Periodic Time and the Stationary Properties of Matter

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The continuous (3+1)-dimensional space-time has proven extremely useful in physical theories describing the dynamic behaviour of matter. If one wants to study the stationary properties of matter in this kind of a space-time, one has to drop off the continuous time by letting the time derivatives equal zero. The spatial boundary conditions then quantise the system.

The concept of a periodic time, the oldest view of time, has been seldom applied to physical theories. In this article an attempt is made to relate periodic time to stationary properties of matter, for example to the eletron rest energy and charge, the structure of the solar system and others.

The fundamental period of time used in this model is the Planck period. Period doubling, found in chaotic systems, is used to lengthen the extremely short Planck period.

In addition, it is found that an agreement between the calculated values and the measured ones is obtained only by assuming the periodic space-time to be symmetric, that is (3+3)-dimensional.

I. INTRODUCTION

It is widely accepted in the western world that space-time, as experienced by man, is a (3+1)-dimensional continuum, where time seems to flow in one direction. However, from the point of view of matter, say an electron, there is no such thing as flowing time. The electron remains an electron whatever processes take place. Its spin, mass, charge etc. are constant throughout its lifetime. There are only two events that alter electron life: its birth and death. There is no flowing time; there are no changes in between. This means that the concept of time is different from the point of view of matter than it is from the point of view of a (subjective) observer.

The oldest view of time, however, is the periodic time. This concept of time has seldom been used in physical theories. The reason is evident: the periodic time fails to describe time-dependent phenomena. In this article an attempt is made to show that periodic time may be useful in physical models related to time-independent phenomena, such as the electron rest energy, charge, structure of the solar system and others.

However, in this context, another fundamental aspect of space-time has to be changed, too. The (3+1)-dimensional space-time continuum is asymmetric because there are three degrees of freedom in space but only one in time. The time-independent (periodic) space-time has to be symmetrised in order to make the calculations agree with the observations.

Several authors have symmetrised the space-time by adding two extra continuous time-dimensions. Dorling[1] has studied the consequences of the extra temporal dimensions to particle instability and shows that 3-d time leads to the non-existence of stable particles. He thus concludes that (continuous) time can only be one-dimensional.

Cole[2,3] shows that for adequate transformations between space-time coordinates of two inertial frames moving superluminally relative to each other, it is necessary to use either four complex space-time coordinates or six real space-time coordinates. The major difficulty is the physical understanding of the extra parameters. He therefore suggests that 3-d time must be highly directed in some way.

Demers,[4] Mignani and Recami,[5] Dattoli and Mignani[6] and Vysin[7] have studied the coordinate transformations, electromagnetism and tachyon monopoles in 6-d space-time. They use $t = sqr(t_x^2 + t_y^2 + t_z^2)$ as the observable time. This choice, however, leads to nonlinear coordinate transformations.

Pappas[8] has taken an axiomatic approach. He maintains a complete symmetry in the (3+3)-d space-time where each space component with conjugate time will be independent of the other, with the produced space being the direct sum of the three two-dimensional spaces.

Continuous space-time can be divided into infinitesimally small intervals dx and dt. It is then, in principle, possible to construct a potential well of width dx, where the ground state wavelength will go towards zero by continuously narrowing the well. This, in turn. means that even the ground state energy will go to infinity. Thus, in a continuum model, infinite local energies can be obtained. In a time continuum this situation means that the period of oscillation will go to zero and the frequency to infinity, which, according to the Planck relation E = hf, also means infinite energies. These infinities of continuum models have been criticised, e.g. by W. Pauli and V. Weisskopf[9] and by W. Pauli[10].

To avoid infinities we assume in this model that locally infinite energies are impossible. As a consequence, there is a maximum local energy that can occur under any circumstances. We assume that the maximum local energy is the Planck energy.

We may recall that Planck resolved the analogus "ultraviolet catastroply" in the beginning of the nineteenth century by quantising the oscillator energy levels of a blackbody radiator.

Furthermore, we shall assume in this article that, from the point of view of matter, time is periodic with the same number of degrees of freedom as space. In fact they are regarded as same, being obtainable from one another with the aid of a constant of proportionality, this being the speed of light.

Periods of time may be converted into energies with the aid of the Planck relation E = h/t, where t is a period.

Forced nonlinear oscillators produce sub-harmonics. This phenomenon is called period doubling and the universal behaviour of these systems has been extensively studied by M. I. Feigenbaum.[11] The maximum local energy corresponds to a minimum period. We shall also assume that all smaller local energies correspond to periods obtained by period doubling.

The existence of a possible period doubling process underlying stationary physical systems may be discovered by taking ratios in base 2 of the energies and lengths characteristic of different physical phenomena. The periods of a simple period doubling system then obey the equation

$$x/y = 2^{\pm M} , \qquad (1)$$

where M is an integer and x and y are any periods of the system. We can also use Eq. (1) to find out whether a system is a period-doubling system by solving for the exponent M:

$$M = \ln(A/B)/\ln 2 , \qquad (2)$$

where A and B are measured values, lengths or energies, for instance. The lengths and energies have their corresponding periods obtained from the relations $r = ct$ and $E = h/t$.

Tables I, II and III represent M values for ratios of magnitudes of different stationary phenomena occurring in Nature. As one may see, there are phenomena from very different surroundings, for instance ratios of radii of planetary orbits to the electron Compton wavelength, electron rest energy to the energy of the "3K-background radiation", etc. There are several ratios for such quantities that are not related to each other in any obvious way.

