHS because the velocity can be quite high and where the current mass and radius of our Sun is used on the RHS, for convenience. Solving for v:

$$v := \frac{\sqrt{G} \cdot \sqrt{M_S} \cdot c \cdot \sqrt{conv_{J\_to\_MeV}} \cdot \sqrt{m_{Th\_kg}} \cdot \sqrt{2 \cdot R_S \cdot m_{Th\_MeV} + G \cdot M_S \cdot conv_{J\_to\_MeV} \cdot m_{Th\_kg}}}{R_S \cdot m_{Th\_MeV} + G \cdot M_S \cdot conv_{J\_to\_MeV} \cdot m_{Th\_kg}} \qquad (51b)$$

$v = 6.176991 \times 10^{5}$ m/sec $\quad \frac{v}{c} = 0.00206$

The total energy is independent of the mass, although only the heavier atoms (those of Fe and above) will make it to the core of the star. The kinetic energy is

$$K := \frac{m_{Th\_MeV}}{\sqrt{1 - \frac{v^2}{c^2}}} - m_{Th\_MeV} \qquad K = 0.355794 \quad MeV \tag{52}$$

which is of the same order of magnitude as the ionization energy. Incidentally, the energy for ionization does not come from the gravitational energy--if it did, there would be nothing left for the kinetic energy; so the ionization energy for the atom under consideration must come from the net energy generated when *another* atom reaches the destructive limit; the atoms in the immediate vicinity must all become fully ionized, if they were not originally.

d. temperature at the core of a star

The temperature of the atom in the core of the star is calculated based on an *assumed* thermal distribution of velocities. One would use Maxwell's distribution for a "perfect gas"--but we're dealing with a condensed gas or a vapor here. Unfortunately, neither conventional theory nor the Reciprocal System has a suitable distribution for this state of matter. Therefore we will have to use Maxwell's distribution as an approximation, pending further theoretical work. Maxwell's equation is:

$$\frac{m_{Th\_MeV}}{\sqrt{1 - \frac{v^2}{c^2}}} - m_{Th\_MeV} = \frac{3}{2} \cdot k_B \cdot T \cdot \sqrt{1 - \frac{v^2}{c^2}} \tag{53a}$$

Incidentally, there has not always been agreement on how to apply the Lorentz factor on the RHS; see Ref. [62]. Solving for T, we get:

$$T := -\frac{2\cdot\left(m_{Th\_MeV} - \frac{m_{Th\_MeV}}{\sqrt{1-\frac{v^2}{c^2}}}\right)}{3\cdot k_B\cdot\sqrt{1-\frac{v^2}{c^2}}} \qquad T = 2.75233\times 10^9 \quad K \tag{53b}$$

The ratio of this temperature to that of the destructive thermal limit is:

$$\frac{T}{T_{destructive\_Th}} = 0.493002$$

So the gravitational energy provides only about *half* the energy necessary. But: the velocity calculated above is the RMS velocity. Some atoms will have a *higher velocity* and thus they *will* reach the "burning" temperature. We can calculate the fraction of atoms reaching the higher velocity as follows.

$$\frac{m_{Th\_MeV}}{\sqrt{1-\frac{v_{destructive}^2}{c^2}}} - m_{Th\_MeV} = \frac{3}{2}\cdot k_B\cdot T_{destructive\_Th}\cdot\sqrt{1-\frac{v_{destructive}^2}{c^2}} \tag{54a}$$

$$v_{destructive} := \frac{c\cdot\sqrt{4\cdot m_{Th\_MeV}^{2}\cdot\left(\frac{\sqrt{\frac{m_{Th\_MeV}+6\cdot T_{destructive\_Th}\cdot k_B}{m_{Th\_MeV}}}}{2}+\frac{1}{2}\right)-4\cdot m_{Th\_MeV}^{2}+9\cdot T_{destructive\_Th}^{2}\cdot k_B^{2}-6\cdot T_{destructive\_Th}\cdot k_B\cdot m_{Th\_MeV}}}{3\cdot T_{destructive\_Th}\cdot k_B} \quad (54b)$$

$v_{destructive} = 9.660338\times 10^{5}$ m/sec $\qquad \frac{v_{destructive}}{c} = 0.003222$

