14 Harnessing Earth-Ionosphere Cavity Energy for Wireless Transmission

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Fundamental Excitatory Modes of the Earth and Earth-Ionosphere Resonant Cavity

Some of the principles of geologic precursor and meteorologic frequencies in the extremely low frequency (ELF) range of the electromagnetic spectrum and the possible relationship to the occurrence of earthquakes and volcanoes are explored. Monitoring of electromagnetic waves and magnetic fields has indicated the presence of characteristic natural and unique ELF frequencies which precede *seismic events*.

We have gathered extensive ELF magnetic field data from 1979 to the present time in many locations on the North American continent before the eruptions of Mt. St. Helens. The pre-eruptive and eruptive phases of Mt. St. Helens in the state of Washington were observed and analyzed in detail. Our system was on-line in the Portland, Oregon area, 40 miles south west of Mt. St. Helens, from 1979 through 1983 and on line in the San Francisco Bay Area from 1984 to the present.

Field measurements have augmented the permanent station data. The detection system utilizes a 150,000 foot antenna wound on a coil form adjacent to a very high permeability mu metal and the signal is passed into unique electronic processing elements which amplify and smooth the signal for flat response and permit readout and analysis in the time and frequency domains. The coil is electrically shielded so that pure magnetic field intensities are observed. The long-axis coil-core system allows directivity as well as high sensitivity. These are the main elements in the T-1050 detection system.

We have observed that characteristic ELF magnetic field oscillations with Earth rotational periods from 1.2 to 1.8 Hz, determined theoretically and subsequently measured at around 1.56 Hz with first harmonics of 2.9 to 3.8 Hz appearing in the Americas which grow greater in amplitude and then disappear from 24 to 72 hours preceding a geologic event. The amplitude of these oscillations is roughly proportional to the distance from measurement to event site and event magnitude. Multi-station detection could forecast locations, time and magnitude of impending events.

We also present some of our theoretical calculations related to the description of coherent collective modes of oscillation in the earth and earth-ionosphere resonance media. We will also examine some of our work in relation to Tesla's wireless energy transmission concepts of harnessing earth-ionospheric cavity energy.

Introduction

Extensive monitoring in areas of the Pacific Northwest during the period of time from early 1979 through late 1983 was conducted by Van Bise. The measured signals showed significant correlation between the volcanic activity of Mt. St. Helens and a range of frequencies between 0.1 and 30 Hz, with the frequency of approximately 3 Hz corresponding to, presumably, magmatic pulsations which preceeded eruptive events. Researchers at Portland State University examined the volcanic ash after the May 18, 1980 eruption and found the ash contained 30% of a material similar to magnetite. In the state of Washington on Sunday morning, 8:32 AM, Pacific Daylight time, May 18, 1980, Mt. St. Helens erupted in a cloud of fire, ash, steam and particulate matter that launched a half a cubic mile of this matter laterally and one quarter of a cubic mile of the volcano's mass was ejected vertically, to a height of 10 miles. When this event was complete, 1,000 feet of the mountain had disappeared and 60 people were dead. Future deployment of detection equipment such as is described here could prevent such a loss of life. [1,2,3]

Since then Rauscher and Van Bise have monitored ambient field impulses in California and many other areas of the United States and Canada. The data show a significant correlation with specific signatures which preceded earthquakes and volcanic eruptions. The pattern of signatures always ceased some 24 to 72 hours before such an event occurred.

Equipment used consisted of a calibrated T-1050-L-H magnetic field detector with a lower frequency range from 0.01 Hz to 300 Hz and a sensitivity factor of 10^{-10} gauss (Low pass system) and a higher frequency range from 1.0 Hz to 50 KHz at 10-6 gauss sensitivity (High pass System) was developed and employed at Tecnic Research Laboratories. The detector specifications are given in more detail later in this paper. Other equipment included a custom designed electrostatic voltmeter, a field intensity meter and two spectrum analyzers. [4,5,6]

The natural planetary impulses and vibrations preceding geologic events suggest that work with multi-station detection can lead to the successful development of an earthquake-volcanic eruption early warning system. We use our magnetic field detector to measure magnetic field changes, some of which reflect oscillatory modes of the earth. These modes of oscillation can be detected as seismic magnetic and electromagnetic pulsations of the earth and earth's surface which move in the earth's normal static magnetic field and the Earth's ionosphere resonance cavity. Movement of magmatic material with ferromagnetic (magnetite) inclusions and corresponding ionospheric changes in turn affect and produce flux fields which affect the entire earth ionospheric processes. [5,7]

In this report, the authors present experimental field data and their analysis and theoretical models demonstrating possible mechanisms of the dynamic earth processes. We also examine the relationship between the results of these data and Tesla's wireless energy transmission concepts.

The ground wave and the ionospheric wave are set up in such a manner as to produce the predicted 1.57 ratio to the velocity of light which was stated by Tesla in one of his 1905 patents. [8] In his model, Tesla treated the earth as a finite capacitive reactive component surrounded by an ion shell of variable altitude, beginning at about 50 km in height, which represents a system whereby a resonant ringing signal can be set up and transmitted. Although the system represents a leaky capacitor with a Q of about 4 to 5, it is possible to set up a resonant state so that it appears as though a signal is transmitted and received from any two points on the earth's surface. In actuality, according to the Rauscher-Van Bise model, the signal is not "transmitted and received," but represents a non-local global coherent state. Any event which can "wiggle" the static earth-ionospheric magnetic flux is transmitted as both a local and non-local influence.

In 1966, Rauscher determined the relationship expressed by Tesla in the Colorado Springs Notes in which he utilizes the dimensions in centimeters to represent the units of inductance, "L" in henries and capacitance, "C" in farads. This conversion factor system has been found to be crucial in understanding the principles involved in Tesla's Colorado Springs experiments. The purpose of the experiments and why, to this day, they have never been successfully completed is given. Also explained in detail is the interpretation of Tesla's work and the operation of his wireless energy device. Rauscher presents the mathematical principles germane to producing ball lightening from a fully ionized resonant stable plasma. [9] This research is summarized in this report and is detailed more completely in other papers. [9,10,11,12]

Tesla's Colorado Springs experiments are examples of a class of coherent state experiments and other experimental examples are discussed. Although much of Tesla's notes and data were lost, "confiscated" or presented briefly and in a cryptic manner, enough information exists to reconstruct some of Tesla's principles and his planned experiments so that we can describe the unfinished phase of Tesla's work. [13] The Tesla materials relevant to this presentation is from the time period of about 1897 to 1910.