TABLE I. M-values of the ratios of the semimajor axes of the orbits of the planets.

	Ven	Ear	Mar	Jup	Sat	Ura	Nep	Plu
Mer	0.90							
Ven		0.47						
Ear			0.61					
Mar				1.77				
Jup					0.88			
Sat						1.01		
Ura							0.65	
Nep								0.39

The tables show that M is not generally an integer. The decimal parts of the exponent are not randomly distributed, however, but form the diagram shown in Fig. 1. The abscissa is divided into intervals of 0.1 and the ordinate shows the number of the decimal parts in each interval. We can see that the decimal parts concentrate near values 0, 1/3 and 2/3, which means that M must be of the form

$$M = N/3 , \qquad (3)$$

TABLE II. M-values for ratios a)(semimajor axis of a planet/Planck length), b) (semimajor axis of a planet/ electron Compton wavelenth, c) (semimajor axis of a planet/ 21 cm) and d) (speed of light/ orbital velocity of a planet at semimajor axis).

	a	b	c	d
Mer	150.00	74.34	38.01	12.59
Ven	150.90	75.24	38.91	13.07
Ear	151.37	75.71	39.37	13.30
Mar	151.98	76.31	39.98	13.60
Jup	153.75	78.09	41.75	14.49
Sat	154.63	78.96	42.63	14.93
Ura	155.63	79.97	43.64	15.43
Nep	156.28	80.62	44.28	15.75
Plu	156.68	81.01	44.68	15.95

TABLE III. M-values of the ratios of energies of different physical quantities. The energies have been calculated from the equations $E = hc/\lambda$ and $E = kT$.

3K-radiation/21 cm Hydrogen line	5.34
Planck energy/21 cm	112.00
Planck energy/electron rest mass	75.67
Neutral pion/electron rest mass	8.05
Neutral pion/muon rest mass	0.35

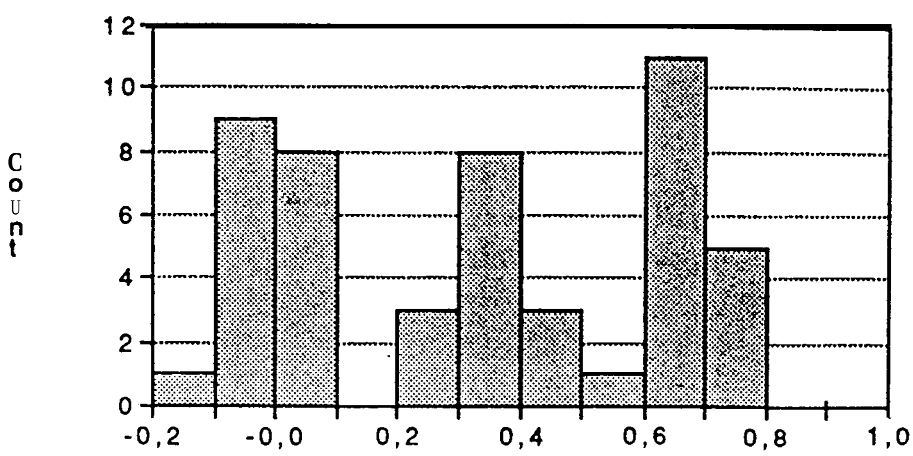

FIG. 1. Distribution of the decimal parts of the M-values from Tables I, II and III. The decimal parts between 0.8 and 1.0 have been replaced by (l-decimal part) e.g. 0.9 is plotted as -0.1.

where N is an integer. This, in turn, means that the ratio of A and B is actually a cubic root of a power of two :

$$A / B = 2^{N/3} \tag{4}$$

This is true if the observed values used in calculating Tables I, II and III originate from a three-dimensional period doubling system but are reduced to one dimension by the method of observation.

Space, as experienced by man, is three-dimensional. It is therefore natural that possible spatial period doubling systems are also three-dimensional. There is a problem with some of the ratios in the tables, however. There are ratios of energies the M value of which is 1/3 or 2/3.

Energy is, according to the Einstein equation $E = mc^2$ and the Planck equation $E = hf = h/t$, a scalar quantity which has a magnitude but not a direction.

The Planck equation contains time, which, according to our everyday experience is a one- dimensional flow.

Figure 1 therefore suggests that, like space, time, related to stationary (i.e. time-independent) period doubling phenomena, also has three degrees of freedom, which, in turn, means that space and time are alike from the standpoint of matter.

However, time needed to describe particle kinematics and dynamics is l-d flow from the point of view of the observer and the 3-d time used in this article should not be considered as a generalisation of the normal 1-d time.

The mathematical model to be used in this article, is based on a three-dimensional cubic lattice, the lattice constant of which increases with integral powers of two. The size of the unit cell, either spatial or temporal, is defined with the aid of natural constants. This choice, the Planck cell, also makes the model absolute.

II. THE UNITS

As soon as the size of the unit cell is defined, the sizes of all other cells also become definite. The size means either spatial size or temporal size. The unit cell is the samllest cell of the lattice (representing the maximum energy). The smallest natural environment is the "Planck environment", where the natural constants h, c and G define about 4 x 10^{-35} m for the unit length and about 10^{-43} s for the unit period. Units for some other quantities may be deduced from these constants as well. All the units used in this model are shown in Table IV.