The fraction, N_v, of atoms at this velocity after traveling to the core is (see Ref. [31], p. 261) (where the average temperature is still T:

$$U := v_{destructive}\cdot\sqrt{\frac{m_{Th\_kg}}{2\cdot k\cdot T}} \qquad U = 1.915167 \quad (55)$$

$$N_{v\_frac} := 1+\frac{2}{\sqrt{\pi}}\cdot U\cdot e^{-U^{2}}-\mathrm{erf}(U) \qquad N_{v\_frac} = 0.061933 \quad (56)$$

So: over 6% have this velocity and "burning" will commence for those atoms.

e. stellar energy generation

The amount of energy so generated is quite astounding, compared with the supposed hydrogen-to-helium process. When Th loses 32 electric rotational displacement units, it becomes Ce. Presumably, Ce is fully ionized upon conversion.

$E_{I\_Ce} := .22738713$ MeV (from Reciprocal System Database)

$$E_{stellar\_energy\_gen} := 32 \cdot 2 \cdot conv_{amu\_to\_u} \cdot conv_{u\_to\_MeV} + \left(E_{I\_Th} - E_{I\_Ce}\right) \quad (57a)$$

$E_{stellar\_energy\_gen} = 5.959714 \times 10^4$ MeV (no isotopes)

This is the situation where the magnetic ionization level is zero, i.e., G = 0 for both of the atoms. But suppose the atomic conversion takes place in an environment where the magnetic ionization level is 1 (as in our present day Solar System), so G is not equal to zero. The difference in G between the two atoms must also be converted to energy! In the Th to Ce case, we have

$G_{Th} := 52$ $G_{Ce} := 22$ So:

$$E_{stellar\_energy\_gen} := \left[32 + .5 \cdot \left(G_{Th} - G_{Ce}\right)\right] \cdot 2 \cdot conv_{amu\_to\_u} \cdot conv_{u\_to\_MeV} + \left(E_{I\_Th} - E_{I\_Ce}\right) \quad (57b)$$

$E_{stellar\_energy\_gen} = 8.753308 \times 10^4$ MeV (isotopes, mid-range, mag. ioniz. level = 1)

Even though heavy atoms are very rare, the amount of energy generated totally compensates.

f. stellar reaction rate

According to Prof. Lang, Ref. [39], p. 236, the luminosity of the Sun is

$$L_{S\_MeV} := 3.828 \cdot 10^{26} \cdot conv_{J\_to\_MeV} \quad L_{S\_MeV} = 2.389438 \times 10^{39} \quad \text{MeV/sec}$$

His hydrogen-to-helium calculation yields, per reaction,

$$E_{conv\_stellar\_energy\_gen} := 4.2 \cdot 10^{-12} \cdot conv_{J\_to\_MeV} \quad E_{conv\_stellar\_energy\_gen} = 26.2164 \quad \text{MeV}$$

Therefore, the number of reactions per second for the conventional theory is

$$N_{conv\_reac} := \frac{L_{S\_MeV}}{E_{conv\_stellar\_energy\_gen}} \quad N_{conv\_reac} = 9.114286 \times 10^{37} \quad \text{reactions/sec} \qquad (58a)$$

For the Reciprocal System, using Th-Ce calculation above as an example or *average*:

$$N_{reac} := \frac{L_{S\_MeV}}{E_{stellar\_energy\_gen}} \quad N_{reac} = 2.729754 \times 10^{34} \quad \text{reactions/sec} \qquad (58b)$$

The ratio of the number of reacting atoms of Th to that of H then needs to be at least

$$\frac{N_{reac}}{N_{conv\_reac}} = 2.995028 \times 10^{-4} \qquad (59)$$

Heavy elements may be rare, but obviously there is a sufficient number to produce the calculated stellar energy generation! Prof. Lang, Ref. [39], p. 164, says "all of the heavier elements comprise only .1%." But this is more than sufficient. The Reciprocal System calculations given above apply to all Main Sequence stars and all stars approaching the Main Sequence (of course substituting the appropriate stellar mass, radius, luminosity, and atomic species).