Tesla's Vision

In 1905, Tesla described the earth as a finite small capacitance with regard to frequencies in the VLF region, and a resonant LRC system to ELF frequencies. He had hoped to utilize the VLF and ELF frequencies in concert simultaneously to provide a very large conduit through which nature's vast reservoir of electrical forces could be routed for the benefit of mankind. Tesla observed that nature's electrical system is activated by lightening storms or through other meteorologic and geologic activity. The type of system originally designed by Tesla could have acted as a "great energy siphon" by exciting the ionosphere and intervening media and then, by tapping into the flow of this immense reservoir of energy and tunneling it down to earth stations, mankind would today have all the "clean" energy necessary with which to put his machines to work. Tesla's visions, confirmed by his experiments at Colorado Springs in 1899 and by his life-long extraordinary ability in constructing electrical and mechanical devices, led him to develop ideas and concepts for his wireless energy transmission which he described in his patents and papers. In his words,

> *Now that I have discovered that, not withstanding its vast dimensions and contrary to all observations heretofore made, the terrestrial globe may be in a large part or as a whole behave(s) toward disturbances impressed upon it]n the same manner as a conductor of limited size; this fact being demonstrated by novel phenomena which I shall hereinafter describe. [8]*

With the formulation in this patent, Tesla treated the earth as a finite capacitor and as an element of a circuit. Through the legalities of patent law, Tesla had patented the earth! Use of his device to harness the energy of the earth was not to be, however, and we may be poorer for this undeployed natural resource. He had exclusive rights to the planet-ionospheric energy for 17 years and we, the people, re-own it by now as it is in the public domain. One wonders what our world would have been like had Tesla's vision come true and his "magnifying" transmitter had been deployed.

Tesla had developed the techniques and conducted experiments on the transmission of information through space before the turn of the century. Tesla, not Marconi, was the first to invent the radio and after his death in 1943 and after a review of the claims and dates given by Tesla relating to the invention of wireless communications, the Patent Office conceded that Tesla had indeed preceded Marconi and was actually the inventor of what we now call radio and television communications. Little serious research has been conducted on his effort to develop a wireless energy transmission grid or to examine the relationship between his work at Colorado Springs and Wardenclyffe, New York. Tesla's research from his Colorado Springs Notes and his work in the design and construction of the tower at Wardenclyffe are examined in relation to our current research. [14] We present our interpretation of these experiments and some of our data on measurements of earth resonant phenomena taken over the last eleven years.

Both authors have been interested in Tesla's research and related work since our early teens. It is interesting, in looking back over one's life, how various pieces of different puzzles began falling into place. [15] Our ideas and research on earth resonant phenomena and some possibilities for wireless energy transmission, both natural and man-made appear to complement those of Tesla.

We suggest that a system which involves a pulsed AC system in a high DC potential can create a "steady state." In Tesla's words in 1934

> *Most people, and not a few electricians, will think that very long and noisy sparks are indicative of great energy, which is far from being the case.*

In fact, at Colorado Springs, Tesla ran an AC system and raised and rotated a capacitor ball on a swivel utilizing the natural DC potential charge and discharge characteristics of the earth.

The Colorado air sustains a high potential before breakdown. The purpose of Tesla's experiments were to build up a voltage to achieve resonance; the necessary voltage was often not attainable from the local AC power generators since over voltage breakdown would occur before the necessary potential could be achieved. Needless to say, the problems created at the local power station by Tesla's experiments did not endear him to the power company or the people living in the area--even though he invented the power system!

Tesla carried on extensive correspondence with his laboratory workers in New York as his work progressed at Colorado Springs. His plan was to use the Colorado Springs laboratory as a resonance generating station and use the system to be built in New York as an amplifier and receiver. Work commenced at Wardenclyffe in 1901 at Shoreham, Long Island. Work on this project was never completed due to lack of funding. In Tesla's words,

> *My wireless tower on Long Island carried a sphere which had a diameter of 67 1/2 feet and was mounted in this manner. It was charged to 30,000,000 volts by a simple device for supplying static electricity and power.*

The key concepts are that it was a static, high voltage device. Later he compared it to a Van de Graaff generator. He also explained the purpose of Wardenclyffe to be that "one does not need to be an expert to understand that a device of this kind is not a producer of electricity like a dynamo, but merely a receiver or collector with amplifying qualities."

We have calculated the proper spacing to produce and receive a signal resonant with the earth. The location of Colorado Springs and the Wardenclyffe tower are in the proper relationship to produce earth-ionosphere resonant waves to achieve Tesla's desired results for worldwide communications and an enormous energy system.

Again in Tesla's words, this system would "not only (make possible) the instantaneous and precise wireless transmission of any kind of signals, messages or characters, to all parts of the world, but also allow the inter-connection of the system, telegraph, telephone, and other signal stations, without any change in their present equipment." Again, his stated purpose was to free the human race from forced labor and to create a time when "rich and poor no longer meant differences of materials conditions but of spiritual capacity and ambition--a time when inter-communication all over the earth should be immediate and universal and even when knowledge should be derived from sources now hardly imagined."

Rauscher and Van Bise formulate a simple model involving a resonant system which sets up a ground and air wave that would be simultaneously emitted and would add by resonant reinforcement. In the following and necessarily incomplete analysis we consider two interactive waves of similar but different frequencies. The analysis proceeds as follows.

In calculating the velocity ratio of air and ground waves, one approach is to consider an air (earth ionosphere) wave travelling at v_2 and a through-the-earth wave traveling at v_1. Consider two waves emitted from the same location on the earth's surface, one in the air and the other through the earth and both traversing paths in the same time so as to come back to the emission location as reinforced. The path length for the air wave is πD and the through-earth wave is 2D. For equal time of travel, the velocity becomes $v_2/v_1 = \pi/2 = 1.57$. In this analysis, the greater velocity wave, v_2, is the air wave. If v_1 is chosen to be the velocity, then the relative velocity (v_2) is $\pi/2 = 1.57$ times the speed of light. We could also consider the velocity v_2 as the velocity of light and then v_1 is $2/\pi = 0.64$ smaller than the velocity of light.

In Tesla's patents he makes it clear that the ground wave is the more rapidly travelling wave and the air wave is an electromagnetic wave travelling at the velocity of light. The above analysis is therefore not consistent with Tesla's model. In fact, there would be a mixing and reinforcing of a phonon/earth wave and an electromagnetic wave in the rarefied air and interaction. Therefore the above simple geometric problem does not apply. The problem, in fact, invokes phonon (longitudinal) and transverse electromagnetic wave interactions, as discussed in the next section.

Before proceeding further, any calculation involved in developing design parameters based on Tesla's work, needs examination in the light of two expressions in order to understand his calculations. In the Colorado Springs notes (1899-1900), Tesla obtained expressed quantities of capacitance (normally expressed in farads) and inductance (normally expressed in henrys) in terms of cm. For example, on June 28, 1899, he calculated the capacitance of the secondary with 26 turn windings as C = 1200 cm with the self inductance of $L_1 = 9 \times 10^6$ cm with a resonant frequency at 93,458 cycles/sec (Hertz). If we are to apply his calculations, we need to construct a system from E.A. Rauscher's research (from 1966) as capacitance C in cm is related to farads as $l(\text{cm}) = \pm\sqrt{Q^2/mf^2C} \propto 1/\sqrt{C}$ so that $\text{cm} \propto 1/\sqrt{\text{farads}}$ where Q is the charge, m is the mass, f is the frequency of the system. Unit dimensions are given as $C[m^{-1}/l^{-2}t^4I^2]$ where I is the current.