In addition to h, c and G, the Boltzmann constant k and the vacuum permittivity ϵ_0 have also been used in defining the units.

Note that the definitions of unit mass and unit charge are analoguous because the gravitational constant G corresponds to the electric force constant $1/4\pi\epsilon_0$. The size of different "shapes" in the 3-d lattice may now be related to the magnitudes of different

TABLE IV. The units used in the model

Period	$t(o) = sqr(hG/c^5)$	1.35×10^{-43} s
Length	$r(o) = sqr(hG/c^3)$	4.05×10^{-35} m
Energy	$E(o) = sqr(hc^5/G)$	3.05×10^{22} MeV
Mass	$m(o) = sqr(hc/G)$	5.46×10^{-8} kg
Force	$F(o) = c^4/G$	1.21×10^{44} N
Temperature	$T(o) = sqr(hc^5/G)/k$	3.56×10^{32} K
Charge	$q(o) = sqr(4\pi\epsilon_0 hc)$	4.70×10^{-18} As
Speed	c	3×10^{-8} m/s

stationary natural phenomena.

III. MATHEMATICAL SECTION

III-l. The lattice

Period doubling in stationary natural phenomena is introduced into the 3-d cubical lattice by letting the lattice constant grow with integer powers of two. The edge length s(a) of the q'th cell may be calculated from

$$s(q) = 2^q s(o) , \quad (5)$$

where q is a positive integer (or zero) and s(o) is the unit length, either spatial or temporal.

The exponent q may be called the quantum number of the edge. In a space-lattice we can denote the quantum numbers q by i, j and k and in a time-lattice by 1, m and n, respectively. Thus the edge lengths of a spatial parallelepiped, corresponding to quantum numbers i, j and k are

$$r(i) = 2^i r(0)$$
$$r(j) = 2^j r(0)$$
$$r(k) = 2^k r(o)$$

and its volume V(i,j,k) is

$$V(i,j,k) = 2^{i+j+k} V(o) , \quad (6)$$

where V(o) is the unit volume $r(o)^3$. In the same way one obtains for the time volume V(l,m,n), corresponding to the quantum numbers 1, m and n, an expression

$$V(l,m,n) = 2^{l+m+n} V(o) , \quad (7)$$

where V(o) now means the unit time-volume $t(o)^3$. The one-dimensional values r(i,j,k) and t(l,m,n) to be related to the observed values are obtained by taking a cubic root from Eqs. (6) and (7):

$$r(i,j,k) = 2^{(i+j+k)/3}\ r(o)$$
$$t(l,m,n) = 2^{(l+m+n)/3}\ t(0)\ . \qquad (8)$$

The period, or time, given by Eq. (8) may be directly related to energy by using the Planck relation E = h/t.

III-2. Classification

The quantum numbers may generally take on any integer value. The n'th period is simply $t(n) = 2^n\ t(0)$.

In the case n may be called a quantum number of the first kind. As may be seen later, quantum numbers n occurring in Nature are often powers of two themselves, i.e. the numbers 1,2,4,8,16,32 etc. In this case one may speak of quantum numbers of the second kind and the (n+l)'st period may be obtained from the simplest Mandelbrot set (with constant = 0):

t(n + 1) = t(n)* (t(o) = 2 in this case)

This article does not deal with period doubling processes leading to the quantum numbers of the second kind.

111-3. Shapes

The mathematical model used in this article is based on a cubical 3-d lattice, whose lattice constant grows with powers of two starting from the unit cell. The possible shapes of "objects" occurring in a lattice are cubes or parallelepipeds.

A cube with quantum numbers i,i,i may be denoted by the vector notation (i,i,i) or simply (i). A parallelepiped may be correspondingly denoted by (i,j,k) or (l,m,n) in the case of a time-parallelepiped (see e.g. table VI).

The edge lengths of a parallelepiped, e.g. (l,m,n), coincide with the edge lengths of three different cubes (l,l.l), (m,m,m) and (n,n,n). One may think that this parallelepiped "binds" these cubes together and it may be called a "binder".

The simplest parallelepipeds are double-cubes and half-cubes. The binary lattice used in this model is further illustrated in Fig. 2 in two dimensions.

III-4. Velocity

In the context of flowing time, a purely timelike object does not have genuine spatial extension. Nor does a spatial object have temporal extension, if it had, the left side of this page could be five seconds in the past and the right side two minutes in the future. This

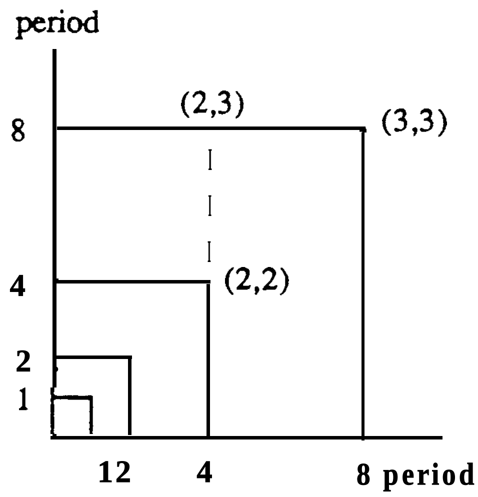

FIG. 2. Square structures in a two-dimensional period doubling lattice and a (2,3)-"binder".

means that a pure spacelike object is not defined in time and vice versa.