Note: the number of neutrinos generated in the Reciprocal System reaction (for the Sun) is not necessarily 30 x N_{reac}/sec; it could be considerably higher simply due to the huge energy generated. The conventional calculation says there are two electron neutrinos created per reaction, yielding a flux of 1.822857 x 10^{38} neutrinos/sec from the Sun. To get this same number from the Reciprocal System, there would have to be 6678 neutrinos/reaction; keep in mind that

$$\frac{E_{stellar\_energy\_gen}}{E_{conv\_stellar\_energy\_gen}} = 3338.867121 \qquad (60)$$

The number of assumed "yellow" photons created per second (equated in energy to the total energy of the initial gamma and x-ray photons) would be:

$$\nu_{yellow} := 4.1 \cdot 10^{14} \quad \text{cycles/sec}$$

$$\frac{E_{stellar\_energy\_gen}}{h \cdot \nu_{yellow} \cdot 10^{-6}} = 5.156891 \times 10^{10} \quad \text{photons} \qquad (61)$$

So a conversion of just a few thousand of these to neutrinos is certainly probable.

Conclusion

This paper has applied the Reciprocal System to numerous properties of space-time, photons, subatoms, and atoms. Included are the properties of multi-dimensional motion, space-time geometry, light deflection, advance of the perihelion of Mercury, red shift of light, Planck's constant, the Stephan-Boltzmann constant, the origin of the 21.1 cm radio waves, Doppler shift equations, polarized light, mass of subatoms and cosmic atoms, the true identity of the so-called "bosons," the cosmic ray decay sequence, atom-building in our sector, the thermal destructive limit of the elements, and stellar energy generation. All calculations are consistent with experimental and observational data.

Acknowledgments

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original publishing date: 11/16/2013

Appendix 1: Neutrino Magnetic Ionization Level

Isotopes are *not* at the same abundance throughout the universe. Let I = neutrino magnetic ionization level. Then:

$I := 0$ for newly formed globular clusters in intergalactic space; all atoms have mass = 2 x Z *only*

$I := 1$ for spiral galaxies like the Milky Way at our current epoch; atoms have mass = 2 x Z + G

$I := 2$ for large, end-of-life spheroidal galaxies; atoms have mass = 2 x Z + G

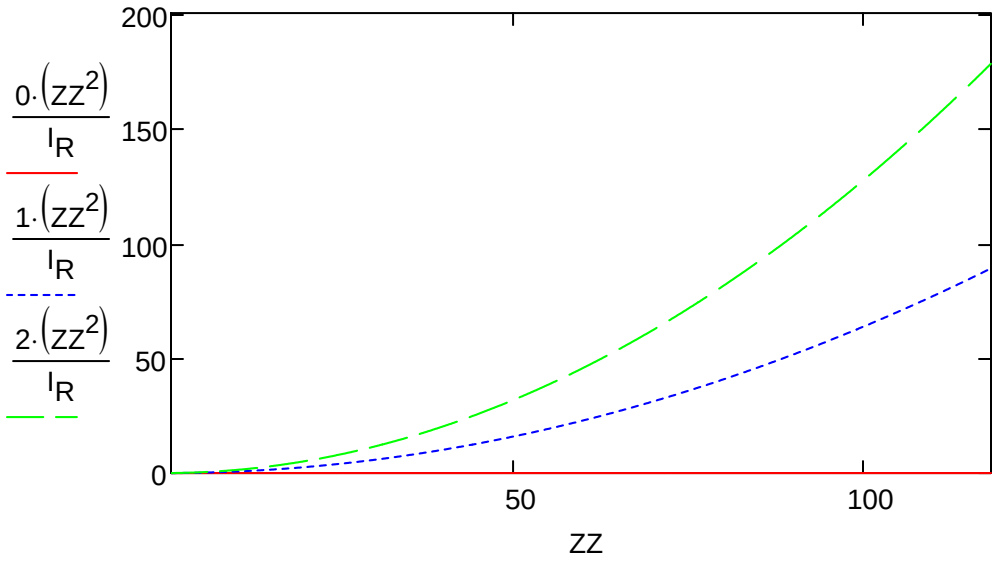
where G = rotational vibrational mass in units of amu. Let m_r = rotational mass in terms of atomic number (total of equivalent number of electric rotational displacements) in units of amu. Then from Ref. [2], p. 264 we have:

$$G := \frac{I \cdot m_r^{\,2}}{I_R} \quad \text{(gravitational or isotopic charges)} \qquad \text{(A-1)}$$

This is the *midpoint* value for isotopic stability. Any mass equalling 236 (2 x 118) or higher will be *radioactive*.

