

# Energy as Order: Derivation of Classical Laws and Constants\*

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**ABSTRACT** A model is proposed which takes energy as order in the form of a radial probability distribution. The energy associated with the distribution is calculated using the Laplacian as an operator and Planck's constant/second as a factor. To complete the model, it is assumed that the sample rate for the elements of the distribution is determined by the distance light travels in a second. Dividing the energy associated with a 3-dimensional distribution, thus obtained, by the sample rate yields an expression for the energy associated with a 2-dimensional distribution. This expression equates to the formula for the energy of light. Dividing the 3-dimensional energy by the square of the sample rate yields as 1-dimensional energy, Planck's constant/second. The 1-dimensional energy appears to represent the ambient energy of the universe in the form of a rotation. Using this model, various laws of classical physics are derived. Newtonian time is found to be a function of the radius of the distribution and the distance light travels in a second, and is a measure of indirection. The uncertainty principle is derived and relativity rationalized. Forces appear to arise from the reduction in order implicit in the overlap of distributions. A single order calculation of the constant of gravitation,  $G$ , is about 1 percent high. A single order calculation of the electrical potential is within 1 percent of the expected value. Consideration of higher and lower order effects yields agreement with observation within the accuracy of the numerical calculation. The possible origin of the electron, proton and neutron is discussed.

## I. INTRODUCTION

Efforts to find a common representation for all fundamental physical interactions have been made since the early twentieth century.<sup>1</sup> This current effort to shed light on this topic was prompted by research in a seemingly unrelated area, the chemical bond. Recent work<sup>2</sup> claims that the problem of modeling the chemical bond can be considerably simplified by explicitly recognizing the reduction in the electron kinetic energy inherent in the overlap of the pairing atom's electron distributions. Distributions represent order (commonly recognized as organization) with narrow distributions representing higher order than broader distributions. Could it be that energy is order and that the observed forces of nature result from the overlap of the distributions representing this order? The current research explores this possibly.

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## II. ENERGY AS ORDER IN THE FORM OF A PROBABILITY DISTRIBUTION

Suppose that energy is order and this order takes the form of a radial probability distribution,  $\Psi = e^{-\rho}$ , where  $\rho$  is a radius which, in first order, is expressed as fractions of the distance traveled by light in a second,  $c_m$ , ( $\rho < 1.0$ ). In second order,  $\rho$  is expressed as fractions of  $c_m^2$ . In third order,  $c_m^3$ , etc.

Furthermore, one calculates the energy associated with this distribution by evaluating the integral,

$$\iiint \Psi b \nabla^2 \Psi \, d\rho \, d\theta \, d\phi,$$

where  $\nabla^2$  is the Laplacian<sup>3</sup> and  $b$  a constant. Evaluating the integral, and converting to metric radial units, one obtains, for energy in 3 dimensions ( $E_{3D}$ ),  $E_{3D} = b \, c_m/r \, c_m/r$ , where  $c_m$  is the distance traversed by light in a second, and  $r$  is the radius of the distribution measured in metric units. If one takes  $b = h_0$ , where  $h_0$  is Planck's constant for one second (Planck's constant in energy units only),

$$E_{3D} = h_0 \, c_m/r \, c_m/r. \quad (1)$$

Note also that higher energies are associated with shorter radii, representing narrower distributions.

To complete a statistical model, one needs to know the rate at which the elements of the distribution are sampled or (re)generated. Herein this rate is referred to as the "paint" rate of the distribution. Suppose that elements of the distribution traverse each of the two axes, on average, the distance,  $c_m$ . The paint rate for each of two axes then becomes  $c_m/r$  and the overall paint rate  $c_m/r \, c_m/r$ . Distributions representing higher energies (narrower distributions) are painted more than wider, less energetic, distributions. Although narrow distributions are painted more often than wide distributions, the average distance,  $c_m$ , traversed along each axis by the elements of the distribution is the same in either case.

For energy in 2 dimensions, one divides the 3-dimensional energy by the paint rate along a single axis,

$$E_{2D} = h_0 \, c_m/r. \quad (2)$$

For energy in 1 dimension, one divides the 3-dimensional energy by the overall paint rate,  $c_m/r \, c_m/r$ ,

$$E_{1D} = h_0. \quad (3)$$

This model would suggest that the natural coordinates of the universe are two Cartesian coordinates and an angle. One-dimensional order appears to be in the form of an ambient rotation. Following this line of argument, two-dimensional order takes the form of order, or constraint, along a single Cartesian coordinate combined with a rotation. Three-dimensional order adds order, or constraint, along a second Cartesian coordinate.

Now introduce an arbitrary variable, time( $t$ ). (Time is defined below.) Expressed in terms of time, (1), (2) and (3) become,

$$E_{3D} = h \, c/r \, c_m/r, \quad (4)$$

$$E_{2D} = h \, c/r \text{ and} \quad (5)$$

$$E_{1D} = h_0$$

where  $c$  and  $h$  have their usual metric units.

$E_{2D}$  appears to be light. Two-dimensional order is comprised of order in a plane rotating about an axis. Two-dimensional order confines elements of the universe to a plane (with average radius  $r$ ) while not constraining them along the perpendicular axis.

The two-dimensional order proceeds along the perpendicular axis at the speed of light. This is counter intuitive. In the macro world, direction is associated with order. Here direction is associated with disorder.

If two-dimensional order proceeds along the perpendicular axis for a distance  $c_m$ , the two-dimensional distribution has painted itself  $c_m/r$  times. The two-dimensional distribution can be said to paint  $c/r$  times per second. The paint frequency in seconds,  $c/r$ , is the frequency of light and  $r$  is the wavelength.  $E_{2D} = h\nu$ .

Because light propagates in one direction along its axis of indirection and not along both directions, there must be directionality associated with  $h_0$ . The apparent directionality associated with the painting of distributions may account for the presence of negative as well as positive electrical charges, spins up as well as down, and perhaps anti-matter.