For Inductance $l(\text{cm}) = \pm\sqrt{Q^2/mf^2L} \propto 1/\sqrt{L}$ so that $\text{cm} \propto 1/\sqrt{\text{henrys}}$ for charge Q, mass m, frequency f, and inductance L, with unit dimensions $L[m^{-1}l^{-2}t^5I^2]$. In the square root relations we utilize the plus solution in both cases. For example, for calculation of capacitance of a hollow conducting sphere with a radius of approximately 250 cm, which can accomodate five million volts charge, the cm equivalent capacitance is 2.9×10^{-4} microfarads. The electricity created will be about 1.45×10^{-3} coulombs, depending on the material in the capacitor. [13,16,17]

Energy and Field Resonances in the Ionosphere and Tesla's Proposed Wireless System

As the earth rotates it carries with it all of the kinetic energy of the earth as well as its steady state magnetic field, particulate matter and the atmosphere in decreasing densities out to and through the most rarefied strata above the various layers of the ionosphere. At the same time, all of the natural and artificially generated mechanical, electric, magnetic, acoustic, thermal and gravitational energies at fixed or moving locations on or within the earth, are adding to or subtracting from each other for resonant and anti-resonant nodes as the rotation of the earth carries and drags these energies essentially past a fixed radiant zone illuminated by the sun and its solar wind, which we define as the magnetosphere and the ionosphere.

The ionosphere-magnetosphere-earth system can be treated as though it were in dynamic equilibrium over archeological time, but as subject to significant local and nonlocal effect perturbations waxing over intervening periods. Other treatments of the potential energy available from the earth up to the ionosphere have involved calculations based on theoretical models and measurements and which deal with the problem of the intervening short periods of time and address the local perturbations as observed and measured by relatively crude instruments within these perturbations. A satisfactory solution which resolves theory, observation and experiment in a self-consistent manner does not yet exist in the literature [17].

We therefore present the following simple calculations based on archeological time and a dynamically equilibrized earth-ionosphere system. The numbers given yield a rough approximation of the potential energy available but the figures are probably conservative since we have not taken into account the well known electrojet-Hall current contributions to the total energy.

We also have not taken into account the Peltier and Seebeck effects, the former occurring at the leading and the latter occurring at the trailing edges respectively, of the earth-ionosphere interface. Thermal energy from the SUN meeting the cold junction of the leading edge of the ionosphere would generate a potential difference and dynamic current as a Seebeck effect. Conversely, the trailing edge Seebeck voltage would be affected by the Peltier junction thermodynamic difference as they trail off into the night-side cold. The night-side hemisphere magnetospheric flux line excitations from the sunlit hemisphere ionosphere-magnetosphere-earth excitation would facilitate transfer of power at the night-side. These effects would give rise to significant local and non-local ionic current flows. An earth-ionospheric interface transverse Hall voltage would be a natural result of the Peltier-Seebeck effect generating earth-ionospheric circulating currents, and these factors are also left out of our potential energy calculations. Nevertheless, the amount of potential energy available within the earth-ionospheric system, if it could be harnessed, is surprisingly large.

The frequency differential between the North American power grid and the European/Asian power grid may also produce unique effects. The 60 and 50 Hertz differential produces a 10 Hz sum and difference frequency ($2 \times 60 = 120 - 50 = 70$ Hz near the Navy project ELF Center frequency). [18]

A great deal of power is being transmitted or pumped into the atmosphere from power line losses as I^2R drop is emitted into the earth-ionosphere cavity, which acts as a leaky but extremely large capacitance. The earth-ionosphere represents two plates of a moving variable capacitor of roughly 24,000 by 24,000 miles area separated by an approximately average distance of some 108 miles.

A simple calculation based on the half sphere of the sunlit hemisphere of the earth shows that the capacitance of the hemisphere from the ground plate up to the D region "plate" of the ionosphere where the peak electron density exists to 65 km (about 108 miles) is approximately 7,568 microfarads.

From the formula $C = (22.45\ KA(N-1))/(10^8 t)$ where C is in microfarads, K is the dielectric constant of free space with a value of 1, A is the area of one plate in square inches, N is the number of plates and t is the thickness of the dielectric in inches.

Using an average value of 100 volts per meter increases in the vertical field at the earth's surface up to 65 kilometers, we have 6.5×10^6 volts per unit meter. Twelve thousand miles is 14,400 meters, and for 14,400 meters squared the available potential is about 1.35×10^{15} volts.

Applying Ohm's law for power, we have $P = E^2/R$, where E^2 is the electric potential in volts for 14,400 meters squared and R is the free space impedance in ohms and since R is about 377Ω, we see that 3.575×10^{12} watts potential is available if it is possible to produce a dynamic resonance motion in the electrostatic potential. By definition, 746 watts is equivalent to 1 horsepower, and for a dynamic resonant earth-ionosphere, the potentially available horsepower on a sunlit hemisphere would be about 4.79×10^9 horsepower!

These factors and radio-television communication systems as well as satellite systems produce extremely complex energy production and re-radiation processes. Certain particular systems can become *locked*; that is, interaction of energy systems with each other and natural sources may become resonantly coupled or locked. Some of this energy resonates in the ionosphere and some is transmitted from this system which has a Q of 4 to 5. The Q is defined the "figure of merit" or the ratio of the energy stored over the energy dissipated. The transmitted power that does not escape forms frequency mixes such as 10Hz and the odd and even harmonics of the 50 and 60 Hz power systems. These frequencies form a complex based on physical areas of emission from the earth and day/night effects.

The observed ELF artificial impulses in the environment lead one to speculate that such pulses may be the result of a device [19,20] similar to the one envisioned by Tesla and which he described as a magnifying transmitter. By means of such a device, high potential stored electric charges should be able to be converted to propagating magnetic wave resonances between the earth's core, the ionosphere and the magnetosphere. Such conversion, if done with sufficient precision, would make it possible to realize a gain of acousto-electric energy by matching and utilizing the approximately 1.5 Hz rotational vibrations set up in and above the earth as it moves on its axis in its orbit around the sun.

The magnifying transmitter, according to Tesla, was to facilitate worldwide communications while at the same time it could be used to transmit electrical power without wires to ground stations on the globe which are suitably designed for resonance and are connected to a power generator. The local power generators would of course have step down transformers and meters and wires for distributing 97% efficient electric power to a convenient radius of customers. Power would still have to be metered and sold but at considerably lower rates. The I^2R losses would be minimal however, although maintenance to the ground generators would be necessary.

The earth's magnetic field lines describe minute motions due to micropulsations set up in them as a result of this rotational vibration. As is known, a moving magnetic field produces a current in a conductor. The earth's core is the likely conductor which would be expected to respond to these minute field variations.

Although the magnetic field of the earth is of small intensity, (about 0.5 gauss in the mid-latitudes) [21], the very large volume of the conductive core and the even larger radius of the surface magnetic field lines, provide a system with a great volume of electric current circulating in it.

Another potentially usable volume of electric current exists in the earth's magnetosphere. Some 10^{12} watts exist as the result of the magnetosphere. The combined electric power potential available from the ionosphere-core-magnetosphere is about 4.5 times the world's electric generation capacity! The major problem seems to be development of a method to gain access to these systems of electric currents.

We believe that Tesla had solved this problem in his experiments in 1899 at Colorado Springs. [13] By means of a specially constructed electrical detection system, he observed stationary waves showing that the earth behaved as a spherical conductor with finite dimensions and he also found that high potential, tuned circuits capacitively coupled to the earth developed two wavelengths when resonance occurred.