Here are the plots for I = 0, 1, and 2:

gravitational or isotopic charges, G (expected)

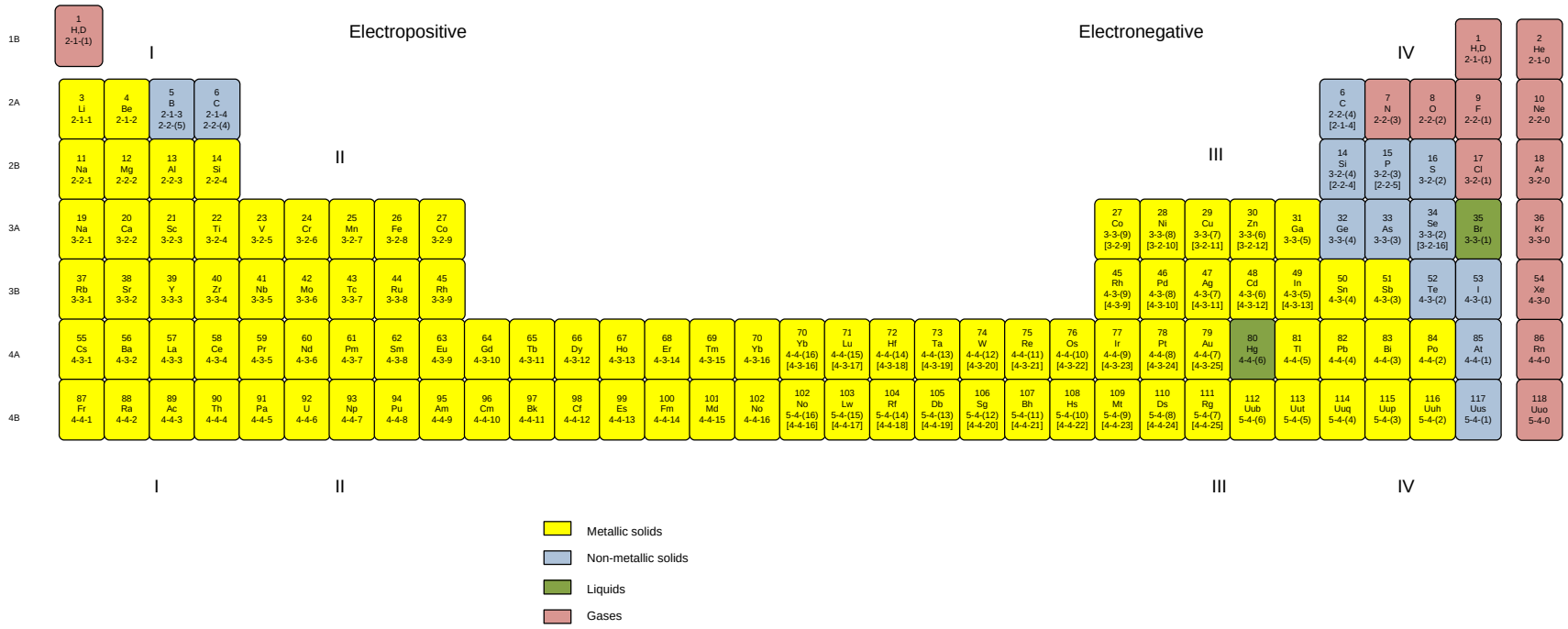


atomic number

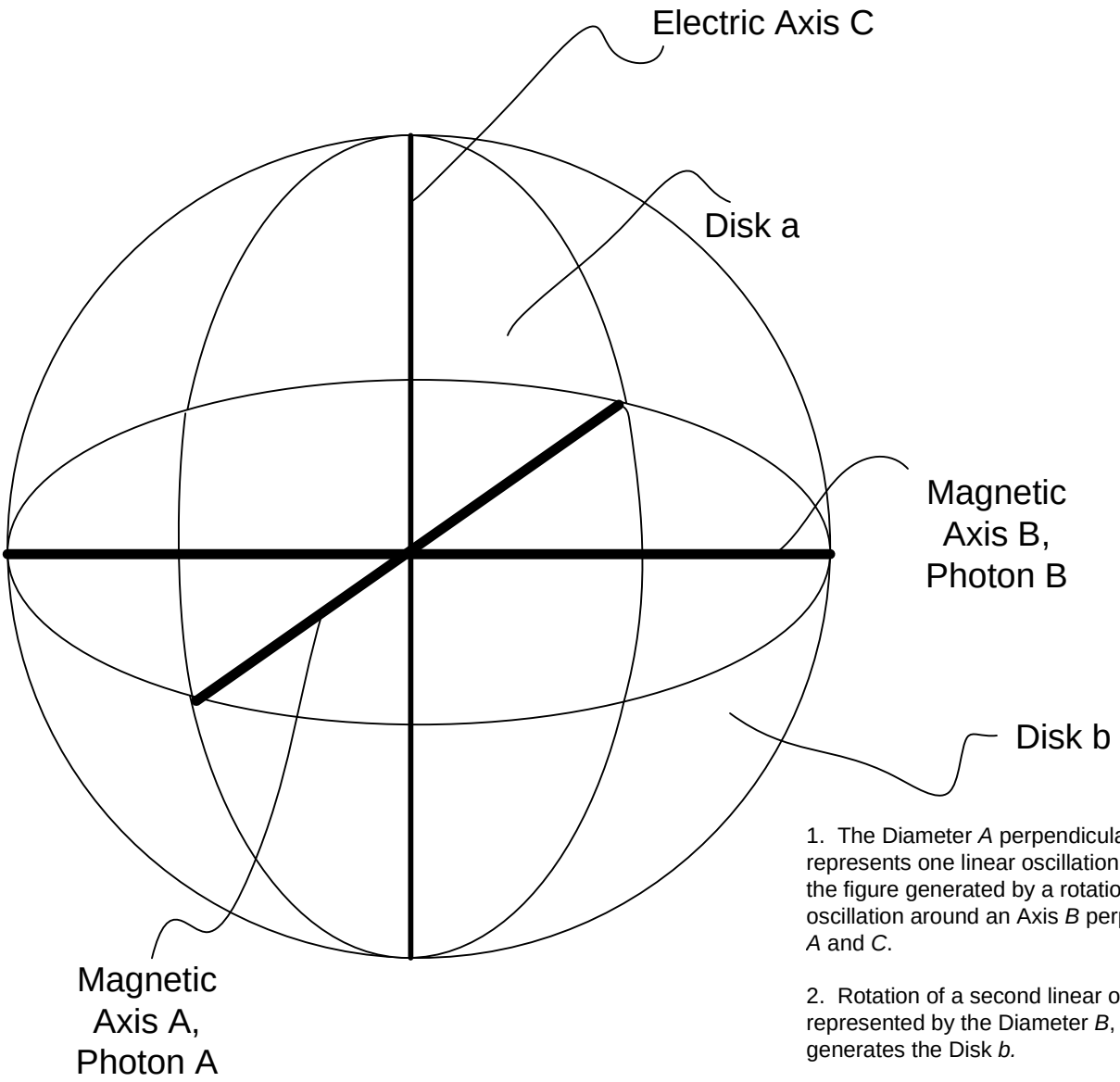
Figure 2. Isotopic Charges Expected as Function of Atomic Number

Appendix 2: Periodic Tables of the Material and Cosmic Elements and Material and Cosmic Atomic Structures

RECIPROCAL SYSTEM PERIODIC TABLE OF THE ELEMENTS



Reciprocal System Structure of the Atom



1. The Diameter *A* perpendicular to *C* in Disk *a* represents one linear oscillation, and the Disk *a* is the figure generated by a rotation of this oscillation around an Axis *B* perpendicular to both *A* and *C*.

2. Rotation of a second linear oscillation represented by the Diameter *B*, around Axis A, generates the Disk *b.*

3. Disk *a* may be given a second rotation around Axis *A,* and Disk *b* may be given a second rotation around Axis *B* without interference at any point, as long as the rotational speeds are equal.

4. Finally the whole assembly may be given a rotation around electric Axis *C*.

5. The principal magnetic rotation (two-dimensional) is designated *a*; the subordinate magnetic rotation (one-dimensional) is designated *b*; the electric rotation (one-dimensional) is designated *c*. Thus: *a*-*b*-*c*.

Dewey B. Larson, *Nothing But Motion*, p. 127, ff.