In the context of periodic time it is possible, however, to define an "apparent" spatial size for a timelike object by multiplying the edge lengths, or periods, by the speed of light, thus obtaining its "size" in light-seconds.

Let us now think that a timelike object (l,m,n) moves step by step through a region of space characterised by quantum numbers (i,j,k). Because the continuation of space and time is not valid in a lattice, we must define velocity as a ratio of r to t, where r and t are given by Eq. (8).

We may further use the notation i+j+k = R and l+m+n = T, thus obtaining:

$$v(R,T) = 2^{(R-T)/3}\, r(o)/t(o) \;, \tag{9'}$$

where R-T is a negative integer or zero. If we denote R-T = N, we obtain the following expression for the "allowed" values of velocity in the lattice:

$$v(N) = 2^{-N/3}\, c \;, \tag{9}$$

because $r(o)/t(o) = c$.

III-5. Energy

Equation (8) gives us the possible values of a period in the lattice as experienced by an observer with no means to separate the three different periods. The inverse value of the period, frequency f, is directly proportional to energy by the Planck relation E = hf, thus giving us the possible values of energy in the lattice:

$$E(l,m,n) = 2^{-(l+m+n)/3}\, E(o) \;, \tag{10}$$

where E(o) is the unit or Planck energy h/t(o). Eq. (10) means that the (rest) energy of an object is determined by its temporal structure alone. Energies calculated from Eq. (10) are shown in the appendix. The energies are grouped into three groups, c-cubical, e-electron, and g.

IV. COMPARISON OF THE MODEL TO OBSERVATIONS

In this chapter we shall compare numerical values given by the model to observations. The observations are elementary particle rest energies, 3K background radiation, 21 cm Hydrogen line, properties of the Solar system, galaxy recessional velocities, electron electric charge and the fine structure constant. The objective of this comparison is to show that the model gives numbers which are very close to the observed values, thus pointing to directions where period doubling may occur in the Nature.

IV-l. Elementary particles

The electron and the proton are the only stable particles. One might thus expect their temporal structure to be rather simple. It turns out that the nucleon energy is almost exactly.

415 MeV + 523 MeV = 938.6 MeV, corresponding to the sum of the (198) and (197) structures. Furthermore, the nucleons are energetically halfway the 830 MeV and the 1047 MeV structures, the difference being the muon energy on either side.

Some simple structures are shown in Table V.

TABLE V. Temporal structures of some elementary particles corresponding to their rest energy. E(s) means the sum of the structural energies.

Particle	Mass (MeV)	Temporal structure	E(s) (MeV)
Z	92900	53160+26580+13290	93030
W	80800	53160+26580+79740	
"59"		53160	53160
n,p	939	415+523	939

The rest energy of the W-particle may be represented by a time-structure consisting of two subsequent cubes (59) and (60). The Z-particle seems to be closely related to the same structure, as there is only the next cube (61) in addition. If this kind of a system exists, there should be a particle denoted by "59" with rest energy of 53 GeV represented essentially by the cube (59) alone.

IV-2. Radiation

There are two well known cosmic electromagnetic radiations: the 21 cm wavelength

Hydrogen atom spin-flip and the "3-K" blackbody background radiation.

The 1.022 MeV gamma quantum is also well known because it can materialise into an electron-positron pair. All three radiations may be related to simple temporal structures (of the second kind, i.e. periods belonging to the simple Mandelbrot series), as can be seen from Table VI.

TABLE VI. Temporal structures related to the three basic radiations

Phenomenon	Observed	Model	Temporal Structure
H-spin flip	Wavelength, energy 21 cm, 5.9×10^{-6} 3V	Wavelength, energy 21 cm, 5.9×10^{-6} eV	(l,m,n) (16,64,256)
3-K background	Temperature 2.75 K	Temperature 2.76 K	(64, 128, 128)
Gamma	Energy 1.022 MeV	Energy 1.021 MeV	(32,64,128)

The 2.76K temperature has been calculated from the unit temperature T(o):

$$T(64,128,128) = 2^{-(64+128+128)/3}\ T(o)\ .$$

This equation comes directly from Eq. (10) by dividing both sides by k. The temporal structure of the 1.022 MeV gamma (or electron-positron pair) may be related to cube within a cube structure of the second kind.

Here we have the neighbouring cubes but the H-spin-flip structure contains the next nearest neighbours of the second kind.

IV-3. The Solar System

The apparent length of the (32,64,128) "binder" is 1.21×10^{-12} m and may be identified with the Compton wavelength of the electron-positron pair. The next "binder" of the second kind has quantum numbers (64,128,256). Its apparent length is 3.64×10^{10} m, or 0.243 au (astronomical units), and we have thus entered the dimensions of the Solar system. The apparent length of the (128,256,5 12) structure is 3×10^{39} light years, which exceeds the dimensions of the known universe.

We therefore have to look for a possible "fine-structure" near quantum numbers (64, 128,256). Table VII shows the r(i,j,k) values calculated from Eq. (8) from quantum number i+j+k = 448 on. Shown also are the observed semimajor axes r(obs) of the orbits of the planets.