A spherical conductor mounted on an insulated pole served as the electrically elevated terminal which emanated radio waves that obeyed the ordinary formula for wave length, where the frequency divided into the speed of light yielded the length of the waves. However, the earth terminal, coupled to the secondary of a critically tuned inductor through a low value capacitance of special design, ostensibly propagated waves at the same time which were longer by a factor of about 1.57 times the velocity of light, or some 40% to 60% greater in length [19]. Tesla said that the Maxwellian electromagnetic component from the elevated terminal would become negligible as resonance of the earth's core and ionosphere developed. The magnetic flux from Earth's steady state can be "strummed" communicating such phenomena as "pearls" or vibrating magnetic flux density increases at nodes and anti-nodes and the vibrations propagate almost with no delays. [7]

The elevated terminal was to be specially constructed with a unique and very large radius of curvature in order to raise the electrical pressure extremely high and to store it there by virtue of its own electrical attraction until released into the air and ground terminals in a pulsed manner. The initial primary current would be of very large magnitude until the condition of resonance was struck on the earth's half sphere radius, after which the primary current could be expected to lower to a more practical value.

The earth-ionosphere was evidently envisioned by Tesla to be able to be treated, in certain electrical cases, as a lossless transmission line containing kinetic energy from its rotational motion which would be able to be utilized with a magnifying transmitter. The air above the elevated high potential terminal would offer the conductive path to the lower ionosphere by virtue of pulsed ionizations of the air molecules directly above this highly charged terminal. All vehicles could operate on electrical power and aircraft could fly on electrically driven motors and none would ever cross the ionization paths due to repulsion effects and thus all could be collision-free.

In order to gain access to the closed earth magnetic field core system, the period of the wave from the transmitter would have to be carefully controlled and would have to be somewhat below 20,000 Hz down to a low of 6 Hz or cycles per second, for practical utilization.

Furthermore, the time interval (on/off time) of the wave train excitation should be between one eighth and one twelfth per second. The electromagnetic component, free space, half wave length and longer magnetic half-wave length would thus be able to couple in a heterodyne manner--"mixing" in a constructive interference pattern at each half wavelength around the earth from the transmitting device producing larger magnitude effects. When these two waves couple, a lateral travelling wave plus a vertical standing wave should develop. By carefully adjusting the repetition rate and impulse duration, these transmitted dual waves may be "latched" onto or ride on the earth's magnetic field lines. The vertical wave might then begin to move in a path through the earth and out into space again, gaining kinetic energy (harmonic pendulum effect) from the earth's mechanical/rotational vibration system. These dual waves of the same period but of different lengths, interacting, may be sufficiently compressed to exhibit plasma-like wave circulation forms which could fit the criteria of a macrocosmic soliton-antisoliton. Solitons or solitary waves are dynamic entities that are localized in space and retain a fixed shape or form. Nonlinear recohering terms in the wave equation describing soliton-like behavior overcome dispersive losses so that the wave appears non-dissipative in space. The amplitude of these wave-like quantities is proportional to their velocity.

Tesla had stated as early as 1904 that the mode of excitation and the action of his magnifying transmitter may be said to be diametrically opposite to that of an electromagnetic transmitting circuit. He described the magnifying transmitter circuit as a device which acts like an immense pendulum, indefinitely storing the energy of the primary exciting impulses and impressing upon the earth and its conducting atmosphere, uniform harmonic oscillations of very great intensities. He also said that the electromagnetic radiations of a properly tuned magnifying transmitter would be reduced to an insignificant quantity. In addition, Tesla said that a number of distinctive elements put together in a manner analogous to the human nervous system, would enable the magnifying transmitter to send, simultaneously, many thousands of encoded messages without serious mutual interference [22].

Tesla had predicted 95% to 98% efficiency in the transmission of electrical energy without wires via his magnifying transmitter. The primary currents, however, would be very large and require a substantial amount of input energy. Once electrical resonance was established with sufficient energy expenditure, Tesla felt that the sustaining of large current-carrying standing wave ionized paths on the planet, could provide almost lossless transmission channels.

The frequency of about 30 Hz is an interesting one in view of Tesla's writings regarding earth-resonance and his magnifying transm]tter. He noted that the ground terminal would produce waves with a length: $\lambda = (\pi/2)c\upsilon$, while the elevated terminal would produce waves obeying the ordinary formula $\lambda = c/\upsilon$, where c can be taken as the speed of light in free space {2.99 (10^8) meters/sec} and υ is the frequency of the pulses. At 30 Hz then, the ground wave length would be 15,707.96 kilometers and the free space wave length 10,000 kilometers (see also Appendix I). Monitoring has indicated that about 30 Hz waves exist over vast areas of the North American continent and maximum intensities appear both from overhead and below a vertical coil orientation as if the core and the ionosphere-magnetosphere were being excited.

The distance from the surface of the earth to the inner core is about 6,370 kilometers and, interestingly enough $\lambda/4$ at 30 Hz in free space is 2,500 kilometers while $(\pi/2)\lambda/4$ is 3926.99 kilometers. The sum of these quarter length waves is 6,426.99 kilometers, almost exactly the distance from the earth's surface to the inner core for $\lambda/2$. If one assumes that a phase velocity delay occurs both from the core up to the surface of the earth and from the magnetosphere, at ten earth radii, down to the earth's surface, a vertically oriented acousto-electrohydrodynamic cylindrical wave may develop along a boundary layer near the earth's surface with its uppermost boundary extended some $\lambda/2$ or 5,000 kilometers. The configuration would resemble a "slow moving" standing wave. Heterodyne-like patterns may be expected to occur which can be measured and the converging up waves and down waves would be able to produce magnetosonic waves near the surface of the earth, which, at times, might reach the audible range as "clicks" and "booms."

Analogies in physical optics might be applied to the concept of a single source frequency with two different wavelengths existing simultaneously; they are the phenomena of birefringance and double refraction [23,24]. It is also possible to consider selective resonance absorption, also known as restrahlen and sometimes referred to as "ghost rays," which we have observed in two of our midnight (graveyard in Portland, Oregon and Skull Valley, Arizona) ELF measurements. These residual rays can be produced by molecular rotation (which is related to magnetic rotary power and magnetic rotary dispersion) [25]. Though resonance absorption is usually associated with optically active absorption bands [26], it is possible to extend the relationship of the optical equations into the ELF regions.

It is known that the index of refraction varies with the wavelength of refractive waves [27]. The earth's core and ionosphere-magnetosphere may be able to be treated as a single-system special case of a dense-rarified reflective medium which may show an anomalous dielectric constant under the condition of resonance. The usual description for absorption and selective reflection defining a complex angle of refraction is $\alpha + i\beta$. Absorbing media can be described by the complex index of refraction $n(1-ik)$ and the wave traveling in it damps and introduces a phase shift between the parallel and perpendicular polarized components of both the transmitted and reflected wave producing elliptic polarization. If $k<<1$, the medium is weakly absorbing, and if $k\sim1$ or $k>>1$ and $\sinh\beta>>1$, wave penetration is only on the order of a few wavelengths. The relationships are paradoxical, ie. a strongly absorbing medium is one which rapidly attenuates the part of the electromagnetic wave that penetrates inside it, but since most of the electromagnetic wave is reflected from its surface, a strongly absorbing medium is really a poor absorber, if measured by the fraction of the total electromagnetic wave energy absorbed. At about 30 Hz, the earth elastic-acoustic wave and the ionosphere magnetic wave couple at the core. Thus about 30 oscillations are able to be sustained by the kinetic energy of the planetary rotation, which fits our observation.

