Foundations oF Neo-Spearsian Gravitational Theory with Application to Earthquake Early Warning Systems

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FOUNDATIONS OF NEO-SPEARSIAN GRAVITATIONAL THEORY WITH APPLICATION TO EARTHQUAKE EARLY WARNING SYSTEMS

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This book is dedicated to the Holy Spirit of God Source of All Wisdom and Knowledge and the Spirit of Truth together with His Most Chaste Spouse without Whom this book could have neither been conceived nor written!

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Introduction

The late Morton F. Spears labored for decades to construct a viable theory of gravitation based on Maxwell-Hertz electrostatic potential theory and also on part of classical circuit theory: Ohm's law, Kirchhoff's laws, and capacitor theory. He seems to have overcome every obstacle but one—namely, he felt he had to assume:

> If one concludes that the proton has the equivalence of about 1836 times the number of particles that make up the electron, it will appear for the electrostatic model as if about 1836 electrons without any charges are situated at the proton position in the far-spaced Hydrogen atom. With this approach all of the interactions result in appropriate gravity forces ["An Electrostatic Solution for the Gravity Force and the Value of G," *Galilean Electrodynamics*, 23-32, Vol. 21, No. 2 (2010)].

But, of course, this was at considerable odds with the current, generally accepted view of the proton as being made up of three quarks, and so was disregarded by theorists. Our approach to eliminate this spurious assumption is set forth in the first four chapters concerning the theory, which comprise Part One of this work.

In Part Two, we will treat the explanation of the Biefeld-Brown effect utilizing the theory presented in Part One, and relate it to the electrically charged torque pendulum of Dr. Erwin J. Saxl, which he discussed in a brief 1964 article in the British journal *Nature*. Dr. Saxl, a post-doctorial student of Einstein, noticed that a torque pendulum exhibits different dynamical properties if it is charged … depending on the polarity of the charge and its charge magnitude. He mentions in this article that powerful earthquakes have been known for years to be proceeded by electrical effects such as lightning from a clear sky, and thus might be able to be predicted shortly before their occurrences by a device employing his electrically charged torque pendulum as a sensor.

1

CIRCUIT THEORY AND RELATIVISTIC ELECTRODYNAMICS

It is generally thought (if the author's experience is to be trusted) that the part of circuit theory (Ohm's law, Kirchhoff's laws, and capacitor theory) used by Spears is merely a relatively elementary application of relativistic electrodynamics to capacitors, resisters, and wires forming closed loops; however, this is an illusion in that covariance results in the situation where, while one observer may see only a non-zero electric field in his laboratory, another moving relative to the first may see (for example) a magnetic field B and an electric field E with E = B (in magnitude). But capacitors pertain to electric phenomena (while inductors pertain to magnetic phenomena) and cannot change into a half inductor and a half capacitor by some feat of legerdemain! And so while it is true that Ohm's law can be deduced from the experimentally verified fact that in metals at constant temperature the current density J and the electric field E are proportional as vectors, and Kirchhoff's laws follow one from conservation of charge and the other from conservation of energy, and further that the rules governing capacitors are a consequence of the fact that if one integrates the electrostatic energy density over all space containing only finite conductors thereby obtaining the total electric energy of this system of conductors, that in the n conductor situation where also the charges on the n conductors are Q_i and the potential on them are V_i, then the key formula for the total energy of the conductor system is:

$$U = (1/2)\ \Sigma\ (V_i\ Q_i) = (1/2)\ \Sigma\ (c_{ik}\ V_i\ V_k),$$

where the c_{ik} are the coefficients of capacitance; nevertheless, when one introduces the notion of universal covariance into the theory, problems arise. Moreover, since one wants to go from electrostatics to gravitational theory, which is, of course, quite a leap, it becomes necessary to first define a new type of "hybrid" intermediate 'field,' which is, roughly speaking, a V / S 'field' where V is volts (potential) while S is darafs (inverse farads).

Of course, the term "darafs" is archaic and the reader may well object to the reintroduction of this terminology, but the author assures him that, while this may be annoying at first, the structure of the theory being developed will vindicate this choice many times over. But a dimensional analysis problem, unfortunately, rears its ugly head here, too ... as this V / S 'force' is soon found to have units of Coulombs, that is, charge, and so our new 'field' does not have its own unique units, but must needs share its units with electrical charge—not good! And herein lies, the author believes, the origin and root of the horrible units problems Spears experienced right up to the end, but felt he had finally solved satisfactorily in his last GED paper published posthumously. So it seems best to begin by quoting verbatim a

key paragraph of this paper containing his explanation of his resolution of these problems:

> For an uncomplicated analogy, consider the example of a linear, one-meg-ohm resistor one meter long with an end-to-end potential difference of one volt. One can quickly observe that the magnitude of the volts/ohm for this resistance is simply 10^{-6} volts/ohm; and the 'field' volts/ohm is simply the electric current I, which remains the same 10^{-6} amperes no matter what system of units is applied for the resistance. One can also quickly see that the length of one ohm is 10^{-6} meters. The difficulty for so long has been the use of these kind of relations without stating them in acceptable mathematical terms. Actually, the mathematical conversion of V / Ω to V / r in the given one-meg-ohm physical system is: V / r = 10^{-6} (volts/ohm) multiplied by 10^{-6} (the number of ohms) times 10^{6} ohms/meter. The V / S volts/daraf 'field' is converted to a V / r volts/meter field in the same manner by multiplying the V / S 'field' by (the number of meters)/(the number of darafs) times the darafs/meter in the physical system defined. The conversion ratio multiplier term is a pure [dimensionless] number that stays the same in all systems of units for the physical system defined.

Note, here, that just as farads are units of capacitance, darafs are units of elastance, and k farads are just (1 / k) darafs, and vice versa, so, while it may take the reader some time to familiarize himself with this new terminology, it should hardly stymie the competent scientist. And, as units problems are, perhaps, best dealt with in concrete situations, we will defer further discussion of this hideous matter until later.

Then the question comes up: is this new ‘field’ we are in the process of introducing a new type of field or not ... as considerable effort is nowadays going into a unified field theory (a theory of everything), and one, of course, would like to avoid introducing a new field that would hamper these efforts. Well, the answer seems to be—strictly speaking—no ... in view of the above-mentioned deduction of circuit theory from relativistic electrodynamics. However, there seems to be no getting around the fact that a purely electrostatic-circuit theory (not involving inductors) must needs clash with the notion of universal covariance and its scrambling of electric and magnetic fields—at some point.

2

NEO-SPEARSIAN THEORY FOR THE TWO-HYDROGEN ATOM SYSTEM

Now to get to the meat of the neo-Spearsian theory. We are here talking about electrons, protons, and neutrons, the last of which will, however, be sometimes treated from the point of view of a electron and proton in close position ... even though it is currently, generally accepted that a neutrino is involved in the neutron—which, however, has no charge and very little mass. Then we add atomic nuclei to our list of quantum particles in conclusion. Our approach is to introduce the above-mentioned part of circuit theory by modeling as a charged, conducting sphere some of our just-mentioned quantum particles with an eye to reducing the mutual electric forces on these particles as forces between spherical capacitors based only on their charges and radii, which, in turn, depend only on their charge and mass ... using simply the classical radius of the electron given by (see Melvin Schwartz’s *Principles of Electrodynamics,* page 224, but in Gaussian units, not in MKS units used here throughout)

$$R_e = Q_e^{\,2} / (4 \text{ pi } \varepsilon_0 M_e c^2).$$

Also we're going to need the well known fact that the capacitance C of a sphere of radius R_e is just (in the MKS system used throughout)

$$C = 4 \text{ pi } \varepsilon_0 R_e.$$

We let

$$R_p = R_e P,$$

where R_p is the proton effective radius and P is the proton-electron mass ratio. And, for a general quantum particle of the type we are considering, we set

$$R = R_e M / M_e,$$

where R is the effective radius and M is the mass of this particle. Next we investigate the capacitance properties of several charged conducting spheres, each having a finite non-zero mass and hence a well-defined effective radius. First, the two-particle case of particles of mass M_1 and M_2 and charges Q_1 and Q_2 and then effective radii of R_1 and R_2. Clearly, if r, the center-to-center distance between the two particles, is quite large, then the capacitance of the two-particle system is given by the following equations since the system capacitance can (as mentioned above) be computed by the method of images (see William R. Smythe's *Static and Dynamic Electricity*, third edition, pages 128-9). The result is (the distance between sphere centers being r) just

$$C_{12} = 4 \text{ pi } \varepsilon_0 R_1 R_2 / r \qquad \text{provided } r >> R_1 \text{ and } R_2.$$

We will make heavy use of this result as we will begin by analyzing the case of two hydrogen atoms quite far apart and, moreover, assume in view of quantum theory that the proton and the electron of each hydrogen atom are also far apart but, of course, not anywhere near as far apart as the two distinct atoms; this is our first major assumption and seems to date from Newton's *Optics*. Next we consider the three-quantum particle case. Our aim here is to examine proton-electron-electron triplets as well as (by utilizing our just-mentioned formula for C_{12}) electron-electron pairs and proton-electron pairs in the two-hydrogen system just mentioned by modeling each pair and triplet by a system of conducting spherical capacitors, each having the mass, the charge, and then the effective radii (where the spheres are centered at the corresponding particle's center of charge) of the particles being modeled and just seeing what happens ... where it is clear that the proton-electron mass ratio being much greater than one means that, in doing this modeling, we do **not** expect that the fact that the two-atom system is, as a whole, electrically neutral must needs mean that this asymmetry will have no higher-order effects!