The table shows that the semimajor axes are situated near the values given by the model but there are often empty orbits in between. We can now use Eq. (2) to calculate the "actual" quantum number M of a planet and compare these figures with the corresponding integers. For the sake of convenience we shall use value 0.243 au for B in Eq. (2) and the

TABLE VII. Values of r(i,j,k) as given by Eq. (8) and the observed semimajor axes r(obs) of the orbits of the planets.

i+j+k	r(i,j,k) (au)	r (obs) (au)	Planet
448	0.243	–	–
449	0.307	–	–
450	0.386	0.3 87	Mercury
451	0.487	–	–
452	0.613	–	–
453	0.773	0.723	Venus
454	0.974	1 .oo	Earth
455	1.227	–	–
456	1.546	I.52	Mars
457	1.947	–	–
458	2.453	–	–
459	3.09 I	–	–
460	3.89	–	–
461	4.91	5.20	Jupiter
462	6.18	–	–
463	7.79	–	–
464	9.81	9.54	Saturn
465	12.36	–	–
466	15.58	–	–
467	19.63	19.19	Uranus
468	24.73		–
469	31.17	30.1	Neptune
470	39.25	39.5	Pluto

following table is obtained :

TABLE VIII. The "actual" quantum numbers M of the semimajor axes of the orbits of the planets as given by Eq. (2) compared to the closest integer value.

Planet	M	Integer	Difference
Mercury	2.014	2	+0.014
Venus	4.720	5	-0.28
Earth	6.123	6	+0.123
Mars	7.944	8	-0.056
Jupiter	13.26	13	+0.26
Saturn	15.89	16	-0.11
Uranus	18.91	19	-0.09
Neptune	20.86	21	-0.14
Pluto	22.04	22	+0.04

The mean value of the differences is -0.03, which means that on the average the planets are close to a quantum orbit. Fig. 3 shows the distribution of the differences in the interval [−1,1] which has been divided into ten equal parts.

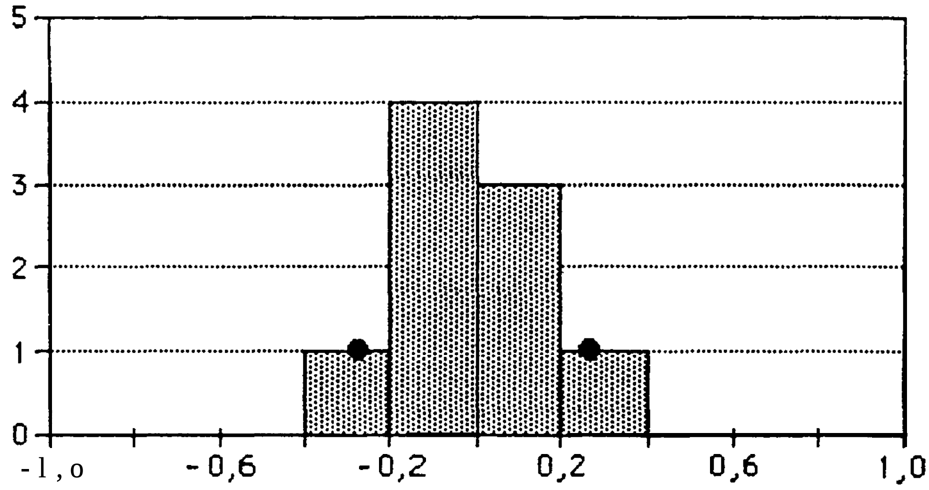

FIG. 3. The distribution of the differences from Table VIII. The dots represent Venus and Jupiter which most.

Figure 3 shows that seven of the planets are situated close to an "integer" quantum orbit and that the two planets, which deviate most, are well within the "halfway" orbits ±0.5.

We shall next compare the velocities given by Eq. (9) to the observed orbital velocities of the planets at semimajor-axis. This comparison is shown in Table IX.

TABLE IX. The observed orbital velocities v(obs) of the planets at semimajor-axis and values values v(N) given by Eq. (9).

Planet	v(obs) (km/s)	v(N) (km/s)	N
Mercury	47.8	46.1	38
Venus	35.0	36.6	39
Earth	29.8	29.1	40
Mars	24.1	23.1	41
Asteroids	17-19	18.3	42
Jupiter	13.1	14.5	43
–	–	11.5	44
Saturn	9.6	9.2	45
Uranus	6.8	7.3	46
Neptune	5.4	5.8	47
Pluto	4.7	4.6	48

Table VII showed that not all of the allowed orbits are occupied. Fig. 4 in turn shows that the empty orbits are not actually allowed, however, because the Keplerian velocity (or the line joining the observed values) for these orbits does not coincide with the lattice.

Figure 4 shows the calculated velocities and radii of the orbits together with the observed semimajor axes and velocities at semimajor axes.