### III. CLASSICAL MECHANICS

#### A. Kinetic Energy

A distribution in 3 dimensions is centered about a point; it does not change position. On the other hand, a distribution in 2 dimensions is centered on a line and moves along this line a distance ( $d$ ) of  $c_m$  for each interval of  $c_m$ . The 3-dimensional order can be made to move by appending 2-dimensional order to it. The 3-dimensional order must paint  $c_m/r$   $c_m/r$  times, while the 2-dimensional order (perpendicular to the direction of translation) is painted only  $c_m/r$  times. Therefore, 3-dimensional order moves in proportion to the square root of the number instances of 2-dimensional order appended to it. Designating the number of instances of 2-dimensional order as  $\gamma$ , one can write, for  $\gamma \ll c_m/r$ ,

$$d = (2\gamma)^{1/2} r, \text{ with } d \text{ as distance.} \quad (6)$$

The factor of two arises because translation occurs along only one of the two axes of the 3-dimensional order. Rearranging (6),

$$\gamma = \frac{1}{2} d^2 c_m/r c_m^{-2} c_m/r. \quad (7)$$

Utilizing the Einstein mass-energy relationship<sup>4</sup>,  $E=mc^2$ , to define mass( $m$ ), makes  $E_{3D} = mc^2$  and  $E_{2D} = mc^2/(c_m/r)$ . Substituting  $c_m/r = mc^2/E_{2D}$  into (7), one obtains

$$\gamma E_{2D} = \frac{1}{2} d^2 c_m/r c_m^{-2} mc^2. \quad (8)$$

Intuitively one would expect time squared to be a function of the paint rate. Defining time( $t$ ) as,

$$t = (r/c_m)^{1/2} \text{ seconds.} \quad (9)$$

Substituting (9) in (8) and recognizing that  $d/t$  is velocity ( $v$ ) gives,

$$\gamma E_{2D} = \frac{1}{2} mv^2. \quad (10)$$

Since  $\gamma E_{2D}$  is the energy of the 2-dimensional order appended to the 3-dimensional mass to make it move, one obtains the classic formula for kinetic energy<sup>5</sup>, kinetic energy =  $\frac{1}{2}mv^2$ . Since at the level of Newtonian mechanics, the 2-dimensional energy associated with moving masses is not converted to free 2-dimensional energy, light, one can also say that kinetic energy must be conserved in interactions among moving masses. Defining a quantity, mass, as  $m = E_{3D}/c^2$  turns out to be convenient in expressing the relationships of classical physics.

## B. Time

Time is a measure of indirection. Given a fixed amount of energy, large masses take longer to move than small masses because of the relatively large amount of indirection (paints opposite to the direction of travel) associated with large masses. Rest masses have total indirection. Light, 2-dimensional order, has no indirection along its propagation dimension. In general, one takes time to move from point A to point B because some of the elements in the 3-dimensional distributions, of which we are composed, move in a direction opposite to the direction of our travel.

According to (9), time squared is equal to the inverse of the paint rate along one of the axes of the 3-dimensional distribution with which it is associated. Time (Newtonian) is defined with respect to the distribution with which it is associated. Time for a narrow distribution with a large paint rate (e.g. a large mass) has smaller units than time for a broad distribution. It takes more of these units of time to reach a second. For a given amount of energy the narrow distribution moves slower than the broader distribution.

Time turns out to be a convenient variable for use in Newtonian calculations but is not fundamental. Time and mass are derivative variables. The universe is defined in terms of  $h_0$ , the background energy;  $c_m$ , which determines paint rates; and the variable,  $r$ .

## C. Conservation of Momentum

To demonstrate the conservation of momentum<sup>6</sup>,  $m\mathbf{v}$ , one must show that, in interactions among isolated masses acting upon each other, velocity is inversely proportional to mass. Motion is induced to a symmetrical 3-dimensional distribution, representing mass, by appending 2-dimensional distributions to it. The resulting combined distribution is asymmetric. Appending a 2-dimensional distribution to a 3-dimensional distribution skews the 3-dimensional distribution perpendicular to the direction of motion. Velocity is proportional to the degree of asymmetry.

The symmetry of narrow 3-dimensional distributions, with high overall paint rates, representing large masses, are less impacted by the addition of each instance of 2-dimensional order than are broad 3-dimensional distributions representing smaller masses with lower paint rates. The impact of the addition of an instance of 2-dimensional order on the asymmetry of the overall distribution, and the velocity, is directly proportional to the overall paint rate, and the associated mass, of the distribution. When, in an interaction, the mass is changed (2-dimensional order transferred from one mass to another), velocity must be change in inverse proportion.

Because the directionality associated with the appended 2-dimensional distribution is maintained, velocity must be a vector. The vector  $\mathbf{v}$  times  $m$  must be conserved.

## IV. de BROGLIE RELATION

Using the expression for  $\gamma E_{2D}$  in (10) and recognizing that  $E_{3D} = mc^2$ , one obtains,  $\gamma E_{2D} E_{3D} = \frac{1}{2} c^2 m^2 v^2$ . Since  $E_{3D} = h c/r c_m/r$ , and  $E_{2D} = h c/r$ ,  $\gamma E_{2D} E_{3D} = \gamma (h c/r)^2 c_m/r = \frac{1}{2} c^2 m^2 v^2$  or

$$mv = h (2\gamma)^{1/2} 1/r (c_m/r)^{1/2} \quad (11)$$

or

$$mv = h/\lambda, \text{ the de Broglie relation}^{7,8},$$

where the de Broglie wavelength,  $\lambda = r ((r/c_m)/(2\gamma))^{1/2}$ .

Notice that when  $\gamma \Rightarrow 0$ , the de Broglie wavelength  $\lambda \Rightarrow \infty$ , as one would expect for mass at rest. When  $2\gamma \Rightarrow r/c_m$ , the de Broglie wavelength,  $\lambda \Rightarrow r$ , as one would expect for light.