During field measurements in 1979 and 1980, a curious anomaly was discovered about one mile east of the Bonneville Dam in Oregon, in a region where no 30 Hz waves were found. The complete area of absent waves was not plotted but the measurements indicated that a "hole" existed beginning at about the Eagle Creek fish hatchery and stretching approximately east south eastward. It is possible that a resonance of the earth-ionospheric cavity might cause resonance absorption bands at nodal locations on the earth's surface. In the case of ELF resonance absorption, the reflection-absorption-retransmission zone would be of large radius and could possibly result in a photon-phonon gyroscopic spin wave effect [28,29]. The spin processional frequency of waves may be sustained by a given absorption producing frequency as long as the driving pulse intensity is present at a given threshold level. The damping factor will be reduced, perhaps to the degree necessary for sustaining a spatial soliton wave [30,31,32]. Latent effect periods (delayed re-emission) would occur and depend upon pulse duration and repetition rate. When pulse transmissions change in frequency, the waves may damp momentarily and at times might precess to a rate that could match the vibrational rate of various piezoelectric geologic materials such as quartz, which might induce earth movements (volcanoes and seismic activity).

Since it is well known that a difference in phase in field intensity and polarization is always accompanied by energy absorption, it may be that ELF magnetic field resonance absorption effects cause far-field electric vector effects (earth to ionosphere E-field) and may produce a near-field, high-intensity magnetic component at even wavelength distances from an ELF source. At the same time, a high intensity electric field may produce as a far-field effect magnetic pulses at each quarter wavelength distance from the electromagnetic emitter source. If ELF absorption effects exist at areas on the earth's surface as a result of core-ionosphere-magnetosphere excitations, the energy may be retransmitted from those areas at substantially greater intensities than the intensity of the pulsed energy originally absorbed. This would be seen as abnormally high electric field intensities.

Examples of real time data covering a period of time from 1979 through 1986 are given in Reference 14, and a few illustrative examples are given in Appendices I and II. Experimental field measurements in the ELF-VLF frequency ranges were begun in 1972 and in that year, an approximately 10 Hz infrared frequency shift pulse was detected in the summer day-lit sky around noon and 4pm from a monitoring station in Portland, Oregon. The pulse was only on at intermittent intervals during the day for the next few months, then the pulse disappeared. In late 1975 and officially in July 1976, the 10 Hz pulses of the "Russian woodpecker" [33] came on the air and has remained on the air until the present time.

In the late summer of 1979 other artificial signals came on the air with repetition rates of 15 and 30 Hz. In November and December 1979, monitoring in the Pacific Northwest yielded magnetic signals of many different waveforms and frequencies mixed in with 10 Hz, 15 Hz and 30 Hz.

Many signals of natural and artificial origin coexist and synergistic effects between the natural resonances and man-made energies allow us to make a working hypothesis of the electromagnetic hydrodynamics of the earth-ionosphere, particularly with regard to geologic activity and weather.

Some of the artificial impulses have been interfering with lawful communications worldwide since 1976. Significant interfering electromagnetic signals were found on the 3 to 30 megahertz (MHz) bands and are usually pulsed at an on/off rate of 10 per second. The 10 Hz signals may have resulted from what the Soviets have admitted to be "radio wave experiments." They presumably originated somewhere east of the Baltic Sea. Some of these signals were seen to be phase and pulse width correlated with magnetic waves. Since July 1979, variable pulse width magnetic waves of approximately 10, 15, and 30 Hz resembling pulse time modulation (PTM), along with data-like impulses, were also observed with intensities exceeding an order of magnitude above the earlier observed natural signals in this frequency range, with an amplitude of about 100 to 150 microgauss (μG). As earlier stated, most of the artificial magnetic waves in the 10 to 30 Hz range were observed to propagate at maximum amplitudes in the vertical direction, suggesting the possibility of altered earth-ionospheric resonance excitations.

We have examined the characteristics of some of the natural waves and, as we have already noted, related these frequencies and wave forms to some of those hypothesized by Tesla. We have also examined some of the artificial, man-made signals as perhaps emanating from a modern variation of a device patented by Nikola Tesla in 1905 and which was termed a magnifying transmitter. (See data in Appendix I).

Measurements of Magnetic and Electromagnetic Pulsations in the ELF Frequency Range

The device we used in making our magnetic field measurements is described as follows. The T-1050 field detector operates on the principle that a coil of conducting wire, insulated and consisting of some 150,000 feet of #44 AWG wound on an insulating spool form with a high (μ) permeability mu-metal material adjacent to the inner windings, responds to a fluctuating magnetic field; or, if the coil is moved in a static magnetic field, it will respond to the field in a dynamic manner [34]. In either case, coil response to magnetic field fluctuations results in the generation of fluctuating voltages. The voltage is proportional to the number of turns of wire and the dimensions of the coil, the permeability of the mu-metal material and the magnitude of the magnetic field.

The sine of the angle of the "cutting" of magnetic field flux lines is another important factor in the sensitivity-frequency response characteristics of a coil-core type of magnetic field detection system. Slow moving magnetic flux changes in the coil, such as would be the case at frequencies below 1 Hertz, will induce a much lower voltage at the coil output than, for example, magnetic fluctuations moving at a 100 Hertz rate. There is an order of magnitude difference between 0.1 Hz and 1 Hz, but there are about three orders of magnitude of decreased sensitivity between these two frequencies and less than an order of magnitude (about three times less) between 1 Hz and 100 Hz.

In a coil system such as used in the T-1050, the resonant frequency of the coil-core is about 48 Hz; normally the resonant frequency is determined by $f_R = 1/(2\pi\sqrt{LC})$. Ordinarily the inductance L and the capacitance C in radio frequency circuits are directly calculable by the above formula. However, in a coil-core magnetic field detection system, other complicating factors are introduced, such as the permeability of the core, the distributed capacitance of the wire over its length, the magnitude of self induction relative to the induced back electromotive force and non-sinusoidal wave fronts acting on the coil-core, etc. These are some of the problems which need to be addressed when utilizing a coil-core type of magnetic detection device system. These are dealt with in the equalization, filtering and amplifying networks following the coil-core generated voltages. We take advantage of the fly wheel-like storage capabilities of a coil system and feed the coil generated voltages through carefully designed electrical networks to achieve extraordinary sensitivity and equivalent frequency response. The Faraday shielded coil allows us to "trap" the E-fields generated internally from the moving B-fields on the coil windings and utilize this energy to "MASE" (Magnetic Amplification of Stimulated Electrons) the sensitivity and frequency response. The T-1050 detection-equalization-amplification network following the detector coil-core sensor well accommodates real time wave shapes, forms and frequencies for ready analysis with spectrum analyzers, oscilloscopes and other instruments. In spite of the complexity of the above addressed problems which the T-1050 solves, its operation is straight-forward. We have examined the magnetic field flux with both shielded and unshielded coils. The shielded coil allows the pickup of varying magnetic lines of force only without electric field components. By using shielded and unshielded coils in simultaneous measurements, we can examine the E field contribution at ELF frequencies, even though externally generated E-fields contribute very little energy below about 300 Hz. [34]