Before we get into the three-sphere case, which involves more subtleties, we wish to quote from *Static and Dynamic Electricity* (third edition) by Smythe concerning the making of the terms "capacitance" and "capacitor" precise:

> One consequence of the fact that all electrical stresses in a medium in an electric field depend on the intensity in the same way is that the equilibrium is undisturbed if the intensity everywhere in the field is changed by the same factor. Thus if we double the surface density at every point in a system of charged conductors, the configuration of the field is unchanged but the intensity is

doubled. The constant charge to potential ratio of an isolated conductor is its capacitance, and the reciprocal ratio is its elastance. These terms are not precise when other conductors are in the field unless all are *both* earthed [shielded] and uncharged. If Q is the charge in coulombs, C the capacitance in farads, S the elastance in darafs, and V the potential in volts, then the definitive equations are

$$Q = C\,V \quad \& \quad V = S\,Q$$

Two insulated conductors near together constitute a simple capacitor. If these two conductors are given equal and opposite charges, the capacitance of the capacitor is the ratio of the charge on one to the difference of potential between them. The ratio is always taken so as to make the capacitance a positive quantity. Thus, for a capacitor we have

$$Q = C\,(V_1 - V_2) \qquad\qquad V_1 - V_2 = S\,Q$$

Now, having spelled out our notions of capacitors and their capacitance and elastance (inverse capacitance), we wish to also briefly discuss the relationship between the coefficients of the self-capacitance and the coefficients of mutual capacitance (following Smythe further) on one hand, and the coefficients of the self-elastance and the coefficients of the mutual elastance on the other hand, and then to illustrate the rather unexpected relationship between these notions and the notions of the capacitance and elastance of a single capacitor in which the two conductors making it up are far apart relative to their sizes. As we have stated above, if we have a system of n initially uncharged conductors, fixed in position and shape, then putting a charge

on any conductor of the group will affect the potential of all other conductors in a definite way, which depends only on the geometrical configuration of the system and the capacivity. The ratio of the rise in potential V_i of conductor i to a charge Q_k placed in a conductor k to produce this rise is called the coefficient of mutual elastance s_{ik}, and one may apply Green's reciprocation theorem to show that $s_{ik} = s_{ki}$. Then a superposition of solutions for charges Q_i and $Q_{k,}$ etc. on conductors i and k gives

$$V_i = \Sigma\,(s_{ik}\,Q_k)$$

where the sum for each i is over k ranging between 1 and n, including 1 and n.

Thus s_{ik} is the potential to which the k-th conductor is raised when a unit charge is placed on the i-th conductor, all other conductors being present but uncharged, and the s_{ii} and the s_{ik} with i not equal to k are called, respectively, the self- and the mutual elastance. Since the correspondence between the n "Q_k" and the n "V_i" is one to one, the matrix s_{ik} is non-singular and its inverse c_{ik} is such that the c_{ii} and the c_{ik} with k not equal to i are, respectively, called the self- and the mutual capacitance. However, of course, it is **not** true that the equality $c_{ik} = 1 / s_{ik}$ in general, unlike the case of a single capacitor made up of two conductors such as two conducting spheres! In fact, Smythe (page 38) obtains the following result for two conductors far apart relative to their sizes having capacitances C_1 and C_2 when alone (r being the distance between them):

$$s_{11} = 1 / C_1,\ s_{12} = s_{21} = 1 / (4\ \text{pi}\ \varepsilon\ r),\ s_{22} = 1 / C_2$$

to a first approximation, and unexpectedly also by solving using the system of equations displayed just above the last set of displayed equations:

$$c_{11} = [(4 \text{ pi } \varepsilon \text{ r})^2 C_1] / [(4 \text{ pi } \varepsilon \text{ r})^2 - C_1 C_2],$$

$$c_{12} = c_{21} = - C_1 C_2 / (4 \text{ pi } \varepsilon \text{ r}),$$

$$c_{22} = [(4 \text{ pi } \varepsilon \text{ r})^2 C_2] / [(4 \text{ pi } \varepsilon \text{ r})^2 - C_1 C_2]$$

neglecting r^{-3} terms. Thus we have $c_{11} = C_1$, $c_{22} = C_2$ provided that $C_1 C_2 << (4 \text{ pi } \varepsilon \text{ r})^2$ and in particular when C_1 and $C_2 << 4 \text{ pi } \varepsilon \text{ r}$ (as C_1 and C_2 are non-negative by definition), but otherwise perhaps not.

Consider, now, the three-sphere case—that is, let there be three conducting spheres in general position (but not touching) of radii R_1, R_2, and R_3 and charges Q_1, Q_2, and Q_3. Then we know from the above that the three self-capacitances C_1, C_2, and C_3 are given by

$$C_i = Q_i / V_i = 4 \text{ pi } \varepsilon R_i, \quad \text{for } i = 1, 2, \text{ and } 3.$$

Now from elementary circuit theory, we have

$$1 / C_{123} = 1 / C_{12} + 1 / C_{23} ,$$

where C_{123} is the capacitance of the partial circuit from the first sphere to the second and then from there onto the third sphere. (This, of course, is because in this partial circuit, the capacitors C_{12} and C_{23} are in series.) Thus, we have equivalently

$$C_{123} = C_{12} C_{23} / (C_{12} + C_{23}).$$

Further, we would like to point out that the three-spherical conductor case does **not** correspond to Smythe's criteria for a system of capacitors, as does the two-sphere case, as the third sphere is not shielded. How, then, can one possibly, reasonably,

and profitably use a capacitor system to model it from the point of view of explaining the phenomena of gravitation? Well, as Newton remarked, "For the whole difficulty of philosophy seems to be tied to find the forces of nature from the phenomena of motions and then to demonstrate the other phenomena from these forces." And the author takes the position that electromagnetic forces are at the root and origin of all physical forces and phenomena whatsoever, and is currently working with David Bergman on an improved version of his (hollow) spinning charged electron model (*Advanced Fundamental Physics* by J.P. Wesley, 1991), which is a completely electromagnetic construct, but our improved model will not be hollow as this is troubling from an energy point of view much as point particles need infinite binding energy to avoid exploding outward. Further, it's not unreasonable to model a system of two conducting spheres, which are far apart relative to their radii, as having a Smythe-style capacitor between the two spheres with one lead touching one and the other lead touching the other, the capacitor being shielded and its capacitance equaling in farads the capacitance of the two-sphere system as mentioned above. This is tantamount to proceeding on the basis that in a many-conducting sphere situation, as though each two-sphere subsystem were a true Smythe-style capacitor and the resulting imaginary capacitor network of all n (n - 1) / 2 two-sphere subsystem's imaginary capacitors (one capacitor for each two-subsystem), which may then be analyzed by circuit theory, can tell the alert physicist something of the higher-order effects (the two-hydrogen atom system containing two electrons as well as two protons, whence electrically neutral) arising from the non-unity proton-electron mass ratio. And, of course, gravitational forces between particles of the type we are considering are much weaker than the electrical forces and thus may be suspected to be higher-order effects of some sort. Finally, we add to the n (n - 1) / 2 capacitors just mentioned, the n imaginary capacitors between the n spheres to the ground, that is one lead is touching the sphere and the other end is grounded with this capacitor having capacitance (4 pi ε R), R being the sphere radius, in view of the fact that this is the conducting sphere's capacitance, as shown above.

Now, back to the three-conducting sphere case. Let's assume that spheres 1 and 3 are far apart enough for our two-sphere capacitance result obtained above to apply, and that $Q_1 = - Q_3$, and, finally, assume that sphere 2 is very far away from both spheres 1 and 3 so that if r is the distance of the center of sphere 2 to the midpoint of the line segment from the center of sphere 1 and the center of sphere 3, then we may assume that the distances from the center of sphere 1 and the center of sphere 2 and from the center of sphere 3 to the center of sphere 2 are nearly r, too. Then, the sphere 1-sphere 3 pair form a dipole and we wish to investigate the force resulting from the new type of 'field' of the V / S form, where V is volts between two spheres or between a sphere and the ground, and S is the elastance between the two spheres or between a sphere and the ground. It might be best to proceed formally and let the reader learn by observing rather than making definitions and then trying to motivate them and so on. Now, of course, the electric field of a dipole is well known to be very direction dependent, but the V / S 'field' is **not**, and we will show that it is not a function of direction, as is a dipole electric field, but rather is as a "gravitational type field" from a pair of closely lying particles, that is, this new 'field' causes sphere 2 to move in the direction of the dipole, where sphere 2 is so far from spheres 1 and 3 that they can be considered to be a point dipole for our purposes. Now, if r_{ik} is the center-to-center distance between sphere i and sphere k, then we have

$$K_{ik} = r_{ik} / S_{ik},$$

where S_{ik} is the number of darafs (equaling 1 / C_{ik}) of the imaginary capacitor (of capacitance C_{ik}) between spheres i and k, where i and k are distinct.