## V. UNCERTAINTY PRINCIPLE

From (11),  $mv = (2\gamma)^{1/2} h 1/r (c_m/r)^{1/2} = 2\gamma h 1/r 1/(2\gamma)^{1/2} (c_m/r)^{1/2}$ . From (6) one knows that distance,  $d = (2\gamma)^{1/2} r$ . Substituting, one obtains  $mv d = 2\gamma h 1/d (c_m/r)^{1/2}$ . Recall that  $t = (r/c_m)^{1/2}$ . So, for linear motion in unit time,  $mv d = h 2\gamma$  and the uncertainties become  $\delta(mv d) = h \delta(2\gamma)$ . Because increments of distance are associated with two units of 2-dimensional order (analogous to photons), the inherent uncertainty in  $2\gamma$ ,  $\delta(2\gamma)$ , is 1. So, one concludes the uncertainty principle<sup>9,10</sup>:  $\delta(mv d) = h$ .

## VI. TIME DILATION

As more 2-dimensional order is superimposed on 3-dimensional order (more instances of 2-dimensional order appended to the mass) it can be said the resulting moving mass is taking on wave-like character. This is a concept not inconsistent with contemporary thinking. As the velocity increases toward that of light, proportionally more instances of 2-dimensional order are needed to overcome the indirection associated with the mass. It is this dilutive impact of increasing numbers of instances of 2-dimensional order that causes relativistic effects. The coefficient 2 in (6) above must be changed to  $(2 c_m/r + \gamma) / c_m/r$  to make (6) general.

The definition of time given by (9) assumes that velocity is so low ( $\gamma \ll c_m/r$ ) that directionality is infinitesimal. At relatively high velocities this relationship must be modified to account for increasing directionality (i.e. increasing  $\gamma$ ). Since  $v^2$  of a moving mass is a function of the associated number of instances of 2-dimensional order,  $\gamma$ , which represent direction, and  $c^2$  represents total direction,  $v^2/c^2$  is a relative measure of direction. With  $v^2 = c^2$ , one has total direction, light. With  $v^2 = 0$ , one has total indirection, rest mass. Time squared,  $t^2$ , as defined by (9) must be reduced by  $(1 - v^2/c^2)$  to account for directionality. Time from the prospective of the stationary observer, is related to,  $t_m$ , the time from the perspective of the moving mass by  $t_m^2 = t^2 (1 - v^2/c^2)$  or  $t_m = t (1 - v^2/c^2)^{1/2}$ , in agreement with the expected relationship<sup>11,12</sup>. Were  $v^2$  to approach  $c^2$ , from the standpoint of the mass, elapsed time would be reduced to the vanishing point, since indirection would have been virtually eliminated.

## VII. THE ORDER OF THE MACRO WORLD

At the outset one does not know the order of the macro world. Intuitively one would suspect that one does not live in a first order world as this would require the radius of the electron to be about a centimeter - surely too large. Derivation of the electrical potential, discussed below, indicates that the macro world is third order. Calculation of

both higher and lower order impacts on both the electrical and gravitational potentials, also discussed below, confirm that the macro world is third order. The dimensions of the macro world are about  $c_0^2$  higher than the smallest elements of the world ( $c_0$  is the speed of light expressed as a factor of one meter/second). This puts the dimensions in macro world about  $10^{17}$  greater than those of the micro world.

## VIII. INTERACTIONS AMONG 3-DIMENSIONAL DISTRIBUTIONS

When two distributions, A and B, each of the form  $\psi = e^{-r}$  overlap, the order associated with the two distributions is decreased. This results because, in the space comprising the overlap, it is impossible to differentiate between the distribution elements belonging to A from those belonging to B. The overlap thus introduces a degree of randomness to the distributions. Because randomness is increased (or order decreased), there is an attraction, or force, between distributions.

The appropriate expression for the energy of a distribution made up of two adjoining spherical distributions, herein described as a composite distribution, is  $\iint \phi b \nabla^2 \phi 2\pi r dr dl$ , where  $\phi$  represents the composite distribution,  $b$  is  $h_0$  and  $\nabla^2$  is the Laplacian. The variable  $r$  represents the radial distance from the cylindrical (bond) axis and  $l$  represents the distance along the bond axis. Because of the difficulty in evaluating the integral, the calculation is done numerically, with integration replaced by summation. The elements of the distribution are represented in huge spatial arrays of the form  $\phi[i][j]$  where  $i$  is the index for the radius from the cylindrical axis and  $j$  the index for the distance along the axis. The elements of the composite distribution are obtained by taking the square root of the sum of the squares of the elements of the overlapping spherical distributions. These numerical calculations are described in detail in reference 2.

The energy of the composite distribution  $E_{AB}$  is reduced by the energy of the individual distributions to obtain the net energy  $E_{AB}^0$ .  $E_{AB}^0 = E_{AB} - E_A - E_B$ . Multiplying by the fraction,  $S/(1+S)$ , where  $S$  is the overlap integral (described in reference 2), gives  $E_b$ , the energy decrease associated with the overlap. The energy decrease associated with the overlap, i.e the energy associated with the overlap, is called the bonding energy. There is a significant reduction in energy associated with the overlap of distributions only when when they are relatively close together. The most effective reduction in energy occurs when the distance between the center of distributions is about 1.4  $r$ .

The components of the universe may be viewed as distributions representing order. The overlaps among these distributions could cause there to be attractions, and sometimes repulsions, among the components of the universe. It is these overlaps that may account for the strong force found in the nucleus, electricity and magnetism, and gravity.

In order for the distributions to account for many of the forces of nature, the distributions would have to have a mechanism to extend their range beyond their core radii. Distributions representing order have extended range because they disaggregate.