We have been making magnetic field measurements for over twelve years. One of us (Van Bise) has been observing an approximately 31.5Hz ambient signal since 1979. We began monitoring of magnetic signatures on a regular basis, observing a signal of about this frequency since the end of 1983. We used a Spectral Dynamics model 335-B Spectrascope II real-time spectrum analyzer with a range of 0.06 Hz to 50 KHz to analyze the frequency components of detected ELF (extremely low frequency) and VLF (very low frequency) signals. With careful analysis, the 31.5 Hz signal was determined to be at 31.4 Hz. Note 2 x 1.57 = 3.14, which is π, which is what led us to consider the relationship of this frequency to the Tesla $\pi/2 = 1.57$ ratio. Even before making more accurate measurements with our spectrum analyzer, Rauscher predicted using Tesla's approach, that the 31.5 Hz signal was 31.4 Hz. The following analysis is intriguing but perhaps not definitive. Using the velocity ratio defined by Tesla as $v_1/v_2 = \pi/2 = 1.57$, for the two velocities for the same wave length, we can determine the two associated frequencies υ_1 and υ_2 for $v_2 = \lambda\upsilon_2$, and $v_1 = \lambda\upsilon_1$ and therefore $\upsilon_2/\upsilon_1 = \pi/2 = 1.57$. One assumption is that a signal associated with this frequency ratio activates oscillations in the earth and the earth-ionospheric resonant cavity and is associated with the so-termed 10 Hz "woodpecker." Then we may consider a ten times factor of the 1.57 frequency ratio or 15.7 Hz. Note that if this wave represents a wave length, then we have 2 x 15.7 = 31.4, which is the dominant frequency outside of the 60 Hz powerline, which we see in the western hemisphere.

We have measured the 31.4 Hz frequency in northern and central Oregon, central and southern California, central Arizona, southern Louisiana, in the New York area and in the Boston area. (See Appendix I.) Intensity of this frequency varies with location and time of day. From 1979 through March 1985 the frequency remained around 31.4 Hz and between March and April 1986, we observed a shift in this major intensity frequency, shifting from 31.4 to between 30.4 and 30.6. We sometimes observed simultaneous 31.4 and 30.6 signals or a cluster of signals in this range with side lobes up to four or five. Other clusters exist, around 48.5 Hz as detected by a "T" antenna measurement of electric field impulses. (See appendix I and II) [35]

We have considered a number of possible sources of this signal and the reason for the frequency shift in 1985. The wave forms are very regular displaying a surge in power from back EMF (electromagnetic force) as the signal goes away which indicates a man made source; perhaps a spurious side band of Project ELF which happens to be near one of the earth's natural resonances. It appears that the 31.4 Hz or 30.6 Hz signal does not involve a powerline subharmonic or mix of 30 Hz but occupies a more fundamental role. One hypothesis is that it involves an excitatory mode of the earth, activated by some specific external man-made source.

The 31.4 Hz signal can be analyzed as about a 30 Hz signal, heterodyning and mixing with the approximate 1.5 Hz earth rotational vector frequency. Other frequencies we have observed associated with natural phenomena, such as volcanoes and seismic activity, are complex, showing sine-waves with interspersed jagged waves unlike the 30 Hz signals and other artificial ELF frequencies. Some of the man-made signals display telemetry like characteristics.

Seismic activity has been occurring periodically in San Leandro in the San Francisco Bay Area of California. We have been observing irregular slow waves of 0.48 Hz and some clusters at 1.32, 1,56, 1.84 and 3.18 to 3.2 for the vertical coil configuration. For example, these frequencies were observed at 8pm on January 14, 1986. News reports later that evening indicated that earthquakes occurred near Salinas and San Jose, California measuring 4.3 and 5.2 respectively on the Richter scale.

We observed the onset of a 3.2 Hz wave maximum with an approximately north-south coil orientation from the 6th through the 13th of November 1986. Previously, this frequency and other specific frequencies had been associated with the volcanoes we observed with the Mt. St. Helens activity in 1980. On November 15th, 1986 the enormous volcanic eruption of volcano Nevada de Ruiz, near Bogata, Columbia was reported and this event occurred south of our observation station. This activity had been preceded by some steam eruptions before the major blast that killed over 23,000 people. A small quake of 3.2 on the Richter scale occurred that day in San Jose, which was consistent with our observation of the north-south coil orientation measurements of slow waves. Some other example predictions of seismic activity are our measurements in the period preceding August 1986, where we observed magnetic field oscillations around 1.5 Hz and 3.2 Hz which were most intense in the north-south direction.

During this period an earthquake occurred in Alaska measuring 5.0 on the Richter scale and two others occurred in China measuring 6.8 on the Richter scale. A "precursor" quake occurred near Mexico City and another occurred at Santa Barbara which measured 3.3 on the Richter scale. Earthquake signatures continued and we expected more and stronger activity. On the 19th of August, 1985, news reports stated that at 8:18am Pacific time, a quake occurred 250 miles west of Mexico City measuring 7.8 on the Richter scale which was felt as far away as Houston, Texas. Predictions of continued activity was made and the next day another quake occurred measuring 7.3 on the Richter scale which was called an "after shock." Some 20,000 lives were lost during that period. [14]

Theoretical Models of Collective, Coherent Resonant States in the Earth and Ionospheric Resonant Cavity

Our observations of frequency and time domain wave form similarity indicates the need to formulate a more complex dispersion relationship than the usual ones. That is, the relationship between wave number (or wavelength) and frequency is not of a simple form, ie. one cannot use the simple relation $c = \lambda\upsilon$. One can, however, proceed from a dispersion relation and then derive specific wave equations for specific applications. We proceed in an opposite manner and utilize our data, interpreting it as wave form solutions to a wave equation and then deduce nonlinear dispersion relations in which the leading order term is $c = \lambda\upsilon$.

The simultaneous occurrence of similar wave forms and frequencies over the globe would indicate a large portion of, or even the Earth as a whole, has been set into dynamic resonance by natural and man-made events. The existence of such electric and magnetic waves indicates the presence of a local and global resonance. The impulse waves observed and the on-off intermittency of the about 30 Hz and other ELF signals, would indicate that one or more local resonator-generators are activating very non-linear modes of oscillation in the Earth. Our data indicates that a mechanical-electrical system or systems can activate normal complex modes of oscillation in the earth and earth-ionospheric resonant cavity, some of which are naturally occurring and some are artificially induced.

We proceed in one or more of three ways to determine a wave equation which describes the observed generated wave forms. (1) One Way is to determine the complex and perturbations-expansion dispersion relationship from which a generalized wave is derived. (2) Another way is to introduce the formation of a new geometric space metric of more than four dimensions, which we term geomagnetic space. The prefix *Ge* is determined from the Greek term for earth and leads to such terms as geology or geography and geometry (earth measure). (3) A third procedure is to present a generalized, nonlinear wave equation and its solution which appears to fit the general form of the data.

Our experience with other electromagnetic and hydrodynamic systems leads us to proceed in the third manner and set down a general nonlinear equation and its solutions. The earth is a highly dynamic and enigmatic system whose origin and detailed structure remain a mystery. It appears in general to be a structure of a layered elastic sphere, as is evidenced by scattering of seismic waves by the Gutenberg discontinuity between the earth's mantle and core. Discreteness of the structure of the concentric zones appears to be due in part to different major compositional components of the various layers such as the crust, mantle (upper and lower) and core, resonantly locked together. The lithosphere, the stony outer portion, is elastic and flexible as determined from ice and geologic materials which show uplift and rebound. Temperature gradients produce convective processes within the earth and associated seismic waves travel at from 7 to 8 km/sec.