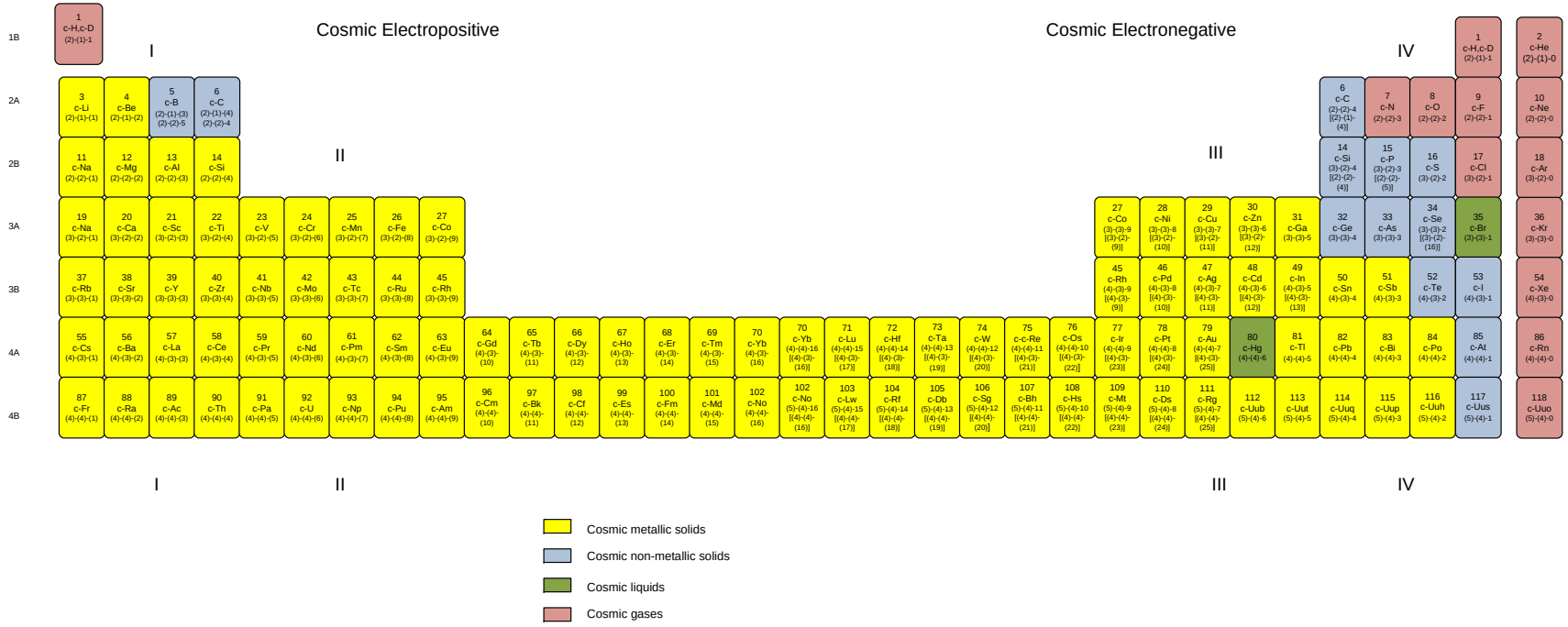
Example: Ti

$$\begin{matrix} 3\text{-}2 \\ \\ 3\text{-}2 \end{matrix} \diagdown\!\diagup 4$$

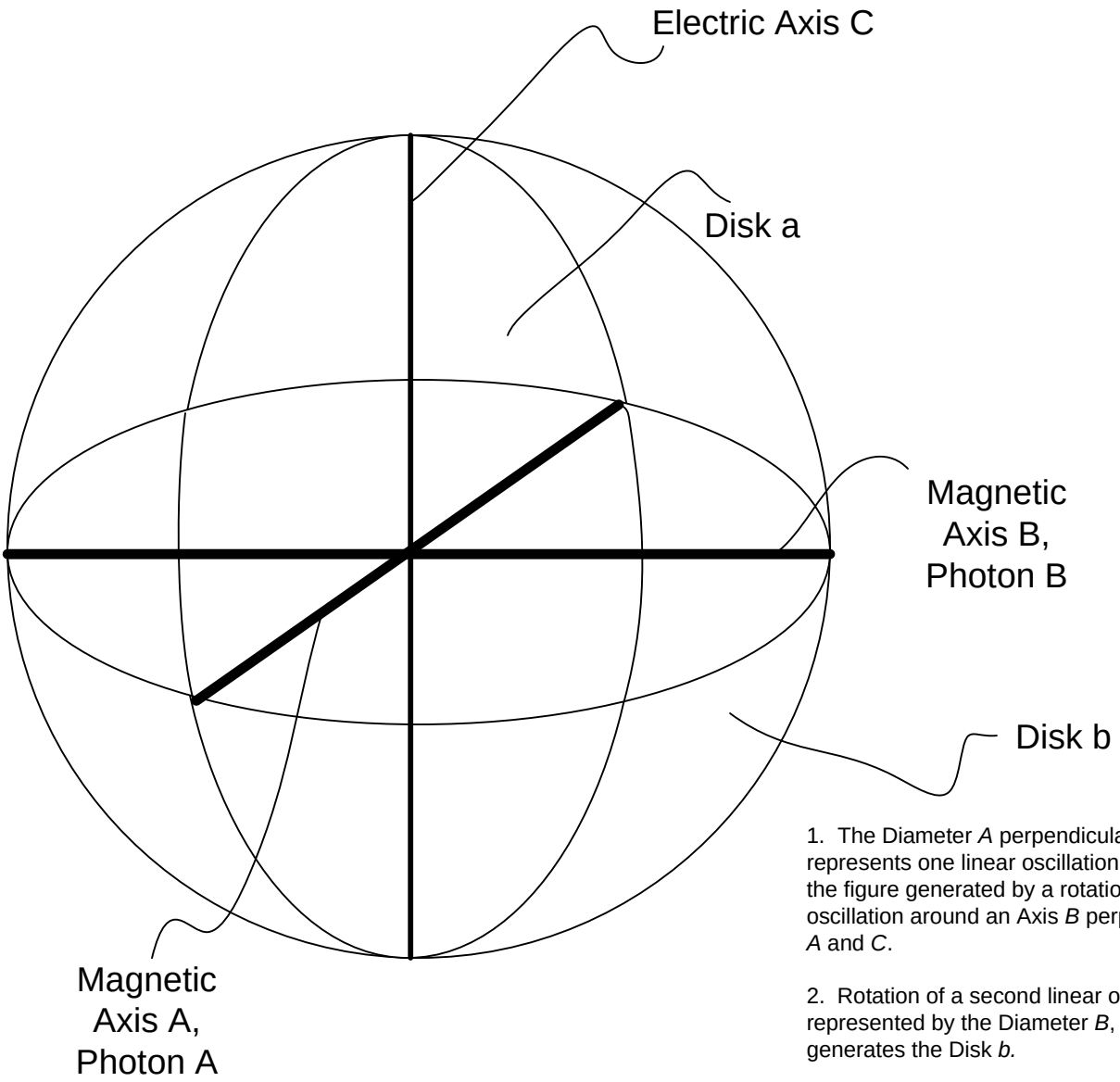
Simplified to 3-2-4

Rotational frequency:
$R/2\pi$ -$2R/3\pi$-$2R/5\pi$, where
$R=3.2880575 \times 10^{15}$ rev/sec;
Photon frequency=2R cycles/sec
Ronald W. Satz, *Reciprocity*,
Autumn, 1980

RECIPROCAL SYSTEM PERIODIC TABLE OF THE COSMIC ELEMENTS



Reciprocal System Structure of the Cosmic Atom



1. The Diameter *A* perpendicular to *C* in Disk *a* represents one linear oscillation, and the Disk *a* is the figure generated by a rotation of this oscillation around an Axis *B* perpendicular to both *A* and *C*.

2. Rotation of a second linear oscillation represented by the Diameter *B*, around Axis A, generates the Disk *b.*

3. Disk *a* may be given a second rotation around Axis *A,* and Disk *b* may be given a second rotation around Axis *B* without interference at any point, as long as the rotational speeds are equal.

4. Finally the whole assembly may be given a rotation around electric Axis *C*.

5. The principal magnetic rotation (two-dimensional) is designated *a*; the subordinate magnetic rotation (one-dimensional) is designated *b*; the electric rotation (one-dimensional) is designated *c*. Thus: *a*-*b*-*c*.

Dewey B. Larson, *Nothing But Motion*, p. 127, ff.

Example: c-Ti (3)-(2) / (3)-(2) \ (4) Simplified to (3)-(2)-(4)

In terms of rotational frequency:
$8R/\pi$ -$8R/\pi$-$10R/\pi$, where
$R=3.2880575 \times 10^{15}$ rev/sec;
Photon frequency=(½) R