## IX. AGGREGATION AND DISAGGREGATION OF DISTRIBUTIONS

Two distributions of radius,  $r$ , and with energy  $E$ , when superimposed (“aggregated”), make a single distribution of radius  $r/2$  and energy  $4E$  (A distribution’s energy changes inversely with the square of the radius.). Because distributions can be aggregated, many diverse distributions combine to look like, from afar, a single distribution, with a radius smaller than any of its components. For example, a nucleus can look like a single, relatively narrow distribution, to a valence electron. Indeed, the earth would look like a very narrow distribution to the sun. Note that, in aggregating distributions, although the energy of the aggregated distribution at its radius is higher than the energy of the components, at distances large compared to its radius the effective energy is the same as the sum of the energies of the components. In fact, the aggregated distribution cannot be approached closer than distances consistent with the radii of its components.

Also, distributions can be disaggregated. A distribution of radius  $r$ , and energy  $E$ , can be disaggregated into two distributions of radius  $2r$  and energy  $E/4$ . Two distributions of radius  $2r$  and energy  $E/4$  give energy  $E/2$ . In general, disaggregation causes energy to fall off with  $1/r$ . That the gravity potential falls off with  $1/r$ , may result from disaggregation causing the effective energy of distributions to fall off with  $1/r$ . Disaggregation cannot be extended beyond the limits of the order (first order to second order, for example) (This is discussed below).

It is important, when calculating interactions among distributions, to understand the distinction between the energy of a distribution at its core radius (its radius prior to disaggregating) and its effective energy at the distance of the calculation. For example, consider two distributions, one, A, with core radius  $r$  and energy  $E$ , with another, B, with core radius  $r/2$  and energy  $4E$ . When these two distributions interact with another distribution, C, at some distance greater than  $r$ , B appears to have an energy 2 times that of A, not 4 times that of A. This is because B has to disaggregate from a radius half that of A. So, when calculating interactions among distributions, the effective energy of a distribution depends upon one’s distance from it.

## X. INTERACTIONS AMONG 3-DIMENSIONAL DISTRIBUTIONS AT DISTANCE

Calculation of the energy of interactions between 3-dimensional distributions at distances large compared to their core radii differs from the calculation at distances near the core radii. To compute the long-distance interaction, one disaggregates the distributions as distributions of equal radii (The higher energy distribution disaggregating more than the lower energy distribution.), until they can overlap at their most favorable distance (Usually about  $1.4 r$ , where  $r$  refers to the radius of the disaggregated distribution.). One then calculates the relative energy decrease associated with the overlap of these distributions,  $F_{ab}$ , in the manner described above. The units of  $F_{ab}$  are energy per unit energy squared. Designating the distributions as A and B, the energy of the bond,

$$E_b = F_{ab} E_A E_B, \quad (12)$$

where  $E_A$  and  $E_B$  represent the energy of the distributions at their core radii. The factor  $F_{ab}$  decreases with  $1/r$  of the disaggregated distribution. Notice that the product of two energies results in an energy, not energy squared.

## XI. CALCULATION OF THE NEWTONIAN CONSTANT OF GRAVITATION, G

According to the law of universal gravitation<sup>13</sup>, the potential energy difference,  $E_{ab}$ , between two masses,  $m_a$  and  $m_b$  is given by  $E_{ab} = m_a m_b G (1/\text{radial distance}(d))$  where  $G$  is the gravitational constant. So,

$$G = [E_{ab} / (m_a m_b)] d. \quad (13)$$

To determine  $G$  one must calculate the gravitational potential between two known masses at a known distance,  $d$ . For this calculation it is convenient to choose the distribution associated with the hydrogen atom.

The first order radius  $r$  associated with any substantial mass is very small. The energy associated with the interaction between masses at or near their core radii is very strong. The first order interaction is too short ranged and too strong to be gravity. Gravity is felt in the macroscopic world. It is a third order interaction. The higher and lower order calculations discussed in a later section confirm this.

Using a computer program, one can calculate the stabilization associated with the overlap of two distributions, each having the Bohr radius<sup>14</sup>,  $a_0$ , at their most optimum separation ( $d$ ) where  $d$  is expressed as a fraction of  $a_0$ . This is done by stepping through a series of separations to find the best stabilization. Designate the relative stabilization associated with the optimum overlap of two distributions having the Bohr radius as  $R_{ab}$ .  $R_{ab}$  has units of radius<sup>2</sup> energy<sup>-2</sup>. The energy per unit energy squared factor,  $F_{ab} = hcc_m R_{ab} c_0^{-2}$  where  $c_0$  is the magnitude of  $c$ . [The values of  $c, h$  and  $a_0$  are taken from the CODATA values<sup>15</sup>] Setting  $E_{3D}$  in (1) to  $mc^2$ , that mass is  $2.3662122 \times 10^{-13}$  kilogram. The energy associated with this mass is  $2.1266455 \times 10^4$  joule. Consistent with (12), the energy of the bond,  $E_b = ((2.1266455 \times 10^4)^2 hcc_m R_{ab} c_0^{-2})$ . Consistent with (13),

$$G = [(((2.1266455 \times 10^4)^2 hcc_m R_{ab} c_0^{-2} d) / (2.3662122 \times 10^{-13})^2)] d a_0$$

The second factor of  $d$  arises because the maximum gravity potential is achieved at a distance of  $d a_0$  not at 0. Energy is inversely proportional to  $r$ . So, for the purposes of the calculation of  $G$ ,  $E_{ab}$  must be increased by a factor of  $d$ . The magnitude of  $R_{ab}$  is found to be about 0.118 and  $d$  about 1.42. Considering only the primary order interaction, one obtains  $G = 0.678145 \times 10^{-10}$ . The accepted value is  $G = 0.667428(67) \times 10^{-10}$ <sup>16</sup>

Considering higher and lower order contributions results in  $G = 0.667378 \times 10^{-10}$ . These other order contributions are discussed below.

The absolute energy accuracy of this calculation is about  $1 \times 10^{-8}$  (expressed as a fraction). The result,  $G$ , is found by finding the peak in the curve of energy versus the separation distance. Since the energy vs. distance curve is continuous and smooth, one would expect that the relative accuracy would be better than the absolute accuracy. Assuming  $10^{-9}$  relative accuracy, the accuracy of  $G$  is about  $10^{-4}$  (expressed as a fraction). Assuming  $5 \times 10^{-10}$  relative accuracy, the accuracy of  $G$  is about  $8 \times 10^{-5}$ . Assuming  $5 \times 10^{-9}$  relative accuracy, the accuracy of  $G$  is about  $3 \times 10^{-4}$ .