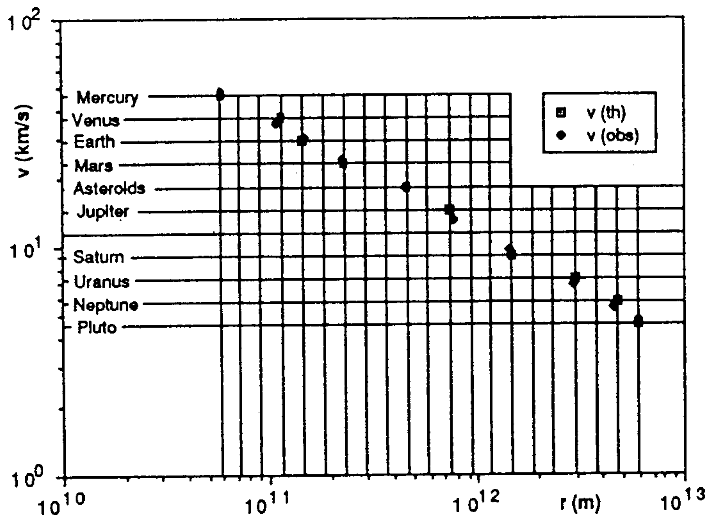

FIG. 4. Observed v(obs) and calculated v(th) orbital velocities of the planets at semimajor axis. Vertical and horizontal lines correspond to theoretical values.

IV-4. The Galaxy Red Shifts

The red shifts of the galaxies, and their differences, have been observed to be quantised.[12] According to the standard model of the universe, galaxy red shift is related to the recession velocity of the galaxy. Table X shows observed recessional velocities and their differences as well as the velocities from Eq. (9).

TABLE X. Galaxy recessional velocities v_R and their differences and velocities v(N) given by Eq. (9).

v_R (km/s)	v(N) (km/s)	N
12	11.5	44
24	23.1	41
36	36.6	39
72	73.2	36
144	146	33
216	217	27-29

In the lowest line of the table, 27-29 means v(27)-v(29).

V. (1+3)-DIMENSIONAL STRUCTURES

In this model (rest) energy is determined purely by the time structure of the object. According to classical physics. the energy distribution, or energy gradient, gives rise to force. This means that we have to give our timelike object a genuine spatial extension, i.e. we have to stretch the timelike object, or energy, along a line in space. We could call this operation *spatial stretching of a timelike object.* As a result of it a structure with three time-dimensions and one space-dimension comes into being, and it represents energy distributed along a line. This object is a (1+3)-dimensional energy gradient. Energy may as well be stretched in two or three dimensions thereby creating a (3+3)-dimensional object in the general case.

If the time-lattice is being stretched a distance x, then every point in the lattice becomes stretched the same amount. This is clarified in Fig. 5. Note, that the stretching is performed with respect to space leaving the time-structure untouched.

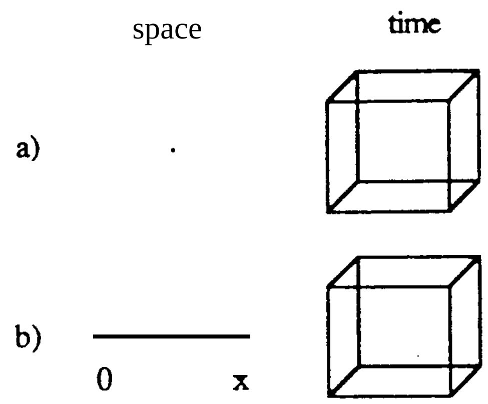

FIG. 5. Stretching with respect to space of a time-cube as seen in space and time a) before stretching and b) after stretching.

We can further clarify the spatial stretching of a time-structure by the 4-d vector (i,l,m, n) representing the energy gradient. Because the spatial and temporal structures are independent, we can change the temporal quantum numbers l,m and n, leaving the spatial quantum number i unchanged. We shall next only consider spatial stretching of "binders" of the second kind, viz. those with quantum numbers (1,2,4), (2,4,8), (4,8,16), (8,16,32) etc. The energies corresponding to these structures are shown in Table XI.

Table XI shows that the energies are very large for the first five structures. They are clearly beyond the performance of the present accelerators. The next two structures, the electron-position pair and the (64,128,256) structure (which was used in the model of the Solar System) fall into the window of observation.

The largest energy gradient or force appears at the stretching of the (1,2,4)-structure. The other forces are correspondingly smaller. We can think that the force created by the stretching manifests itself as charges, which attract each other. In this case, however, our energy gradient is four-dimensional, creating a one-dimensional force.

TABLE XI. Energies of the "binders" of the second kind.

l	m	n	Energy (MeV)
1	2	4	6.1×10^{21}
2	4	8	1.2×10^{21}
4	8	16	4.8×10^{19}
8	16	32	7.4×10^{17}
16	32	64	1.8 x 10"
32	64	128	1.021
64	128	256	3.4×10^{-22}

This means that we have to reduce the 4-d structure to one dimension by taking the fourth root of the volume of the 4-d object. This procedure is exactly analoguous to that used in deriving Eqs. (8).

The force F may now be calculated from the energy gradient

$$F = E(o)/r, \tag{11}$$

where r is the fourth root of the volume of the energy gradient. In order to calculate r one needs the 4-d volume.