Before we go any further, following Spears, we must resort to an artifice to get the units to conform to the usual rules so that we can go from one system of units to another with little difficulty because, as mentioned above, the theory has a history of terrible units problems. It will soon become apparent that we need K_{ij} to be unit-less but it clearly has units of meter-farads or meters per daraf, and so is not dimensionless as it stands. We simply redefine D_{ik} as r_{ik} / (1 meter) and also N_{ik} as S_{ik} / (one daraf), making both dimensionless, whence $K_{ik} = D_{ik} / N_{ik}$ is also dimensionless. Of course, this is tantamount to simply "fiat" changing the units of K_{ik} to being a dimensionless constant, but the author thinks it better to follow Spears here as he is a mathematician, not a physicist, and units and unit problems drive him crazy!

Now we are ready to go. We define

$$r^*_{ik} = r_{ik} / K_{ik},$$

where evidently r^*_{ik} has formal units as meters since K_{ik} has been reset to be dimensionless, but we think of r^*_{ik} as the length in meters per daraf for the imaginary capacitor corresponding to the i and k sphere system.

Now, let's consider, again, a two-conducting sphere system, which, moreover, has the property that the spheres are far enough apart so that the above derived capacitance formula is valid, and finally assume that both have identical charges, that is, $Q_1 = Q_2 = Q$. Then it follows from elementary theory that

$V = Q\ S$, where the Q, of course, is measured in volts per daraf. Let v denote the volts associated with one daraf (in this two-sphere system) so that $v = Q$ (1 daraf), an expression measured in volts that is invariant to the units in which darafs are measured. Then from above, $r^*_{12} = r^*_{21} = r^*$, and so $r^* = r / K$, where $K_{12} = K_{21} = K$ and $r_{12} = r_{21} = r$ (both K and D being reset just above to be dimensionless). Then

$$V / r^* = V\ K / r = [Q\ S]\ D / (N\ r) = [Q\ (1\ \text{daraf})]\ D / r = v\ D / r,$$

where N is the number of darafs associated with the sphere pair we are considering whence $S / N = 1$ daraf as N is chosen to be dimensionless and also D is the numerically equal to r but is dimensionless, unlike r, which has unit meters. Thus it follows that V / r^* is measured in volts per meter and is invariant to the units in which darafs are measured.

The usual force equation for electrostatic problems is, of course, given for our two-sphere system by $F = Q\ V / (2\ r)$ [the forces being directed away from the other particle as $Q_1 = Q_2 = Q$, and like charges repel]; thus, we have

$$F = Q\ V / (2\ r) = Q\ V / (2\ K\ r^*).$$

Now, we note that one can define another (gravitational-like) force in close analogy by setting

$$F_g = Q\ V / (2\ r^*) = (1/2)\ K\ Q\ V / r = K\ F,$$

where F_g has the units of force, as K is reset to be dimensionless to make this very thing happen, and for no other reason whatsoever. Further, we assume that $R_1 = R_2 = R_e$, the classical radius of the electron derived above. Also note that by definition

$$K = D / N = [r\ \text{meters} / 1\ \text{meter}] / [S\ \text{darafs} / 1\ \text{daraf}]$$

$$= [4\ \text{pi}\ \varepsilon_0\ R_e^2\ \text{farad-meters}] / [1\ \text{farad-meter}] = 8.83538 \times 10^{-40}.$$

First assume we have two spherical conductors that are uncharged and far apart, and then introduce a charge of Q at the first sphere, and let us determine the resulting voltage at spherical conductor 2, assuming, as we always do, that the two imaginary capacitors, one from sphere 1 to the ground and one from sphere 2 to the ground, are such that the ground is taken to be at zero potential. We, of course, utilize our fundamental equations of elastance together with Smythe's above-mentioned result so that $s_{11} = 1 / C_1 = 1 / (4\ \text{pi}\ \varepsilon\ R_1)$, $s_{12} = s_{21} = 1 / (4\ \text{pi}\ \varepsilon\ r)$, $s_{22} = 1 / C_2 = 1 / (4\ \text{pi}\ \varepsilon\ R_2)$, $r = r_{12}$, and $Q_1 = Q$. The solutions to

$$V_1 = s_{11}\ Q_1 + s_{12}\ Q_2$$

$$V_2 = s_{21}\ Q_1 + s_{22}\ Q_2$$

are then

$$V_1 = Q_1 / C_1 = Q_1 / (4\ \text{pi}\ \varepsilon\ R_1)\ \text{and}$$

$$V_2 = Q_1 / (4\ \text{pi}\ \varepsilon\ r) = Q_1\ s_{12} = Q_1\ C_{12} / (C_1\ C_2),$$

as may be verified by substitution, and also $Q_2 = 0$. Next, consider a three-sphere system with its system of imaginary capacitors, but this time let the spheres be charged as follows:

$Q_1 = Q_2 = Q_e$, where Q_e is the (negative) charge of the electron

$Q_3 = Q_p = - Q_e$, where Q_p is the charge of the proton so that if we think of a fourth sphere having the charge of a proton also, we are in the two-hydrogen atom case provided that the electron-proton pairs composing the two atoms are quite far apart relative to their effective radii and, moreover, the atoms are extremely far apart so as to appear as dipoles to each other. Assuming this and that the radii of the three spheres are given by the "effective radius" formulas mentioned above, we can proceed to compute the new, higher-order 'force' between the two electrons by using our imaginary capacitor model, and this will, hopefully, yield G, which is Newton's universal gravitational constant—otherwise we evidently have to junk the whole works! But we first need to reject an assumption about our three-sphere model made by Spears, namely, that V_2, the potential at sphere 2 relative to the ground, is zero, as this appears to fly in the face of our earlier assumption that $V_2 = Q_2 / (4 \text{ pi } \varepsilon R_2)$, which evidently fails to vanish since $Q_2 = Q_p$, which is non-zero. Why is this? Well, to be consistent, we must stick with the universal—up to this point—assumption that the capacitance of the imaginary capacitor from sphere 2 to the zero potential ground is given by the equation just mentioned when solved for Q_2 / V_2, just as we had to insist that the effective radius of a quantum particle of the type considered here was given by the "effective radius formula from the electron's effective radius only" using the particle's real mass divided by the electron mass for non-electron particles! Then we have to turn the mathematical crank and hope for the right result when we get the answer for Newton's G via Spearsian analysis. Then our theory will need little in the way of assumptions concerning nucleons and should pretty much fit any and all nuclear models and/or theories!

Now, in view of our assumption that $R_p = R_e P$, our computation of the "indirect capacitance between two particles by way of a third particle," which basically boils down, when we consider the two-electron and one-proton example presented just above, to the usual formula for the capacitance of two capacitors

in series where the two particles are the electron-proton pair consisting of spheres 1 and 3 having radii R_e and R_p with

$$C_{123} = C_{12}\, C_{23} / (C_{12} + C_{23}) \qquad \text{[where, note, } C_{123} = C_{321}\text{]}$$

with C_{123} being the combined series capacitance of sphere 3 via sphere 2 to sphere 1. And the third particle being the electron second spherical conductor having radius R_e has capacitance $C_2 = 4 \text{ pi } \varepsilon R_e$. Thus, the voltage across C_1, the imaginary capacitor from (electron) sphere 1 to the ground, has a contribution from proton sphere 3 via electron sphere 2 to sphere 1 of

$$V_{321} = Q_p\, C_{123} / (C_1\, C_3)$$

as may be verified by our argument just above the three-sphere case we are considering now, where recall that C_{123} is the combined series capacitance of sphere 3 via sphere 2 to sphere 1, and, of course, C_1 and C_3 are the single-sphere capacitances of the two spherical conductors under our usual assumption of the various particles being sufficiently far apart. Thus we get for the component of the gravitational force between the electron particles 1 and 2 due to particle 3 to be given by (where, of course, F_{321} is in analogy with F_e mentioned near the beginning of this chapter during our discussion of "gravitational like" 'forces')

$$F_{321} = (1/2)\, Q_e V_{321} / r^*$$

$$= (1/2)\, K\, Q_e\, Q_p\, [C_{123} / (C_1\, C_3)] / r$$

$$= (1/2)\, K\, Q_e\, Q_p\, [(C_{12}\, C_{23} / (C_{12} + C_{23})] / (C_1\, C_3\, r)$$

$$= -(1/2)\, (4 \text{ pi } \varepsilon R_e^2)\, (Q_p^2)\, \{[4 \text{ pi } \varepsilon R_e^2 / r]\, [4 \text{ pi } \varepsilon R_e\, (R_e P) / r] /$$

$$[(4 \text{ pi } \varepsilon R_e^2 / r + (4 \text{ pi } \varepsilon\, (R_e^2 P)) / r]\} / \{r\, (4 \text{ pi } \varepsilon R_e)$$

$$(4 \text{ pi } \varepsilon R_e P)\}$$

$$= -(1/2)\ (R_e^{\,2}\ Q_p^{\,2})\ /\ \{(P+1)\ r^2\}.$$

We can now evaluate this Spearsian 'force' between the two electrons (sphere 1 and sphere 2) by dividing

$$\{(M_e\ M_e)\ /\ r^2\}\ /\ F_{321} = -\ 2\ [M_e\ /\ (Q_e\ R_e)]^2\ (P+1)$$

$$= -\ 6.68541 \times 10^{-11}\ \text{(coulomb-volt-meters) / (kilograms)}^2$$

(using the usual values of the electron and proton constants in the MKS system used here throughout) which agrees with the widely accepted value of $G = -\ 6.67259(85) \times 10^{-11}$ to within 0.2%, which will be adequate for our audience (mainly seismologists).