## XII. THE ELECTRICAL INTERACTION AND CALCULATION OF THE ELECTRICAL POTENTIAL

There are several aspects of the electrical interaction which suggest its origin. The fact that particles, no matter their mass, have integral charge suggests that the electrical interaction has as its source, rotating 2-dimensional order. Were this 2-dimensional order associated with 3-dimensional order (a particle of some mass), interactions among the various instances of 2-dimensional order would be the equal when disaggregated to distributions of equal radii. The interaction would be independent of the mass with which it is associated. The energy of the 2-dimensional order associated with a given mass is proportional to  $1/r$  and falls off with  $1/r$ , making the interactions among the 2-dimensional orders associated with different masses identical.

The electrical attribute of a particle does not cause the particle to move, so the 2-dimensional order associated with the particle must rotate. Because electrical charge can be both plus or minus, it seems reasonable to associate the electrical attribute of a particle to a rotation (I do not use the term spin since it is not clear at the outset that this is the attribute commonly called “spin”.) of associated 2-dimensional order, with plus and minus corresponding to opposite rotations. (Recall that light must have an associated rotation. Absent a rotation, light would proceed in both directions along its symmetry axis.)

Key to the understanding of the electrical interaction is the electron. The electrical potential can be derived simply from the electron mass. Substituting the Einstein relationship in (1) and substituting  $\hbar_0$  for  $h_0$  to reflect the rotational nature of the interaction, one obtains,

$$\text{electron energy} = m_e c^2 = \hbar_0 c_m / r \quad c_m / r \quad \text{or} \quad c_m^2 \hbar_0 \langle r^{-2} \rangle, \quad (14)$$

where  $m_e$  is the electron mass. (The energy of a spherical distribution is sometimes written as  $h_0 c_m^2 \langle r^{-2} \rangle$ .)

Assuming that the macro world is third order and that therefore  $m_e$  is a third order measurement, the  $r$  in  $\langle r^{-2} \rangle$  in (14) is a third order radius. Because rotation is an attribute superimposed on a particle, one hypothesizes that the electrical interaction may reflect the second order  $\langle r^{-2} \rangle$ . The second order electron  $\langle r^{-2} \rangle_{2nd}$ , where  $r_{2nd} = c_0$  times the first order electron radius (or  $1/c_0$  of the third) is  $\langle r^{-2} \rangle_{2nd} = 7.76344078 \times 10^{20} \text{ m}^{-2}$ .

One can demonstrate the relationship of the electron radius to the electrical potential by calculating the electrical potential at the Bohr radius. The  $\langle r^{-2} \rangle$  for the Bohr radius ( $a_0$ ) is  $3.57106486 \times 10^{20} \text{ m}^{-2}$ . (The ratio  $7.76344078/3.57106486 = 2.17398481$ . Increasing  $\langle r^{-2} \rangle$  of the Bohr radius by this factor the yields  $\langle r^{-2} \rangle_{2nd}$  for the electron.) The maximum stabilization associated with the overlap of two distributions representing the electron (As discussed above, the electrical  $\langle r^{-2} \rangle$  associated with the central proton is the same as that of the electron when it is disaggregated to the radius of  $\langle r^{-2} \rangle_{2nd}$  for the electron.) occurs at  $0.96613612 a_0$ . Recognizing that the electrical potential falls with  $1/r$ , the calculated electrical potential at  $a_0$  becomes  $0.9912983$  atomic units. The expected electrical potential for an electron in the innermost Bohr orbit is  $1.0$  in atomic units<sup>17</sup>.

The absolute energy accuracy of this calculation is about  $2 \times 10^{-8}$  (expressed as a fraction). Assuming  $10^{-9}$  relative accuracy, the accuracy of the electrical potential is about  $3 \times 10^{-5}$  (expressed as a fraction). Assuming  $5 \times 10^{-10}$  relative accuracy, the accuracy of the electrical potential is about  $7 \times 10^{-5}$ . Assuming  $5 \times 10^{-9}$  relative accuracy, the accuracy of the electrical potential is about  $2 \times 10^{-5}$ . Since the approximate 1% error in the calculated potential is well outside accuracy of the calculation, it is clear that a single order calculation is not adequate.

If interactions up to the fourth order are considered, the calculated electrical potential = 0.9999913 atomic units. Calculation of higher order and lower order effects is discussed below.

The calculation above confirms that electrical interaction is a second order interaction. (As discussed above, the gravitational interaction is third order.) The rotational order associated with the electrical attribute appears to reach out radially by a factor of  $c_0$  from the first order radius of the mass with which it is associated. The electron itself appears to be a pseudo particle. It looks like a 3-dimensional particle because it is rotating 2-dimensional order and has a mass equivalent. It may not have a mass in the sense of that of other particles.

### XIII. INTERACTIONS AMONG THE VARIOUS ORDERS

Second order and higher effects among instances of 3-dimensional order are enhanced via disaggregation/aggregation. A single probability distribution of energy  $n$  can be looked at as  $n^{1/2}$  broader distributions a factor  $1/n$  lower in energy. This disaggregation is equivalent to a single distribution of energy  $n^{1/2}$ . Conversely, a single probability distribution of energy  $n$  can be looked at as  $1/n^{1/2}$  narrower distributions, a factor of  $1/n$  higher in energy. This aggregation is equivalent to a single distribution of energy  $n^{1/2}$ . Since the distributions representing the various orders can be disaggregated or aggregated, significant interactions among the orders are possible.

There are two types of higher-order interactions; like-order interactions and cross-order interactions. Higher-orders can interact with lower-orders because the higher-orders overlap with the lower-orders. The cross-order interactions involve the overlap of a broad higher-order distribution with a much narrower lower distribution. Consider like-order interactions first.