The time-volume of the 4-d energy gradient is

$$V(l,m,n) = 2^{(l+m+n)}\ t(o)^3$$

and its spatial length r is

$$r = 2^i\ r(o) \quad .$$

However, the volume of the 4-d object is not represented by the product of r and V(l,m,n) because the temporal object. has no spatial volume. Instead we can use the apparent volume of the temporal object which is obtained by using the relation r = ct. One now obtains for the 4-d volume:

$$V(i,l,m,n) = 2^{(i+l+m+n)}\ r(o)^4 \ .$$

The fourth root of this volume now yields for r:

$$r(i,l,m,n) = 2^{(i+l+m+n)/4}\ r(0) \ ,$$

and the force F becomes

$$F(i,l,m,n) = 2^{-(i+l+m+n)/4}\ F(o) \tag{12}$$

The magnitude of the force thus depends on both the spatial quantum number i and the temporal quantum numbers or energy of the object. If the object is i.e. "cube-within-cube" structure, the forces will be different for different cubes. The power of two in Eq. (12) may be denoted by g and called the geometric factor:

$$g(i,l,m,n) = 2^{-(i+l+m+n)/4} \quad . \tag{13}$$

The geometric factor g describes the magnitude of the ratio of the force F(i.l,m,n) to the unit force F(o). Ratios of this kind are normally called force constants of strong force, electromagnetic force, weak force, and gravitational force.

Table XII shows the absolute values of forces created in the spatial step by step stretching of the (1,2,4)-"binder".

TABLE XII. Forces appearing on the (1,2,4)-"binder" under spatial stretching corresponding to a quantum number i and the related geometric factors or force constants g.

i	F(i.1,2,4) (N)	g
1	3.0×10^{43}	0.25
2	2.5×10^{43}	0.21
4	1.8×10^{43}	0.15
8	9.0×10^{42}	0.074
16	2.3×10^{42}	0.019
32	1.4×10^{41}	0.00116
64	5.5×10^{38}	4.5×10^{-6}
128	8.4×10^{33}	6.9×10^{-11}
256	1.9×10^{24}	1.6×10^{-20}
512	1.1×10^{5}	8.7×10^{-40}

The table below shows experimental values for the coupling constant of the strong force obtained by different methods.[13]

0.20 ± 0.03
0.17 ± 0.04
0.19 ± 0.06
0.16 ± 0.03
0.19 ± 0.04
0.24 ± 0.06

These values are compatible with the first three values in Table XII. We shall next take a closer look at the stretching corresponding to i = 32. We remember that the quantum numbers of the electron-position pair were (32.64.128) and i = 32 corresponds to the shortest edge of this structure.

VI. STRETCHING WITH i = 32

By using the unit electric charge one can write for the unit force F(o)

$$F(o) = q(o)^2/4\pi\epsilon_0 r(o)^2 .$$

By combining this expression with Eq. (12) one obtains for the electric force

$$F(i,l,m,n) = 2^{-(i+l+m+n)/4}\, q(o)^2 / [4\pi\epsilon_0 r(o)^2] \quad . \tag{14}$$

The charge appearing in Eq. (14) may be denoted by e and written in the form

$$e^2 = 2^{-(i+l+m+n)/4}\, q(o)^2 \quad . \tag{15}$$

For quantum numbers (32,1,2,4) e has a numeric value of

$$e = 1.602 \times 10^{-19}\ \text{As},$$

which is exactly the same as the elementary electric charge e. The spatial stretching corresponding to quantum number i = 32 thus results in a force, which is "seen" as the elementary electric charge in the (32,1,2,4)-structure.

The electric force constant is called "fine structure constant" alpha. We would now expect g(32,1,2,4) to be related to this constant. Alpha is defined by

$$\alpha = e^2/2\epsilon_0 hc \quad .$$

By dividing both sides by 2π, one obtains

$$\alpha/2\pi = e^2/4\pi\epsilon_0 hc = e^2/q(o)^2 ,$$

or

$$e^2 = (\alpha/2\pi) q(o)^2 \quad . \tag{16}$$

By comparing Eq.'s (1.5) and (16) one finds that

$$\alpha/2\pi = 2^{-(i+l+m+n)/4}$$

which results in

$$\alpha = (2\pi) \times 2^{-39/4} \tag{17}$$

Eq. (17) yields for alpha

$$\alpha = 137.045\text{-i}$$

which differs from the measured value 137.036-i by 0.007%.

We may note that stretching by i = 32 means stretching the (32,64,128)-"binder" (or the electron-position pair) with respect to its shortest edge, which is a natural break-up point.

VII. DISCUSSION

The basic elements of this model are the symmetrisation of the space-time with a new meaning of time, period doubling processes, and the assumption of the existence of maximum local energy.

Symmetrisation of space-time means giving periodic time three degrees of freedom. Because physical measurements of energy do not separate different degrees of freedom, we have to reduce the three-dimensional periods to one representative period by taking the geometric mean of the three periods. This period is used to calculate energies which are compared with the observed ones.

Themaximum local energy (the Planck energy) corresponds to a maximum frequency of oscillation, the sub-harmonics of which, in turn, correspond to the permitted periods and energies. The (1+3)-dimensional energy gradients may be considered "strings". 'In the present string theories the ground state energy of a string is the Planck energy. Other string energies are generated by the harmonics of the ground state oscillations, thus producing even higher energies.

Consequently, it is difficult to produce leptonic and hadronic energies because these are vanishingly small compared to the Planck energy. In this model the opposite happens: the sub-harmonics produced by period doubling represent energies that fall into the region of the observed energies.

Furthermore, the apparent sizes of the temporal structures with energies of the order of 1 GeV are about 10^{-15} m in agreement with the range of the strong force.

The Planck energy is defined with the aid of the natural constants h,c and G. The Graviational constant G is the most inaccurate of these constants. However, the electron rest energy is known to many decimal places and we can use Eq. (10) to calculate a value for G by using the known electron rest energy. We thus obtain $G = 6.656 \times 10^{-11}\,\mathrm{Nm^2\,kg^{-2}}$, which is slightly (c. 0.5%) smaller than the value of G used in the calculations.