Now, we find that if we compute analogously the indirect force F_{143} of sphere 4 (proton of atom 2) acting on sphere 3 (proton of atom 1) due to the indirect influence of sphere 1 (electron of atom 1) via sphere 4, then we have

$$F_{143} = (1/2)\ Q_p\ C_{143}\ V_{143}\ K_{43}\ /\ r,$$

where

$$C_{143} = C_{14}\ C_{43}\ /\ (C_{14} + C_{43})$$

$$= [4\ \text{pi}\ \varepsilon\ R_e\ (R_e\ P)\ /\ r]\ [4\ \text{pi}\ \varepsilon\ (R_e\ P)^2\ /\ r]\ /\ [(4\ \text{pi}\ \varepsilon\ R_e\ (R_e\ P)\ /\ r) + 4\ \text{pi}\ \varepsilon\ (R_e\ P)^2]$$

$$= (R_e\ P)^2\ (4\ \text{pi}\ \varepsilon)\ /\ ([1+P]\ r) = (4\ \text{pi}\ \varepsilon)\ (R_e^{\,2})\ [P^2\ /\ (P+1)]\ /\ r$$

and

$$V_{143} = Q_e\ C_{143}\ /\ (C_1\ C_3)$$

$$= Q_e\ \{(4\ \text{pi}\ \varepsilon)\ R_e^{\,2}\ [P^2\ /\ (P+1)]\ /\ [(4\ \text{pi}\ \varepsilon\ R_e)\ (4\ \text{pi}\ \varepsilon\ (R_e\ P)]\}\ /\ r$$

$$= [Q_e\ /\ (4\ \text{pi}\ \varepsilon\ r)]\ [P\ /\ (P+1)]$$

and further

$$K_{43} = D\ /\ N_{43}$$

where

$$N_{43} = 1\ /\ C_{43} = [r\ /\ (4\ \text{pi}\ \varepsilon\ (R_e\ P)^2)] \quad \text{and} \quad D = r$$

so that

$$F_{143} = (1/2)\ Q_p\ [Q_e\ /\ (4\ \text{pi}\ \varepsilon)]\ [P\ /\ (P+1)]\ [4\ \text{pi}\ \varepsilon\ (R_e\ P)^2]\ /\ r^2$$

$$= -\ (1/2)\ Q_p^{\,2}\ R_e^{\,2}\ \{P^3\ /\ (P+1)]\ /\ r^2$$

However, the corresponding value of the Spearsian G is then

$$\{(M_e\ P)^2\ /\ r^2\}\ /\ F_{143} = -\ 2\ (M_e\ /\ (R_e\ Q_e))^2\ ((P+1)\ /\ P)$$

which differs from the value of G obtained in the previous case using Spearsian methods by a multiplicative factor of P^{-1} = 0.00054 approximately. Thus, the Spearsian analysis in the F_{143} case fails by several orders of magnitude! And this is no doubt the reason Spears felt that he had to make the unfortunate assumption:

> If one concludes that the proton has the equivalence of about 1836 times the number of particles that make up the electron, it will appear

for the electrostatic model as if about 1836 electrons without any charges are situated at the proton position in the far-spaced Hydrogen atom. With this approach all of the interactions result in appropriate gravity forces.

But the author submits that the indirect Spearsian 'force' of a sphere 1 of mass M_1 on a sphere 3 of mass M_3 having charge Q_p and sphere 1 having charge Q_e, via a sphere 4 having charge Q_p and mass M_4 is just given by

$$F_{143} = [M_3 \, M_4 \, / \, M_e^2] \, F_{321},$$

where note that even though M_3 and M_4 need not equal M_e, we are going by the electron case. Thus, in other words, we are going entirely with a straightforward generalization of the Spearsian computation for his 'force' between two electrons of a two-hydrogen atom system … which, of course, is completely in step with Einstein's famous dictum: "It would be enough to understand the electron."

3

NEO-SPEARSIAN THEORY FOR THE TWO-DEUTERIUM ATOM SYSTEM

Next, we investigate the two-deuterium atom situation where neutrons are involved so as to perceive just how they should be handled. Let us be in the same four-sphere system except that spheres 3 and 4 would be a pair of proton-neutron (deuterium) pairs instead of a proton pair. Let us again compute the Spearsian 'force' of the sphere 2 on the sphere 1 (both electrons) due to the influence of sphere 3 (proton-neutron pair of atom 1) along the same lines as above in the two-hydrogen atom case and see where it leads. We evidently have

$$F_{321} = (1/2) \, Q_e \, V_{321} \, K / r = (1/2) \, Q_e \, [Q_3 \, C_{123} \, / \, (C_1 \, C_3)] \, [4 \text{ pi } \varepsilon \, R_e^2] \, / \, r$$

Now, the only difference between this calculation and the calculation of F_{321} in the last chapter is that we must everywhere replace P by (2 P) since if M_d is the mass of the deuterium nucleus, then $M_d \, / \, M_p = 2$ and so $M_d = [(2 \text{ P}) \, M_e]$, all approximately, as on one hand the mass of the neutron is slightly larger than the mass of a proton but on the other hand the mass of a deuterium nucleus is slightly less than the sum of the masses of a proton and the mass of a neutron because of the mass equivalence of the binding energy, which, of course, must be subtracted from this sum. So there are two small effects here, which lead to errors in opposite directions, and so, for our purposes (mainly for applications in seismology), we will be content with the approximation that the mass of a nucleus will be taken to be (M_p A) = (A P) M_e with A being the mass number (that is, the number of protons and neutrons in this nucleus). Consequently, in view of the fact that Spears takes the "effective radius" R of a nucleus of mass M as:

$$R / R_e = M / M_e$$

whence

$R_d = R_e\ (M_d / M_e) = (2\ P)\ R_e$ for R_d and M_d being the radius and mass of a deuterium nucleus, respectively; it follows that

$$F_{321} = (1/2)\ Q_e\ Q_3\ R_e^{\,2} / [((2\ P) + 1)\ r^2],$$

that is, one merely replaces P by (2 P) and Q_p by Q_3, respectively. But clearly we need that $Q_3 = 2\ Q_p$ if we are to get the right value for Newton's G as

$$\{M_e\ M_e / r^2] / F_{321} = -2\ [M_e^{\,2} / (Q_e\ Q_3\ R_e^{\,2})]\ [2\ P + 1]$$

which, in case $Q_3 = 2\ Q_p$, then we get

$$-\ 2\ [M_e / (Q_p\ R_e)]^2\ [P + (1/2)]$$

which is the same value approximately as we obtained in chapter 2 for G [with the (1/2) on the right replaced by 1, a small change that amounts to little percentage-wise and is completely acceptable with our applications (mainly to seismology) in mind]. But how to justify the value of (2 Q_p) for Q_3, the charge of sphere 3 (a deuteron)? Well, the neutron is generally thought to be a combination of a proton, an electron, and a neutrino, the last having very little mass and no charge, and so (neglecting the neutrino completely) may be considered as a proton and an electron in close proximity. But in the calculation of F_{321}, we are, following Spears, interested mainly in the indirect Spearsian 'force' of the positive charge of the deuterium nucleus on the electron of the deuterium atom 1, this theory being, as it is, an electrostatic one. Thus, it does not seem to be too much of a stretch at all to set Q_3 = (2 Q_p)! Of course, if we were considering a two-tritium atom example, the appropriate substitution would be Q_3 = (3 Q_p) in view of our philosophy just outlined, and then instead of the factor (P + 1) for the hydrogen case and the (P + 1/2) factor for the deuterium case, we would have the factor (P + 1/3) ... all of which are the same (approximately) for our just-mentioned purposes.

As for F_{143} computed using analogous Spearsian methods in chapter 2 and shown to be incorrect there, we recall that we had to resort to the rule that F_{143}, the indirect force on sphere 3 (the atom 1 proton) by sphere 1 (the atom 1 electron) via sphere 4 (the atom 2 proton) that gives us in this case

$$F_{143} = (M_d / M_e)^2\ F_{321},$$

where the identity of direction as well as magnitude follows approximately from our assumption that the deuterium nuclei (each with their electron) are far apart relative to $R_d > R_p > R_e$, and, moreover, the inter-atom distance is much larger even than the pair distance just mentioned.

The author would like to add that Spears did a number of very ingenious and careful experiments leading to the construction his gravitational theory that are recorded in his book "The Capacitance Theory of Gravity" that may be downloaded (gratis) at http://www.econ.iastate.edu/tesfatsi/MFSpears/.

4

NEO-SPEARSIAN THEORY FOR THE TWO-ARBITRARY-IONIZED-ATOM SYSTEM

We now are in a position to investigate the two-arbitrary-(possibly)-ionized-atom system in the light of Spears's theory, where the two atoms are not assumed to have the same atomic number. Let atoms 1 and 2 have mass numbers A_1 and A_2, and let them have neutron numbers N_1 and N_2, respectively. Further, let them have n_1 and n_2 electrons, respectively, with both n_1 and n_2 greater than or equal to one. At this point we introduce the idea of a proton-deuteron-tritium decomposition of a nucleus, which we define as a partition of the atom's protons and also neutrons (if any) into protons, deuterons, and tritium-nuclei such that the number of deuterons is a maximum of all such partitions and then (subject to that) the number of protons is a maximum that, of course, is unique up to assuming that the protons are indistinguishable, as are also the deuterons, and tritium-nuclei, too, being indistinguishable, and we refer to such a decomposition of a nucleus as proper. That such a partition exists follows from a glance at a periodic table of the elements, whether radioactive or not. The reader may be assured that we will use the uniqueness of the proper proton-deuteron-tritium-nuclei partition only to avoid being imprecise and for no other purpose. Our plan is to first examine the indirect Spearsian 'force' of a hydrogen, deuteron, or tritium-nuclei on one of the $n_1 > 0$ electrons of atom 1 via one of the $n_2 > 0$ electrons of atom 2, thereby generalizing the results of the preceding two chapters.