The elemental unit of first-order distributions is  $c_m$  (the number of meters traveled by light in a second). The elemental unit of second-order distributions is  $c_m^2$ . The elemental unit of third-order distributions is  $c_m^3$ , etc. The energy associated with the second-order distribution is  $1/c_0$ . The second-order energy is not  $1/c_0^2$  as one might expect because the relative core radius of the second-order is  $c_0^{1/2}$  smaller than the core radius of the first-order. As one proceeds to the higher-orders, the energy of the orders decrease by a factor of  $1/c_0$  as the radius increases by a factor of  $1/c_0$ .

For there to be a like-order, higher-order, interaction, the radius of the higher-order distribution must be reduced to the radius of the lower-order distribution. Aggregating a higher-order which is nominally  $1/c_0$  lower in energy produces a distribution at the lower-order radius which, after aggregation, is  $(1/c_0)^{1/2}$  lower in energy. So, higher-order 3-dimensional distributions are  $(1/c_0)^{1/2}$  lower in energy than the order below.

Cross-order interactions involve the interaction of a relatively narrow lower-order distribution with a much broader higher-order distribution. (This is a kind of superposition of the higher order on the lower order.) For the cross-order interaction to be significant, the lower order radius must be within a few orders of magnitude of the higher order distribution. Optimum interaction occurs when the lower order distribution disaggregates to the maximum extent. For example, consider a first order-second order interaction. The first order is  $c_0$  higher in energy than the second order. Therefore, its

radius is  $(1/c_0)^{1/2}$  lower than the second order radius. Disaggregation can increase the first order radius to  $(1/c_0)^{1/4}$  of the second order radius. Using a computer program one can calculate the interaction (stabilization) between two distributions, one with a radius  $(1/c_0)^{1/4}$  smaller than the other.

Higher-order interactions have an impact on the optimum bond length between the distributions representing the instances of order. In particular, cross-order interactions reduce the optimum bond length. Cross order interactions are at a maximum when the bond length is zero. However, decreasing the bond length from the first order bond length increases the energy penalty associated with aggregation. Therefore, to calculate higher-order effects, one must adjust for changes in the bond length from the optimum bond length of the first-order interaction.

The ratio of bond length/first-order bond length is the factor that adjusts the interaction energy for changes in bond length from the optimum first order bond length. So, higher-order distributions are (bond length/first-order bond length)  $(1/c_0)^{1/2}$  lower in energy than the order below. This results because any increase in the bond length from the first-order bond length proportionately decreases the extent of aggregation required of the higher-order. Similarly, any decrease in the bond length from that of the first-order bond length increases the extent of aggregation required of the higher-order.

If one takes  $engy_{1-1}$  as the stabilization energy associated with the overlap of the first order distributions, then the second order stabilization energy  $engy_{2-2}$  is

$$engy_{2-2} = (\text{bond length/first-order bond length}) \text{ } engy_{1-1} / c_0^{1/2} ,$$

and the third order stabilization,

$$engy_{3-3} = (\text{bond length/first-order bond length})^2 \text{ } engy_{1-1} / c_0 .$$

Cross-order interactions must also be adjusted for changes in the bond length from the first-order bond length interaction. The radius of the inner lower-order distribution must be adjusted in accordance with its disaggregation. Since disaggregation brings the lower-order distribution's radius to  $(1/c_0)^{1/4}$  of the radius of the higher-order, the lower-order's radius must be adjusted by a factor of (bond length/first-order bond length) $^{1/4}$ . In addition to these adjustments, the energy of the higher-order distribution of the cross-order interaction must also be adjusted in the same manner as it was adjusted for same-order interactions. Also recognize that cross-order interactions are multiplied by 2 as there are two cross-order interactions for each same-order interaction.

If one takes  $engycross_{0-1}$  as the stabilization associated with a first order distribution superimposed on a (hypothetical) distribution with radius (bond length/first-order bond length) $^{1/4}$   $(1/c_0)^{1/4}$  smaller than the cross-order stabilization at the first order bond length,  $engy_{0-1}$  is

$$engy_{0-1} = 2.0 (\text{bond length/first-order bond length}) \text{ } engycross_{0-1}$$

and the cross-order stabilization associated with the second order overlapping the first order is

$$engy_{1-2} = 2.0 (\text{bond length/first-order bond length}) \text{ } engycross_{0-1} / c_0^{1/2} .$$

In the macro world one experiences gravity as a 3-dimensional third order interaction. So, the total interaction,  $engy$ , including both lower order and higher order interactions is

$$engy = engy_{3-3} + engy_{2-3} + engy_{4-4} + engy_{3-4} + \text{etc} .$$

Recognizing that  $engy_{2-3} = engy_{3-4}$ , the total interaction is

$$engy = engy_{3-3} + 2.0 (\text{bond length/third-order bond length}) \text{ } engycross_{2-3} +$$

$$\begin{aligned} & (\text{bond length/first-order bond length}) \text{ engy}_{3-3}/c_0^{1/2} + \\ & 2.0 (\text{bond length/first-order bond length}) \text{ engcross}_{2-3}/c_0^{1/2} + \\ & \text{etc.} \end{aligned}$$

Since the calculations are limited to about  $10^{-5}$  (relative) accuracy, only the first 4 terms are meaningful in the calculation of the gravitational constant. Including these four terms yields  $G = 0.667378 \times 10^{-10}$ . This is to be compared with the accepted value  $G = 0.667428(67) \times 10^{-10}$ .