Because the period doubling processes yielding the subharmonic energies are unknown, we are not able to predict what kind of elementary particles exist. We can only represent findings obtained by comparing the observed rest energies of the particles with the model energies. As Tables V and VI show, it is possible to construct simple temporal structures with energies coinciding with the observed particle rest energies. The particularly simple temporal structures found in Table VI (as well as the electron charge) can be related to a Mandelbrot set $t_{n+1} = t_n^2 + c$, with c equal to zero.

The idea of the origin of the electric charge is rather straightforward. We only stretch a purely temporal spatially dimensionless energy concentration in space thus obtaining a one-dimensional energy gradient or force, which manifests itself as charges.

In the astronomical scale the model has been comapred to the dimensions and velocities found in the Solar system and outer space. It is well known that there is a planet missing from between Mars and Jupiter. Fig. 4 suggests that, in addition, there is another planet missing from between Jupiter and Saturn because the orbit with velocity quantum number 44 is empty. Also the orbital velocities of both Jupiter and Saturn are pulled towards this orbit. With this exception the velocity quantum numbers of the planets are consecutive integers.

It is possible to calculate energies related to microscopic systems using quantum mechanics. However, a drawback of quantum mechanics is its unability to predict structures of microscopic systems, e.g. a proton. The discrete model, however, can be related to both energy and structure.

VIII. SUMMARY

An attempt is made to develop a mathematical model which would give absolute physical values to be related to stationary natural phenomena and space-time geometry.

The development of the model starts with considerations of the two views of time: the continuous 1 d flowing time and the periodic time, seldom used in physical theories.

The prominent feature in the continuous space-time is its asymmetry. There are three spatial dimensions, but only one temporal dimension. In this model periodic time is used and two extra temporal dimensions added in order to make (periodic) space-time symmetric.

Because continuous space-time leads to infinite local energies, it is assumed that there must exist a minimum spatial distance corresponding to a minimum period of oscillation or a maximum frequency. This, in turn, corresponds to maximum local energy assumed to be the Planck energy. It is further assumed that period doubling, produced by nonlinear oscillators, takes place in natural physical processess thus bringing the large Planck energy down to our everyday world.

As a consequence of these assumptions the space-time and related energies become discrete or quantised without introducing boundary conditions.

This idea is tested by taking ratios of observed values of various stationary discrete systems. It is found that the exponents of two thus obtained seem to group near 0, 1/3 and 2/3.

The data consist also of ratios of energies related to time according to the Planck relation $E = h/t$. To explain the grouping of the exponents one must assume that like space, (periodic) time also has three degrees of freedom. This finding also removes the fundamental asymmetry present in the 4-d space-time.

The period doubling is introduced into the mathematical model by a 3-d cubical lattice, the lattice constant of which increases with powers of two. The same lattice is used for performing calculations either in space or in time. The numeric calculations give absolute values because the size of the unit cell is defined 3 with the aid of natural constants.

It is found that particle (rest) energy may be related to a pure timelike object and force, or energy gradient, to a (1+3)-d object resulting in charges. It is further shown that velocity may also be quantised in a (3+3)-d discrete space-time.

The model energies are compared to the rest energies of some elementary particles showing that relatively simple temporal structures may be related to these particles. A particular energy gradient seems to be related to the elementary electric charge and the fine structure constant.

The quanta of velocity seem to fit with the orbital velocities of the planets and with the observed quantised recessional velocities of the galaxies.

The model thus finds applications both in the microworld and in the macroworld. However, the model itself, originally published in Ref. 14, is still in its infancy and should be regarded as a "vision" by the reader.

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APPENDIX

TABLE XVI. Energies related to temporal structures from Eq. 10.

l+m+n	E(MeV)	l+m+n	E(MeV)	l+m+n	E(MeV)
c		e		g	
258	0.00040	257	0.00050	256	0.00063
255	0.00079	254	0.00100	253	0.00126
252	0.00158	251	0.00200	250	0.0025 1
249	0.00317	248	0.00399	247	0.00503
246	0.00634	245	0.00798	244	0.01006
243	0.0 1267	242	0.01597	241	0.020 12
240	0.0253	239	0.03 19	238	0.0402
237	0.0507	236	0.0639	235	0.0805
234	0.101	233	0.128	232	0.161
231	0.203	230	0.256	229	0.322
228	0.406	227	0.511	226	0.644
225	0.811	224	1.022	223	1.288
222	1.622	221	2.044	220	2.575
219	3.245	218	4.088	217	5.151
216	6.489	215	8.176	214	10.30
213	12.98	212	16.35	211	20.60
210	25.96	209	32.70	208	41.20
207	51.91	206	65.41	205	82.41
204	103.83	203	130.82	202	164.82
201	207.66	200	261.63	199	329.64
198	415.32	197	523.27	196	659.27
195	830.63	194	1046.53	193	1318.55
192	1661.27	191	2093.07	190	2637.10
189	3322.54	188	4186.14	187	5274.20
186	6645.08	185	8372.27	184	10548
183	13290	182	16744	181	21096
180	26580	179	33489	78	4 2 1 9 3
177	53160	176	66978	175	843 87
174	106321	173	133956	172	168774