We begin by selecting an arbitrary but fixed electron of atom 2 modeled by conducting sphere 2 of radius R_e and an arbitrary electron from atom 1 modeled by sphere 1 also of radius R_e. Then we chose a nucleus of an equivalence class of the proper partition of the nucleus of atom 1 having mass number A = 1, 2, or 3, with atomic number equal to one. We note that the total positive charge of this nucleus, counting each neutron (if any) as a proton-electron pair, as in the last chapter, is equal to A, the mass number, whence the total positive charge is $(A\, Q_p) = Q_3$, the charge of sphere 3. Now, each of the n_2 electrons (outside the nucleus of atom 2) is assumed connected to an imaginary capacitor of capacitance

$$C_{32} = (4 \text{ pi } \varepsilon)\, (A\, R_p)\, (R_e) / r = (4 \text{ pi } \varepsilon)\, R_e^2\, (A\, P) / r$$

where, as usual, R_p and R_e are the effective radii of the proton and electron since the parts of atom 1 and those of atom 2 are of distance $r >> R_p > R_e$. We remarked above that R, the effective radius of the nucleus of mass number A and atomic weight one we are here considering, has that $R = A\, R_p = A\, P\, R_e$. Recall that there is assumed a capacitor of capacitance $C_1 = (4 \text{ pi } \varepsilon\, R_e)$ between sphere 1 and the ground, and a capacitor of capacitance $C_3 = (4 \text{ pi } \varepsilon\, A\, P\, R_e)$ between the nucleus we are considering and the ground, and also a capacitor of capacitance $C_{23} = C_{32}$ (mentioned just above). Thus recalling further that the capacitance C_{123} of C_{12} and C_{23} in series is given by

$$C_{123} = C_{12}\, C_{23} / (C_{12} + C_{23})$$

$$= (4 \text{ pi } \varepsilon)\, R_e^2\, [(A\, P) / (A\, P + 1)] / r$$

we see

$$V_{321} = (A\, Q_p)\, C_{123} / (C_1\, C_3) = \{Q_p / (4 \text{ pi } \varepsilon\, r)\}\, [(A\, P) / (A\, P + 1)]$$

$$= (Qp / (4 \text{ pi } \varepsilon\, r)\, [P / (P + (1 / A)]$$

Thus,

$$F_{321} = (1/2)\, (Q_e\, V_{321}\, K / r) = \{(1/2)\, Q_p\, Q_e\, R_e^2 / r^2\} / [(P + (1 / A)]$$

$$= - \{(1/2)\, [Q_e^2\, R_e^2 / r^2] / [P + 1]\ \text{(nearly)}$$

which is independent of A, but we are really only interested in the total indirect Spearsian force on sphere 1 (arbitrary atom 1 electron) due to the entire nucleus of atom 1 via sphere 2 (arbitrary electron of atom 2), and so we must add the co-directional and equal (approximately as $r >> R_p$) Spearsian 'forces' F_{321} summing over the nuclei of the equivalence classes of the proper partition of the atom 1 nucleus into protons, deuterons, and (perhaps) tritium-nuclei. But if there are k_1 protons, k_2 deuterons, and k_3 tritium-nuclei in the proper partition, we evidently have $k_1 + 2\, k_2 + 3\, k_3 = A$. So we have the sum of the identical F_{321} over $(k_1 + k_2 + k_3) = k_t$, which equals n_1 if atom 1 is not ionized (and conversely). But what we need is to calculate the Spearsian 'force' on the n_1 electron "cloud" of atom 1, taken as bound to atom 1 so that it may be considered as a unit for gravitational purposes, which is due to the n_2 electrons of atom 2, similarly considered as a unit bound to atom 2, due to the indirect influence of the nucleus of atom 1. Thus we have the total Spearsian 'force' F_e due to the bound electron cloud of atom 2 on the electron cloud bound to atom 1 due to the nucleus of atom 1, is given by simply

$$F_e = [- (1/2) (Q_e R_e)^2 / r^2] [n_2 k_t] / [P + 1]$$

since k_t is the number of protons (not counting neutrons as a proton and electron pair) in atom 1, that is, the atomic number, and, of course, n_2 is the number of electrons in atom 2 (outside its nucleus). The multiplicative factor n_2 in this formula comes from the fact that for capacitors in parallel, the capacitances add, and, of course, then we must replace C_{123} by $[C_{123}\ n_2]$ as there are exactly n_2 paths from an arbitrary but fixed nucleus from our proper partition of the nucleus of atom 1 to an arbitrary but fixed electron of atom 1 (outside the nucleus) via all the n_2 electrons of atom 2 (outside the nucleus). So we can see that we get a Spearsian value for Newton's G as follows:

$$\{(M_e n_1) (M_e n_2) / r^2\} / F_e = - \{2 [M_e / (Q_e R_e)]^2\} (P + 1) \{n_1 / k_t\},$$

where, of course, if atom 1 is not ionized, then $k_t = n_1$ (and conversely) and then this reduces to exactly the same result for G obtained in chapter 2 for the two-hydrogen atom system and for the two-deuteron system in chapter 3 (nearly), but otherwise not. Further, the formula for F_e is not symmetric in atoms 1 and 2 even when one takes into account the fact that the algebraic signs of the two Spearsian 'forces' must be reversed to assure that both are attractive 'forces' but attracting in opposite directions! Thus Newton's third law fails ... as it must in view of the Biefeld-Brown effect:

> The first empirical experiments by Townsend Brown had the characteristic simplicity which has marked most other great advancements, and concerned the behavior of a condenser when charged with electricity. The startling revelation was that, if placed in free suspension with the poles horizontal, the condenser, when charged, exhibited a forward thrust toward the positive pole! A reversal of polarity caused a reversal of the direction of thrust [taken from Dr. Thomas Valone's *T. T. Brown's Electrogravitics Research*, page 13].

Now, the negative sign in front of our formula for F_e indicates that the Spearsian 'force' is toward atom 2 and away from atom 1. We reverse the roles of atom 1 and atom 2 and get

$$F'_e = \{- (1/2) (Q_e R_e)^2 / r^2\} \{n_1 k'_t\} / (P + 1),$$

where $k'_t = k'_1 + k'_2 + k'_3$ = number of protons (not counting neutrons as an electron-proton pair) of atom 2 since the (k'_1, k'_2, k'_3) correspond to a proper partition of the nucleus of atom 2. But we must reverse the sign of F'_e to take into account the attraction toward atom 1 as being negative so that the new plus sign indicates that the Spearsian 'force' $(- F'_e)$ is away from atom 2 and toward atom 1, while the negative value of F_e indicates attraction toward atom 2 and away from atom 1. Now, assume that we have two silver atoms (of the same isotope) so that $A_1 = A_2$ and their atomic numbers are equal, too. Then assume further that atom 2 is positively ionized by one extra electron and atom 1 is negatively ionized by the amount of one electron missing. Then $n_2 - n_1 = +2$ if n_1 and n_2 are the numbers of electrons of atoms 1 and 2, respectively (outside the nuclei). But the expression

$$[F_e - F'_e]$$

is proportional to and has the same algebraic sign as

$$[n_1 k_t - n_2 k'_t] = (n_1 - n_2) k_t = - 2 k_t < 0$$

since the proper partitions of the silver atoms of the same isotope are unique up to the indistinguishability of protons as well as the indistinguishability of deuterons and also the indistinguishability of tritium-nuclei, whence $k_i = k'_i$ for i = 1, 2, and 3, so that

$$k_t = k_1 + k_2 + k_3 = k'_1 + k'_2 + k'_3 = k'_t.$$

However, then the composite Spearsian 'force' is negative, indicating a net force of attraction in the same direction as F_e, that is, toward atom 2 and away from atom 1 ... and, of course, this is just the above-mentioned Biefeld-Brown effect, as the positive ion-negative ion pair—taken as a unit—experiences a net force toward the positive ion and away from the negative ion! Also, as in chapters 2 and 3, we treat the Spearsian 'force' F_{143} on sphere 3 (the atom 1 proper partition class nucleus we are considering) indirectly via sphere 4 (the atom 2 nucleus proper partition class nucleus we are considering) due to the influence of sphere 1 (the atom 1 electron we are considering) in line with the Spearsian 'force' just treated between one electron cloud of atom 2 acting on the other electron cloud of atom 1 due to the influence of the particular atom 1 proper partition class (of the atom 1 nuclei), only we use the formula

$$F_{143} = [M_1 M_2 / M_e^2] F_{321}$$

where M_i is the mass number A_i times M_p (being the proton mass) of the atom i proper partition equivalence class nucleus we are dealing with here, for i = 1 and 2.