The higher order interactions in the calculation of the electrical potential are somewhat different from the above. The electron, and the electrical aspect of other charged particles, are rotating 2-dimensional distributions. While in some respects they appear as 3-dimensional distributions, the energy of interaction of these distributions falls off with  $1/r$  without disaggregation. Because electrical interactions fall off with  $1/r$  rather than  $1/r^2$  as do the true 3-dimensional interactions, the electrical interactions are a power of 2 lower (or a power of 1/2 of) the true 3-dimensional interactions.

$$\begin{aligned} & \text{The second order electrical stabilization energy } \text{eleengy}_{2-2} \text{ is} \\ & \text{eleengy}_{2-2} = (\text{bond length/first-order bond length}) \text{ eleengy}_{1-1}/c_0^{1/4}. \end{aligned}$$

The cross-order stabilization associated with the second order overlapping the first order is

$$\begin{aligned} & \text{eleengy}_{1-2} = 2.0 (\text{bond length/first-order bond length})^{1/2} \text{ eleengcross}_{0-1}/c_0^{1/4} \\ & \text{where } \text{eleengcross}_{0-1} \text{ is the stabilization associated with a first order distribution} \\ & \text{superimposed on a (hypothetical) distribution with radius (bond length/first-order bond} \\ & \text{length})^{1/4} (1/c_0)^{1/4})^{1/2} \text{ smaller than the cross-order stabilization at the first order bond} \\ & \text{length (This differs from the 3-dimensional case above by a power of 1/2 in } c_0 \text{).} \end{aligned}$$

The third order electrical stabilization energy  $\text{eleengy}_{3-3}$  is

$$\text{eleengy}_{3-3} = (\text{bond length/first-order bond length})^2 \text{ eleengy}_{1-1}/c_0^{1/2}.$$

Recognizing that the electrical interaction is manifest in the second order, the total electrical potential for the Bohr atom,  $\text{eleengy}$ , including higher order interactions is

$$\text{eleengy} = \text{eleengy}_{2-2} + \text{eleengy}_{2-3} + \text{eleengy}_{3-3} + \text{eleengy}_{3-4} + \text{etc.}$$

So the total interaction is

$$\begin{aligned} \text{eleengy} = & \text{eleengy}_{2-2} + \\ & (\text{bond length/first-order bond length}) \text{ eleengy}_{2-2}/c_0^{1/4} + \\ & 2.0 (\text{bond length/first-order bond length})^{1/2} \text{ eleengcross}_{1-2}/c_0^{1/4} + \\ & (\text{bond length/first-order bond length})^2 \text{ eleengy}_{2-2}/c_0^{1/2} + \text{etc.} \end{aligned}$$

Including these four terms the calculated Bohr electrical potential = 0.9999913 atomic units.

The above derives the electrical potential at the Bohr orbit, where the electrical potential is manifest in the second order (There is no electrical interaction in the first order world.). There is no interaction with a lower order. In the macro world one experiences the electrical potential as a third order interaction. Performing the analogous calculation in the third order requires us to add an additional term reflecting the second order/third order cross-order interaction. The Bohr electrical potential calculated from a macro world perspective is

$$\text{eleengy} = \text{eleengy}_{2-3} + \text{eleengy}_{3-3} + \text{eleengy}_{3-4} + \text{eleengy}_{4-4} + \text{etc.}$$

Recognizing that  $\text{eleengy}_{2-3} = \text{eleengy}_{3-4}$ , the total interaction is

$$\begin{aligned} \text{eleengy} = & \text{eleengy}_{3-3} + \\ & 2.0 (\text{bond length}/\text{first-order bond length})^{1/2} \text{eleengycross}_{2-3}/c_0^{1/4} + \\ & (\text{bond length}/\text{first-order bond length}) \text{eleengy}_{3-3}/c_0^{1/4} + \\ & 2.0 (\text{bond length}/\text{first-order bond length})^{1/2} \text{eleengycross}_{2-3}/c_0^{1/4} + \\ & (\text{bond length}/\text{first-order bond length})^2 \text{eleengy}_{3-3}/c_0^{1/2} + \text{etc.} \end{aligned}$$

Notice the addition of a cross term. This is because, in the macro world, there is a lower order term. Including these five terms, the calculated macro electrical potential = 0.99764235 atomic units.

The Bohr electrical potential - macro electrical potential = 0.9999913-0.9976424 = 0.0023498 atomic units. The electron g factor<sup>18</sup>,  $g_e = -2.0023193$ .  $g_e + 2.0 = -0.0023193$ . Since the accuracy of the calculation is in the range of 2 to  $5 \times 10^{-5}$ , one has agreement within measurement accuracy. It appears that the magnitude of  $g_e$  differs from 2.0 because the electrical potential in the macro world is different from the electrical potential in the macro world.

#### XIV. ELEMENTARY PARTICLES

The model presented here suggests that items of mass, or particles, should be considered differently in the micro world than in the macro world in which we live. In the macro world, when an item or particle is split into fragments, these fragments are considered as pieces or components of the item or particle from which they came. The micro world presents a different perspective. Consistent with viewpoint presented here, in the micro world, when a non-composite particle (a particle made up of a single distribution) is fragmented, the fragments would be represented by broader distributions than the particle from which they came. These broad distributions could not be considered as pieces or components of the narrow distribution from which they came. From the perspective of this model, elementary particles are those with the most-narrow distributions, and highest energy, of their kind.

The following analysis explores the possible nature of electrons, protons and neutrons.

If elementary particles are truly the smallest, most energetic particles of their type there must be a factor that limits their energy and  $\langle r^2 \rangle$ . Recall that, for 3-dimensional order:

$$\text{particle energy 3D} = c_m^2 \hbar_0 \langle r^2 \rangle,$$

where  $\langle r^2 \rangle$  represents the probability distribution. For rotating 2-dimensional order:

$$\text{particle energy 2D} = c_m^2 \hbar_0 \langle r^2 \rangle.$$

It would not be meaningful to define a distribution more narrowly than its inherent uncertainty. Recall that  $c_m$  is the distance traversed by the distribution elements as the distribution is regenerated or “painted”. The inherent uncertainty of the  $c_m$  distance within the 2-dimensional probability distribution is  $c_m^{1/2}$  and the inherent uncertainty of  $c_m^2$  within the 3-dimensional distribution is  $c_m$ .