The earth forms certain normal modes of oscillatory states which are a function of its size, composition, inhomogeneties, elasticity, viscosity, capacitance etc. These normal modes can be activated by natural phenomena, as we mentioned before, such as volcanoes, meteorological activity, solar wind, etc. These states can also be activated by artificial or man-made systems. For example, nuclear testing, power line systems of 50 to 60 Hz, radio, television and other communications systems. A vast amount of power is pumped into the earth-ionosphere resonant cavity primarily during daytime and early evening hours on the sunlit hemisphere of the earth. Some of these frequencies interact with the natural electromagnetic fields of the earth and can either enhance or diminish these resonant modes. We strongly believe that the current power grids and other electromagnetic radiation will prohibit the design and use of the wireless energy system as Tesla perceived it. Certainly a system based on Tesla's design would have to be modified to accommodate current developments including aircraft travel and satellites.

There are some very striking and intriguing properties of soliton phenomena that lead us to formulate a model of earth resonance in terms of a dispersive-nonlinear wave equation having soliton-like solutions. The earth system is a media which has elastic rebound properties or acts fluidly as observed by the continental drift, and supports nonlinear coherent resonant wave modes that disperse, such as Love waves (or S-wave or stress wave-like) and Rayleigh waves (or P-waves or pressure wave-like) which can be activated from seismic adjustments. The earth acts as a dynamic nonlinear resonator with dispersion. (See Appendix I and II)

We have made extensive measurements of some of these resonant modes which are activated by man-made or other natural sources. Some of these modes may be self sustaining soliton-like waves similar to the process suggested by Tesla. A soliton is a pulse-like traveling wave solution of a linear dispersionless wave equation or a nonlinear equation with dispersion. The basic form of soliton wave equations have the classical wave equation as their leading order terms. If we have a linear equation with dispersion, ie. the usual classical wave equation, no soliton waves will occur as the Fourier components of any initial condition, and it will propagate at various different velocities and as the interface of Fourier as components in which energy will be lost. If nonlinearity is introduced without dispersion , again the possibility of soliton wave modes does not occur since a continuous source of pulse energy must be injected via harmonic generation into higher frequency modes. In the time domain, we often see such phenomena as a shock wave, ie. a wave of relatively short duration. Soliton waves can form with both dispersion and nonlinearity. The soliton wave can be quantitatively understood and interpreted as representing a balance between the effect of the nonlinearity and of the dispersion process. Phenomena amenable to this type of description involve nonlinear, coherent resonant states with dispersive losses.

Examination of natural phenomena, such as sun spot activity, ball lightening, hydrodynamic solitary waves and biological colonies including man, exhibit self-organizing approximately "non-dispersive" processes. These classes of phenomena that involve (1) non-linearity, (2) non-equilibrium, (3) coherent resonance and (4) collective particle states, can be described as self-organizing and non-dispersive. These phenomena can involve solid, liquid, gas and plasma states of matter-energy and can be mechanical and/or electrical (or electromagnetic, chemical or biological) in nature. The key element in such processes is that they do involve dispersion (or diffusion) but that this dispersion (diffusion) is overcome and recohered by the non-linear structure and or fields of the system under consideration. A prime example is that of the hydrodynamic soliton phenomenon, well described by the Korteweg-deVries equation developed in 1895 to describe the observations of John Scott Russel in 1834.

These equations describe phenomena which is dispersive in the third order derivative in space, $\partial^3 U/\partial x^3$, rather than the usual wave equation, which is dispersive in the second order in space, $\partial^2 U/\partial x^2$, which is "balanced" by the nonlinear term of the form $U(\partial U/\partial x)$, where U is a wave function amplitude dependent on space and time. There are also quantum analogies to this classical equation such as the sine-Gordon equation.

We have examined the structure and form of soliton equations applicable to a wide variety of physical, chemical and biological systems and demonstrate how these equations relate to the usual wave equation.

$$\frac{\partial^2 U}{\partial x^2} - \frac{1}{c_o^2}\frac{\partial^2 U}{\partial t^2} \qquad (1)$$

where c_o is the velocity of the wave amplitude, U, and we have the usual dispersion relation for $k = \upsilon/c_o$ for wave number k and frequency υ. Each non-linear equation which exhibits a soliton wave-like solution has a different associated dispersion relation. We have presented ample examples of natural phenomena that exhibit these properties and demonstrate the application of these theoretical models to describing geologic phenomena [34,36].

We will now discuss the soliton model for the development of possible efficient energy devices. Although these devices will not violate the second law of thermodynamics, they are highly efficient and utilize some of the available ambient energy as efficient energy converters [37].

In deriving the form of a generalized nonlinear wave equation, one can usually proceed from a general dispersion relation where in the wave equations the dispersion term is independent of the nonlinear aspect. This method has its limitations when the above condition does not hold, ie. these terms are interrelated such as in the sine-Gordon equation, the method breaks down and becomes cumbersome to use.

Proceeding along the lines suggested by A.C. Scott's mechanical analogy [37], we examine the wave forms we have observed as describable by solitary wave-like phenomena and that these solitary waves are solutions to the sine-Gordon equation. We will also demonstrate the manner in which one can easily relate the sine-Gordon equation to the Korteweg-deVrles equation.

We consider the periodic variation of the amplitude of the earth's magnetic flux ϕ and governed by the nonlinear evolution equation. We proceed from the sine-Gordon equation

$$\frac{\partial^2\phi}{\partial x^2}-\frac{\partial^2\phi}{\partial t^2}=\sin\phi \tag{2}$$

which can be written in compact notation as $\phi_{xx} - \phi_{tt} = \sin\phi$. If diffusion as well as dispersion occurs, then additional terms in ϕ_{xx} and ϕ_t will exist on the right side of the above equation. The flux amplitude ϕ plays the role of the wave amplitude, U

$$L=\frac{1}{2}\left(\frac{\partial\phi}{\partial x}\right)^2-\frac{1}{2}\left(\frac{\partial\phi}{\partial t}\right)^2-\cos\phi \tag{3}$$

or in compact notation

$$L=\frac{1}{2}(\phi_{xx})^2-\frac{1}{2}(\phi_{tt})^2-\cos\phi \tag{4}$$

For x dependence only. For the more general case, x,y,z dependencies of the flux can be examined.

The wave equation and its Lagrangian can be modified by the introduction of certain pertubation terms that can account for fundamental and harmonic resonances [14]. These terms are taken as small and in the form of an exponential. Examples are given in the above reference.

For example, the linear stability of traveling wave solutions of the sine-Gordon equation have the form $\phi(x,t) = \phi(x - ut)$ which is expressed in terms of an elliptic integral with three arbitrary parameters, u, the traveling wave velocity, ϕ_o, the value of ϕ for $(x - ut) = 0$ and C an integration constant,

$$\int_{\phi_o}^{\phi}\frac{d\pi}{\sqrt{2(C-\cos\phi)}}=\pm\frac{x-ut}{\sqrt{1-u^2}} \tag{5}$$

If $C = 1$ is chosen and $\phi_o = \pi$ is set and corresponds to ϕ rotating by 2π as $-\infty < x < \infty$, the integral yields a soliton solution,

$$\phi=4\tan^{-1}\left[\exp\pm\frac{x-ut}{\sqrt{1-u^2}}\right] \tag{6}$$

If $u = 0$, the factor in the exponent reduces to x.