Finally, we briefly examine the question of the velocity of propagation of Spearsian 'force' effects. One might (perhaps) think that if gravitation is an electric effect, then it must then propagate with velocity c, the speed of electromagnetic radiation in a vacuum. But J. D. Jackson, in his *Classical Electrodynamics* (second edition) on pages 222-3, writes:

> [W]e note a peculiarity of the [physically natural] Coulomb gauge. It is well known that electromagnetic disturbances propagate with finite speed. Yet ... the scalar potential 'propagates' **instantaneously everywhere in space.** The vector potential, on the other hand, satisfies the wave equation ... with its implied finite speed of propagation c.

But clearly we are fundamentally dealing with the scalar potential of the Coulomb type in the above neo-Spearsian electro-gravitational theory, and so we would expect Spearsian gravitational 'force' fields and effects to be propagated instantaneously! And Al Kelly in his excellent 2005 book, *Challenging Modern Physics*, on pages 254-5, writes that T. Van Flandern, (somewhere) in his book *Dark Matter…*, states:

> The Sun's gravity emanates from its instantaneous true position, as opposed to the direction from which its light seems to come. If gravity propagated at the speed of light, it would act to accelerate the orbital speed of bodies. By observation, no such acceleration exists down to the level of about one arc second per century squared for the Earth's orbit. The absence of the acceleration implies that the gravitational lines of force arriving at the Earth from the Sun are not parallel to the paths of its arriving photons, but rather have directions which differ by about

20 arc seconds. This is true for any model of gravitation.

In Part Two of this book, we will relate the Saxl effect to the Biefeld-Brown effect and then examine Dr. Saxl's very interesting ideas concerning the possibility of devising a working earthquake early-warning device using his electrically charged torque pendulum as a sensor … in light of the theory presented above ... as the principal reason Saxl's earthquake early-warning idea has not as yet resulted in a serviceable alarm mechanism appears to be that there has been no sound theory of electrogravitatics to utilize in the design of such a device in order to give some reasonable expectation that it should function reliably once developed.

5

AN INTRODUCTION

At this point, the reader will probably (if the author's experience is any guide) have burning within him first of all the question: who does the author think he is to offer a gravitational theory at odds with the magnificent and incredibly beautiful General Theory of Relativity due to Albert Einstein himself??? Does he know anything at all about either differential geometry or Einstein's Special Relativity (to which general relativity reduces in the case of a region of space with little mass)? Well, actually, yes, the author studied mathematics (with a minor in physics) at the University of California at Berkeley for years and obtained a bachelor's, a master's, and a Ph.D. in mathematics from that university in 1964, 1966, and 1968, respectively, with all the highest grades in mathematics both as an undergraduate and as a graduate student. In the process, he took courses in linear spaces, metric spaces, projective geometry, and differential geometry as an undergraduate. And the course in differential geometry was taught not as was usual in those days as "index pushing," but rather out of F. and R. Nevanlinna's *Absolute Analysis*, which treats this subject from a coordinate-free point of view in which the great beauty of the theory is not concealed, but rather revealed.

However, other branches of mathematics are beautiful, too, and the one the author fell in love with was the Algebraic Theory of Automata, a subject that was introduced in a very important paper by M. Rabin and D. Scott, "Finite automata and their decision problems," *IBM J. Res. Develop*. 3, 114-25 (1959), in which they showed that a unique minimal semigroup together with a right congruence on that semigroup could be assigned to each and every finite state automaton, which pretty much determined it ... algebraically. (Here an automaton will be taken as a function of two variables, one a finite string of characters from a finite input alphabet, and the second an element of a set of "states" of the automaton with the function taking values in an finite output set and the input string changing the state of the device, in general, also.) He was fascinated by the way the idea of an algebraic automaton captured the twin ideas of "efficiency" and that of a "task." The efficiency notion was that they showed the existence of a unique minimal "reduced" state set for any automaton, which was actually equivalent to a partition of the state set that was preserved under the action of the semigroup of the automata in that an input string of its input alphabet caused its new state to be in the same equivalent class of the reduced state congruence as would have been the case if the automaton had originally been in another state, but one which was in the same congruence class as the original state the automaton was in. And, furthermore, the automaton in question needed no more information to output the correct output character than was contained in the reduced state congruence, that is, it did not become confused by knowing only the reduced congruence class the new state was in. Then comes the "task" part of the automaton. Clearly, the input strings can

be considered as acting (on the right by convention) on the state set as a semigroup of translations (that is, as a semigroup of functions from the state set into itself that will not, in general, be permutations), and so, if the original semigroup of the automaton is replaced by the semigroup of the translations of the state set into itself after reducing the state set as just described, then this new semigroup will be both unique and minimal!

Now, the author realizes that this may seem rather esoteric to the physics reader and so he is copying a four-page paper into this book next in which the automaton that recognizes the prime positive integers to a base m > 1 is examined as to its reduced state set and its associated reduced semigroup in view of the fact that the modern physicist **is** familiar with elementary number theory due to the rise of quantum theory. And the author hopes that the reader will be impressed with the fact that the famous theorem of Peter Gustav Lejeune Dirichlet states that in any arithmetic series a, a + d, a + 2 d, ... , where a and d are relatively prime, there are infinitely many primes, and when the notion of an automaton is "projected" into the area of elementary number theory, then one immediately arrives at the statement of the Dirichlet theorem! The interested reader who wishes to pursue this topic is referred to *Algebraic Theory of Machines, Languages, and Semigroups* (1968) and *Monoids and Semigroups with Applications* (1989), as well as the web site of Professor Emeritus John Rhodes, the author's thesis adviser, where the reader might be interested in Prof. Rhodes's ideas of automata theory as "finite physics" with the state sets of automata being analogous to "phase space" in classical mechanics and with the notions of continuity and differentiability being replaced by the notion of finiteness. The author guarantees that the reader will find Prof. Rhodes quite the colorful character!

On a Characterization of the Nonregular Set of Primes

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The purpose of this paper is to illustrate the important relationship between the various ways to enter coordinates in a free semigroup S on a finite number of generators so that the action of S on itself is in triangular form ([*4*], [*5*]) and the determination of the right congruence classes for a given subset of the semigroup S. This relationship is illustrated by extending a recent result of Minsky and Papert [*1*] that the prime integers to a base $m > 1$ do not form a regular set. Let Σm be the set of all nonempty finite words on the alphabet $m = \{0, 1, ..., m-1\}$ so that Σm is a free semigroup under concatenation, and let f be the machine which accepts the primes represented with the base m so that f has Σm as its domain. Then the main result of this paper gives a simple characterization of the right congruence on Σm by which the minimal reduced state set of f is defined [*2*]. This characterization is obtained from a well known theorem of Dirichlet [*3*] which asserts that if a and b are relatively prime positive integers, then the arithmetic progression $a + nb$, $n = 0, 1, 2, ...$, contains infinitely many primes. Conversely, this characterization in turn implies the theorem of Dirichlet. Finally, as a corollary to this characterization, we obtain the result that the semigroup of the machine which accepts the primes is free.

If m is a positive integer greater than one, we may represent any nonnegative integer k as a sum

$$\sum_{i=0}^{l} a_i m^i$$

where a_i is an element of the nonnegative integers N for each i, $m^{l+1} > k$, and $0 \leqslant a_i < m$ for each i; two such representations $(a_0 \cdots a_l)$ and $(\bar{a}_0 \cdots \bar{a}_s)$ can only differ in that (say) $s > l$ and $\bar{a}_{l+1} = \bar{a}_{l+2} = \cdots = \bar{a}_s = 0$. (The reason for writing the integers with low order digits first will be made clear in the concluding discussion of our results.) If m is an integer greater than one, then, as mentioned above, we denote the free semigroup on the generators $m = \{0, 1, ..., m-1\}$ by Σm, and we define the natural function $P : \Sigma m \to N$ by

$$P(a_0 a_1 \cdots a_j) = \sum_{i=0}^{j} a_i m^i$$

where $a_i \in m$ for $i = 0, 1, ..., j$. Let $f : \Sigma m \to \{0, 1\}$ such that $f(\lambda) = 1$ if and only if $P(\lambda)$ is a prime. Then, f is the machine which accepts the prime integers represented to the base m. (For the equivalence between this definition of a machine and that used in [*1*], see [*2*].)

If m and n are two positive integers, let us denote by (m, n) their greatest common divisor, and if either m or n is zero, let us set $(m, n) = +\infty$. We say that m is prime to n if $(m, n) = 1$.

Now, let R denote the partition of Σm so that two strings of Σm, γ and λ, with γ, $\lambda \neq (0)$ are in the same block of R if either $\gamma = \lambda$, or

(a) $(m, P(\gamma)) > 1$, $(m, P(\lambda)) > 1$ and neither $P(\gamma)$ nor $P(\lambda)$ is a prime, or else

(b) $P(\gamma)$ and $P(\lambda)$ are primes dividing m.

If m is prime, we put the string (0) in a block of its own, and if m is composite, we put the string (0) into the block defined by (a) above. Then we have the following.

THEOREM. *The above mentioned theorem of Dirichlet is equivalent to the following statement: R is the reduced state congruence of f.*

Proof. We leave consideration of the string (0) to the reader. The proof that if γ and λ are two strings of Σm which are contained in the same block of R, then γ and λ are contained in the same reduced state of f is an easy consequence of the following elementary result which gives us a way to coordinatize Σm in terms of the function P by which f is defined and which explains why the reduced state congruence of f can be computed explicitly, a fact which may at first seem a little surprising.