Substituting the Einstein relationship in the latter and recognizing that  $\langle r^2 \rangle$  is limited to  $c_m^{1/2}$ , one obtains, for the smallest and most energetic of rotating 2-dimensional order,  $m = \hbar_0 c_m^{1/2} = 1.82594 \times 10^{-30}$  kg. Since the rotation of the electron is only in one direction it is reasonable to take one half of this value. This gives, for the electron,  $m_e = 9.12969 \times 10^{-31}$  kg. The accepted value for  $m_e$  is  $9.10938 \times 10^{-31}$  kg.

Substituting the Einstein relationship in the former and recognizing that  $\langle r^{-2} \rangle$  is limited to  $c_m$ , one obtains, for the smallest and most energetic of 3-dimensional order,  $m = h_0 c_m = 1.98644 \times 10^{-27}$  kg, about 18% higher than the mass of the proton. However, if one recognizes that, for the distribution representing 3-dimensional order, which has 2 Cartesian axes, the average distance between distribution elements is  $2^{1/2}$  of  $r$ . This yields  $m = h_0 2^{-1/4} c_m = 1.67039 \times 10^{-27}$  kg, close to the accepted value for the proton,  $1.67262 \times 10^{-27}$  kg.

Since the proton has an electrical charge, it must have an associated rotation of 2-dimensional order. This rotational 2-dimensional order should have a relatively small associated mass (as the electron has mass). Since the neutron is neutral and is heavier than the proton, the neutron must have a rotation and a counter rotation as well. It follows that the difference between the masses of the neutron and the proton should be approximately equal to the mass associated with the rotation. The difference between the mass of the neutron and the mass of the proton is  $2.31 \times 10^{-30}$  kg.

Since the energy associated with the 2-dimensional rotation falls off with  $1/r$  (rather than  $1/r^2$  as does the 3-dimensional order), the energy associated with the rotation (and the mass associated the rotation) should be less than the energy associated with the 3-dimensional order by a factor of  $c_0^{-1/4}$ . Taking into account the geometric factors described above:

mass rotational 2-dimensional order =  $2^{-1/4} (2\pi)^{-1} c_0^{-1/4}$  mass 3-dimensional order.  
This yields mass rotational 2-dimensional order =  $2.40 \times 10^{-30}$  kg, in reasonable agreement with observation.

## XV. CONCLUSION

The modeling of energy as order represented as a probability distribution is notable for its lack of complexity. Although the concept of the physical world having its origin in “order” is difficult to grasp, physical laws follow easily from this concept. The energy of the three forms of matter; mass, light, and background/dark energy differ only by a single constant factor. Recognizing that motion can be induced by skewing 3-dimensional distributions (mass) by appending 2-dimensional distributions to them, gives way to the uncomplicated derivation of the classical laws of motion. This leads seamlessly to the idea that moving masses have a wave character. Relativistic effects arise from the dilutive impact of appending increasing numbers of instances of 2-dimensional order to achieve higher velocities. The uncertainty principal results from the fact that only integral numbers of instances of 2-dimensional order are appended. Forces arise from the reduction in order arising from the overlap of distributions. Although the derivation of the constant of gravitation and the derivation of electrical potential requires an understanding of the aggregation and disaggregation of distributions and the magnitude of these constants depends on the order (i.e. 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>) of the macro world, the actual numerical calculation of the constants is straight forward.

<sup>1</sup> For a review some of these efforts see H.F.M. Goenner, *Living Rev. Relativ.* 17(1) Springer (2014)

<sup>2</sup> Paul B. Merrithew, ChemRxiv. [Preprint] <https://doi.org/10.26434/chemRxiv.13049927> (2020).

<sup>3</sup> See, for example, Ira N. Levine, *Quantum Chemistry (7<sup>th</sup> edition)*, (Pearson 2014) p.45, p119.

<sup>4</sup> A. Einstein, *Annalen der Physik*, **328**(7), 371 (1907).

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- <sup>5</sup> H.Goldstein, C.P. Poole, J.L. Safko, *Classical Mechanics (3<sup>th</sup> edition)* (Addison Wesley 2002) p. 3.
- <sup>6</sup> H.Goldstein, C.P. Poole, J.L. Safko, *Classical Mechanics (3<sup>th</sup> edition)* (Addison Wesley 2002) p. 2.
- <sup>7</sup> L. deBroglie, PhD Thesis, University of Paris, 1924.
- <sup>8</sup> Ira N. Levine, *Quantum Chemistry (7<sup>th</sup> edition)*, (Pearson 2014) p.5.
- <sup>9</sup> W. Heisenberg, *Zeitschrift fur Physik* **43**(3-4), 172 (1927).
- <sup>10</sup> Ira N. Levine, *Quantum Chemistry (7<sup>th</sup> edition)*, (Pearson 2014) p.7.
- <sup>11</sup> A. Einstein, *Annalen der Physik*, **17**(10), 891 (1905).
- <sup>12</sup> H.Goldstein, C.P. Poole, J.L. Safko, *Classical Mechanics (3<sup>th</sup> edition)* (Addison Wesley 2002) p. 279.
- <sup>13</sup> H.Goldstein, C.P. Poole, J.L. Safko, *Classical Mechanics (3<sup>th</sup> edition)* (Addison Wesley 2002) p. 101.
- <sup>14</sup> Ira N. Levine, *Quantum Chemistry (7<sup>th</sup> edition)*, (Pearson 2014) p.136
- <sup>15</sup> P.J.Mohr, B.N.Taylor, and D.B.Newell, *Rev. Mod. Phys.* **80** (2), 709 (2008), **80** (2), 710 (2008)
- <sup>16</sup> P.J.Mohr, B.N.Taylor, and D.B.Newell, *Rev. Mod. Phys.* **80** (2), 709 (2008)
- <sup>17</sup> J.P. Lowe, *Quantum Chemistry (2<sup>nd</sup> Edition)*, (Academic Press 1993) p.107.
- <sup>18</sup> P.J.Mohr, B.N.Taylor, and D.B.Newell, *Rev. Mod. Phys.* **80** (2), 710 (2008)