LEMMA. *Let $y : N \to$ (endomorphisms of N) be defined by*

$$y(k)(n) = m^k n$$

for $k, n \in N$. Since N is the additive semigroup of nonnegative integers, y is a homomorphism. Define the semigroup $N \times_y N$, called the semidirect product of N and itself with respect to y, as the set $N \times N$ and so that if $[a, b]$, $[c, d] \in N \times N$, then

$$\begin{aligned}[a, b] \cdot [c, d] &= [a + c, b + y(a)(d)] \\ &= [a + c, b + dm^a].\end{aligned}$$

Let $l : \Sigma m \to N$ be defined by $l(a_1 \cdots a_k) = k$ for $a_1, ..., a_k \in m$. Then, if $i : \Sigma m \to N \times_y N$ is defined by

$$i(\lambda) = [l(\lambda), P(\lambda)]$$

for all $\lambda \in \Sigma m$, the map i is a monomorphism.

Proof. Clearly, i is an injection. Thus it only remains to verify that if $\gamma, \lambda \in \Sigma m$, then

$$i(\gamma\lambda) = [l(\gamma) + l(\lambda), P(\gamma) + m^{l(\gamma)} P(\lambda)],$$

which is clear.

We can now continue the proof of the theorem. When we say that γ and λ are members of the same reduced state of f we mean precisely that $f(\gamma) = f(\lambda)$ and if $\alpha \in \Sigma m$, then $f(\gamma\alpha) = f(\lambda\alpha)$. Let us assume that γ and λ are two different strings of Σm which are contained in the same reduced state of f and that $\gamma, \lambda \neq (0)$. We wish to show that $\gamma \equiv \lambda \bmod R$ through the use of the aforementioned theorem of Dirichlet, thus completing the proof that the reduced state partition of f is given by R. Suppose that $(m, P(\gamma)) > 1$. Then, if $\alpha \in \Sigma m$, we have that

$$(m, P(\gamma\alpha)) = (m, P(\gamma) + m^{l(\gamma)}P(\alpha)) > 1,$$

and that $P(\gamma\alpha)$ is composite. But, if $(m, P(\lambda)) = 1$, then there exists a positive integer k with $P(\lambda) + m^{l(\lambda)}k$ being a prime by the above mentioned theorem of Dirichlet. Hence, if $\alpha \in \Sigma m$ with $P(\alpha) = k$, then $P(\lambda\alpha)$ is prime. Thus, if $(m, P(\gamma)) > 1$, we must also have $(m, P(\lambda)) > 1$, and, from this it is easy to show that $\gamma \equiv \lambda \bmod R$. On the other hand, suppose that m is prime to both $P(\gamma)$ and $P(\lambda)$. Then $(m^{l(\lambda)}, P(\lambda)) = 1$, and so there exists a positive integer y with $P(\lambda) + m^{l(\lambda)}y = p$, a prime. Thus, if $\alpha \in \Sigma m$ with $P(\alpha) = y$, then $P(\lambda\alpha) = p$ and $P(\gamma\alpha) = q$, a prime. Furthermore, $p \neq q$ since by assumption $\gamma \neq \lambda$. Also, both p and q are greater than m and hence prime to m. Finally, $\lambda\alpha$ and $\gamma\alpha$ are members of the same reduced state of f since the reduced state partition of Σm is a right congruence. Therefore, we can assume that $P(\lambda) = p$ and $P(\gamma) = q$ with p and q as above. Dirichlet's result then shows the existence of a positive integer k with $p + (m^{l(\lambda)}q)k = r$ a prime since clearly $(p, m^{l(\lambda)}q) = 1$. Thus, if $\alpha \in \Sigma m$ with $P(\alpha) = qk$, then $P(\lambda\alpha) = r$, a prime, while $P(\gamma\alpha) = P(\gamma) + m^{l(\gamma)}P(\alpha) = q(1 + m^{l(\lambda)}k)$ is composite. This is impossible; therefore m is prime to neither $P(\lambda)$ nor $P(\gamma)$, and the first half of the theorem is proven. The proof of the reverse implication is elementary and will be omitted.

We immediately obtain the following:

COROLLARY. *The semigroup of f is free on m generators.*

Proof. The semigroup of f, S_f, is defined by the two sided congruence on Σm where $\gamma \equiv \lambda \bmod S_f$ if for all $\alpha, \beta \in (\Sigma m)^I$ we have $f(\alpha\lambda\beta) = f(\alpha\gamma\beta)$, where $(\Sigma m)^I$ denotes Σm with the empty string I adjoined to give Σm an identity. Let us assume that γ and λ are strings of Σm so that $\gamma \equiv \lambda \bmod S_f$ but $\gamma \neq \lambda$. Then, clearly, we must have $\gamma \equiv \lambda \bmod R$. Let $\alpha = (1)$; then since $\gamma \equiv \lambda \bmod S_f$, also $\alpha\gamma\alpha = \alpha\lambda\alpha \bmod S_f$. But, $P(\alpha\lambda\alpha)$ and $P(\alpha\gamma\alpha)$ are prime to m and unequal. Thus, $\alpha\gamma\alpha \not\equiv \alpha\lambda\alpha \bmod R$. This is impossible, and therefore S_f is free on m generators.

Of course, one immediately deduces from the theorem above or its corollary that $\{\lambda \in \Sigma m : P(\lambda) \text{ is prime}\}$ is a nonregular set since, by definition, this means that the number of reduced states of f is infinite or, equivalently, that the semigroup of f is infinite. Thus, the notion of a regular set is a relatively weak one; in fact, one can easily show that if X is a regular set, then the set X^* of all strings of X with their order

reversed is also regular. However, the reader will easily convince himself that the theorem above becomes quite incorrect if the nonnegative integers are represented to the base m with lowest order digits written last according to the usual custom.

ACKNOWLEDGMENT

We are indebted to E. K. Blum for the information that since this paper was written J. Hartmantis and H. Shank have independently proved that if $m = 2$, then R is the reduced state congruence of f.

REFERENCES

1. M. MINSKY AND S. PAPERT. Unrecognizable sets of numbers. *J. ACM* 13, 281–286 (1966).
2. M. RABIN AND D. SCOTT. Finite automata and their decision problems. *IBM J. Res. Develop.* 3, 114–125 (1959).
3. J. L. LEVEQUE. "Topics in Number Theory," Vol. 2. Addison Wesley Publishing Company, Incorporated, Reading, Massachusetts, 1956.
4. K. KROHN AND J. RHODES. Complexity of finite semigroups. *Ann. Math.* 88, 128–160 (1968).
5. M. A. ARBIB, Editor. "Algebraic Theory of Machines, Languages and Semigroups." Academic Press, New York, 1968.
6. J. HARTMANIS AND H. SHANK. Two Memory bounds for the recognition of primes by automata. To appear.

6

THE SAXL CHARGED TORQUE PENDULUM

Dr. Erwin J. Saxl, in a July 11, 1964, article in the British journal *Nature*, begins as follows:

> Using precisely timed parts of each period of an oscillating torque pendulum, a determination of individual short-time events were made in sequence. The disc of the torque pendulum with which the subsequent observations were made is suspended from an isoelastic wire, the modulus of which is constant to 0.5 parts in 10^6/deg. C. Within the multiple enclosures, the temperature was maintained to + or - 0.5 deg. C. The elastic restoring force of the wire remains, therefore, constant; only the difference is shown that is produced due to the slight winding-up and winding-down of the rotating pendulum oscillates in a Faraday cage which can be charged electrically together with the pendulum.

Saxl goes on to say:

Unexpected phenomena were noted as follows:

(1) When the pendulum was charged electrically with different, carefully controlled electrostatic voltages (together with its equipotential shields), it was observed that positive and negative charges caused different delays. A positive charge caused the pendulum to rotate slower, as a rule, than when the pendulum was charged negatively. The grounded pendulum swung fastest. (There are exceptions to this rule at times.)

(2) The time of swing follows in first approximation a square law with a small negative bias. In view of this asymmetry there must exist, therefore, effects in addition to the usual eddy current damping since the latter would cause a symmetrical time delay.

(3) There exist differences between the influence of voltage on the pendulum at different times. While consistent within themselves, there may be one time-delay in spring and another in mid-summer ...

Saxl continues:

The physicist hesitates to form a working hypothesis for such observations. Having accounted carefully, however, for all other influences, he is driven reluctantly to the conclusion that there may exist variations in g even if such cannot be noted with grounded quasi-stationary instruments. These new effects may become noticeable if geo-gravitic flux-lines are cut dynamically and electrically charged apparatus is used. When working as a post-doctoral student with Einstein, we discussed the possibility that there were interrelations between electricity, inertial mass and gravitation. These experimental results make me wonder whether they may properly be so interpreted.

The author feels that Saxl is correct here and that, moreover, by a straightforward application of the Liu, Yang, Guan, et al Saxl-type experiments [*Physics Letters A*, 244 (1998), 1-3], followed by the theory of Part One of this work, one can show this. First, consider the result of chapter 4, where we noted that in the general two-ion case that Newton's third law failed in this interaction in that if the two ions were considered to be a rigid body, then there was, in general, an out-of-balance force parallel to the line joining these atoms, provided they were far enough apart. We first summarize our results in the two-ion case, where we have atoms 1 and 2 (F_e and F'_e are, respectively, the neo-Spearsian forces of the electron clouds of atom 1 and atom 2 on atom 2 and atom 1, and where these atoms may be ionized):

$$(F_e - F'_e) = (1/2)\ ((Q_e R_e)^2 / r^2)\ [n_1 k_2 - n_2 k_1] / (P + 1)$$

where k_1 (respectively k_2) is the number of protons (not counting neutrons as an electron-proton pair), that is, the atomic number of atom 1 (atom 2). Moreover, n_1 (respectively n_2) is the number of electrons in the atom 1 ion (atom 2 ion). And, of course, if the atoms are not ionized, then $k_1 = n_1$ and $k_2 = n_2$. Now our pendulum disc is going to be chosen as made out of silver, as that is a good conductor and is thought to have exactly one loose conducting electron per atom, and this, of course, means that in this silver pendulum, if atom 1 is silver, the only silver ions that we need to consider are those with one more or else those with one less electron than the atomic number of silver. That is, $k_1 = n_1$ + or - 1.

Now, the weight of the electron cloud (recall we go by the electron clouds because the two nuclei must follow the corresponding electron clouds) is just the sum of all the gravitational forces on it due to all the other particles in the universe, according to Newton's Universal Law of Gravitation, and Spears' theory confirms that in the case where all the particles belong to non-ionized atoms. But in the case of our pendulum, the central player in an object's weight is, of course, the earth itself. And the earth is thought to be more or less electrically neutral. Therefore, it follows that we ought to consider—with Saxl's pendulum in mind—the two cases where (a) the ionized atom 1 is a silver atom of the most common isotope, which is ionized with one less electron than its atomic number, and atom 2 is not ionized, and the other case being (b) atom 1 is an (again) silver atom of the most common isotope but this atom is ionized with one additional electron than its atomic number. Now in our formula above, the determining factor is the multiplicative term $[n_1 k_2 - n_2 k_1]$, and so in the first case (a) we have $n_2 = k_2$ and $n_1 = k_1 - 1$, and so this factor reduces to

$$[(k_1 - 1)\, n_2 - n_2\, k_1] = - k_2,$$

from which it follows that there is a net 'force' away from atom 1 electron cloud and toward atom 2 electron cloud (parallel to the line joining the two), and this net unbalanced force is

$$-[(1/2)\, ((R_e\, Q_e)^2 / r^2) / (P + 1)]\, k_2.$$

But the Newtonian gravitational force of the electron cloud of atom 1 on the electron cloud of atom 2 toward atom 1 (where we now take $n_1 = k_1$, and with all else the same concerning atom 1 and atom 2) is, according to our neo-Spearsian theory, just (again)

$$- (1/2)\, ((R_e\, Q_e)^2 / r^2)\, [k_2\, k_1] / (P + 1)$$

and so the neo-Spearsian unbalanced 'force' of the two atoms system in case (a) is just in magnitude $(1 / k_1)$ times the Newtonian (and also neo-Spearsian) force on the silver atom due to the un-ionized (perfectly general) atom. Thus it follows that in case (a) that if one can calculate the charge on the silver pendulum disc (equal to the disc's capacitance times the potential of the disc in volts, as mentioned above), and then by dividing by the charge quanta of the electron to determine the number of missing electrons, which, in turn, is the number of silver ions on the silver disc (the silver atom being thought to have exactly one free conducting electron), then the unbalanced force making the disc appear to be heavier is simply the $(1 / k_1)$ (number of electrons missing from the disc causing it to have a deficit of negative charge) (mass number of the silver atom we are considering) (mass of the proton), where, again, recall that in computing the gravitational force between two atoms, we are going by the gravitational forces on their electron clouds (see the end of chapter 4). This means that if A is the mass number of the silver atoms we are considering, then the (signed) change of weight of the disc charged to potential V is just

$$M_p\, [(V\, C / (Q_p\, k_1))\, A] = (A\, M_p)\, (V\, C) / (k_1\, Q_p).$$

And it's easy to see that the situation is the same in case (b) as in case (a) except, of course, that the effect will be to decrease the weight of the disc rather than increase it, the magnitude of the (a) and (b) effects being identical.

But what does the weight of the disc have to do with the period of the corresponding torsion pendulum, assuming the moment of inertia is arbitrary but fixed? Well, consider a rubber band twisted: one easily convinces one's self that the untwisting force on this rubber band increases as it is stretched, and so one would expect that the untwisting force on the torsion pendulum due to the disc (whose moment of inertia remains constant) to increase with its apparent weight gain and for its period (its starting displacement being arbitrary but fixed) to decrease with its apparent weight gain, would tend to oscillate faster as its weight increased since the torsion constant would tend to increase. And, of course, vice versa.

However, recall that Saxl's experimental results indicate that when the voltage that the disc is charged to is varied between plus and minus 5,000 volts and the change of the period from the period exhibited at zero potential (grounded), then one gets to the first approximation a square law for the change in period plotted versus this voltage—although the parabola is biased to the negative values of V. This, of course, is not what one would expect based on our analysis just given since that analysis would lead one to expect that the parabola would instead be an increasing curve, as negative voltage meaning negative charge on the disc would be expected to mean less apparent weight on the disc, and so then the period would be greater, and vice versa. However, at the same time we note that the just-mentioned bias toward the negative voltages of the curve, t = f(V), fitted to the data, does tend to indicate that we are on the right track, but that there is another effect, too, that must be subtracted off since g(V) = [f(V) - f(- V)] is a slowly increasing function of the voltage V > 0.

The author's candidate for this extra effect is found in an article by Liu, Yang, Guan, Hu, Wang, and Huang in *Physics Letters A*, 244, (1998) 1-3, entitled "Test of Saxl's effect: No evidence for new interactions." In this article, they describe some Saxl-type experiments they have preformed, and they uncover an error in Saxl's experimental methodology. They state:

> From the results of repeating Saxl's experiment and the careful investigation of Saxl's experimental design, we found that Saxl's effect of the approximate square law was possibly caused by the disconnection of the electro-magnet and the cage and the subsequent inequality of the electro-static potentials. The electro-magnet and Faraday cage equivalently formed a distributive capacitor, and thus resulted in an effective electro-static force *F* due to the potential difference of *U* volts. The motion of the electrically charged pendulum was regulated by this effective force *F*.

They continue: "This shows that the electro-static force due to a capacitor can cause an effect of the Saxl type. Because the electro-static force *F* is proportional to the square of the potential difference (U^2), the curve $T_{1/2}$ plotted versus U should be a parabola, which is confirmed by the fitting of our experimental data." And a curve fitting their data is plotted in their Figure 2 (Change of $T_{1/2}$ versus electro-static voltage (U).), where note that their parabola is **not biased to the left, as is Saxl's Figure 2 plot!** (Also, they fail to mention Saxl's left bias of his data anywhere in their paper.) And this is evidently because they first perform Saxl's experiment with his above-mentioned experimental error corrected, and conclude: "The approximate square law of $T_{1/2}$ plotted versus U observed in Saxl's experiment does not appear in our experiment. The motion of the pendulum was independent of its electro-static potential." But in view of our theory, this is probably because they used a tungsten suspension torsion wire, which is 1.5 mm in diameter, which would **not** likely be very sensitive to small changes of apparent weight of the pendulum cylinder they use (as far as its torsion constant is concerned), whereas Saxl probably used a more weight-sensitive isolastic wire in his torque pendulum, yielding his left bias—but, unfortunately, he does not describe his torsion wire or mention its torsion constant. However, what other explanation could there be for his left bias of the curve fitting his data while Liu, Yang, et al do not apparently observe this bias? (Here we see the benefits of **sound theory**, which points to the correct parameters to be measured.)

Therefore, the author would suggest that the Faraday cage be dispensed with, as to sense electrical effects with Saxl's charged pendulum one would want to jettison the cage, which would shield the pendulum from ambient electric fields, and, moreover, this was precisely Saxl's experimental error—namely, the incorrect use of his Faraday cage. So the above seems to explain the apparent disparity between our expected results concerning Saxl's charged torque pendulum and his actual results: the negative bias noted by Saxl being such that, roughly speaking, the left biased parabola of f(V) corresponding to Saxl's data basically agrees with (to first order) the parabola of Liu, Yang, et al mentioned above when shifted appropriately to the right.

Now, of course, we have been assuming almost all along in this chapter that atom 2 was not ionized, but, as Saxl

points out in the conclusions of his paper, in the case of (for example) some minutes before a big earthquake, powerful electrical effects have been often observed, which could be used to provide warning that such a large quake was going to happen soon. And our theory, if substantially correct, should give a good basis for investigating such powerful electric effects, as it may additionally be used as a tool to handle the case where the earth under or near the charged torque pendulum sensor has become charged, too, and to what extent. At last, it would appear that all the variables germane to this earthquake early-warning idea of Saxl's have been incorporated into a relatively simple and straightforward theory, and it seems that the design and building of such a warning device can proceed using the neo-Spearsian theory developed in this book!

Correction for pages 30-31

The Biefeld-Brown effect has now been shown to actually be an ion wind effect in that when the air is evacuated from around the charged and suspended capacitor, the effect ceases; however, this effect (in air) completely dominates and is of a much lower order than the effect we are actually considering in this work and so masks it. We would like also to point out that this effect was only used for motivation, and our results here do *not* lean upon it!