The plus sign in the exponent corresponds to a positive sense of rotation and the wave pulse can be conceded to be a soliton; the minus sign can be considered to be a negative sense of rotation yielding an "anti-soliton." Solitons and antisolitons are created or annihilated in pairs and the sine-Gordon equation is invariant to a Lorentz transformation which can be defined for luminal and sub-luminal velocities.

The soliton model yields a description of a very stable entity which exhibits both particle and wave like properties. The solution to the sine-Gordon equation are stable for example for $u = 0$ and $C \geq 1$, and unstable for $|C| < 1$. For moving solutions where $u \neq 0$, the dynamic symmetry of the nonlinear wave equation can be expressed by its invariance to the Lorentz transformation defined by $\phi(x,t) \dashrightarrow \phi'(x';t')$ as

$$x \rightarrow x' = \frac{x - ut}{\sqrt{1-u^2}} \quad \text{and} \quad t \rightarrow t = \frac{t - ux}{\sqrt{1-u^2}} \tag{7a,b}$$

and the appropriate derivatives $\partial/\partial x$ and $\partial/\partial t$.

The point to be taken at this juncture is that although the sine-Gordon form of nonlinear equations yield solutions which appear to reflect some of the properties of elementary particle physics [38], these forms may be useful to our application as well. Scott's mechanical analogy description in reference [37] suggests to us that some of our observed wave forms might well described by a similar approach involving elliptic integrals with space, time, velocity and also frequency arguments; see Appendix II.

We can write a more familiar form of the soliton solution by writing our elliptical integral as

$$\int_{\phi_o}^{\phi} \frac{d\phi}{\sqrt{P(\phi)}} = x - ut \tag{8}$$

where the term $P(\phi)$ can be written as a polynomial expansion in terms of integration constants C and C_2, and velocity u up to third order in ϕ as

$$P(\phi) = 2C_2 + 2C_1\phi + u\phi^2 - (g/3)\phi^3 \tag{9}$$

The above integral can the be written (in the form which in general is not Lorentz variant) as

$$\phi(x - ut) = \frac{3u}{g}\operatorname{sech}^2\left[\frac{\sqrt{u}}{2}(x - ut)\right] \tag{10}$$

which now looks like the solution to the Korteweg deVries equation for $u \geq 0$. The constant g then appears as the nonlinear term of the nonlinear equation of the form

$$\frac{\partial\phi}{\partial t} + g\phi\frac{\partial\phi}{\partial x} + \frac{\partial^3\phi}{\partial x^3} = 0 \tag{11}$$

which is the Korteweg-deVries equation that occupies the role of a coupling constant of the nonlinear term which balances the highly dispersive term $\partial 3\phi/\partial x^3$.

For completeness we can write the Lagrangian density as

$$L = \frac{1}{2}\frac{\partial\theta}{\partial x}\frac{\partial\theta}{\partial t} + \frac{g}{6}\frac{\partial^2\theta}{\partial x^2} + \frac{\partial\theta}{\partial x}\frac{\partial\psi}{\partial x} + \frac{1}{2}\psi^2 \tag{12}$$

or as $L = 1/2\, \theta_x\theta_t + (g/6)\,\theta_{xx} + \theta_x\psi_x + (1/2)\,\psi^2$ where we define $\partial\theta_x = \theta_x = \phi$ and $\theta_{xx} = \partial^2\theta/\partial x^2$, etc.

We have observed similar wave forms in both the time and frequency domain. See Appendix I. From these data taken simultaneously in time and in frequency, we deduce that the dispersion relations governing these wave forms is a complex relationship between wave number (inverse of wave length) and frequency or frequencies. Since the wave length of these waves are so long for these low frequencies, we are essentially detecting these waves as observers from a frame of reference "*within these waves*." The approximately 30 Hz waves which we observe always look like well formed sine waves.

For the usual kinematic wave equation $c = \lambda\upsilon$ we can relate the frequency and the time as $\upsilon = 1/t$. For more complex wave equations, this simple relation of time and frequency may not hold.

Analysis of the periodic nature of the observed data waveform amplitude in time (oscilloscope tracing) and power density vs. frequency (spectrum analyzer display) allows us to deduce the relationship of time t and frequency υ. One procedure is to identify the frequency μ with a frequency domain time τ. From this theoretical model we can construct a five dimensional geometry in the coordinates (x,y,z,t,τ) where $\mu \equiv 1/\tau$ and $t \neq \tau$. We have explored in detail elsewhere, the construction and application of five and eight dimensional geometries. See References 40 and 41 and references therein.

Measurement and analysis of the acoustic-seismic modes and magnetic field oscillations in the ELF and the VLF region of the earth and earth-ionosphere cavity, leads us to re-examine issues related to the measurement process. We proceed from a generalized wave equation with coherent, solitary wave solutions to a wave equation with five independent variables, three dimensions of space, the usual time and associated frequency, and an additional time-like variable with a unique additional frequency variable.

Interestingly, the problem of measurement of the ELF phenomena is opposite, in a sense, to that for high energy process--x-rays, gamma rays, elementary particles and quarks. For ELF phenomena, the observer is significantly smaller (internal) than that which is observed, which is external large-scale phenomena. Whereas, for high energy quantum processes where $\hbar$ applies, the observer is significantly larger (outside) than that which is observed. Treatment of the problem of an internal or inside observer of an external large-scale phenomena is made in terms of a five dimensional wave equation. A four-space description may well suffice if the observer is larger than the scale of that which is observed.

The recent GUT (Grand Unification Theory) for strong, weak and electromagnetic interaction, involve ten and eleven dimensional spaces. Part of the subspaces of the GUT theory is the five-dimensional space of Kaluza-Klein with four spatial dimensions (one a periodic rotational spatial dimension) and the usual time dimension.

We explore in more detail, the relationship of macroscopic electromagnetic and gravitational interaction. Also examined is the modification of the gauge conditions as applied to electromagnetic interactions in the ELF region. In the conventional view, an electromagnetic wave of about 7.8 Hz has a wavelength of approximately the circumference of the earth. In the conventional view of wave packets, we are dealing with a photon the size of the earth! [5,14]

We can treat the problems of an internal (inside) observer or an external (outside) observer. It may be most useful to treat the wave equation as solvable in five-space for the internal observer whereas our-space may suffice for the external observer, where the relationship of υ and t is less complex. We can define a frequency υ associated with t as $\upsilon = 1/t$, we associate a wave number k with υ as $k = 1/\lambda$ where $c_\omega = \lambda\upsilon$ and a wave $q = 1/\Lambda$ where $c_w = \Lambda\mu$ where c is the velocity of the wave so that c can be equal to c_ω or c_w where w equals $2\pi\mu$.

We can write a general form of the electromagnetic field $F_{\mu\upsilon}$ which depends on the electric and magnetic fields E and B so that (for $\psi \rightarrow \mu,\tau$)

$$F(x,\chi,t,\tau) = F_o(x,\chi,t,\tau)\, e^{i(kx-\omega t+q\chi-wt)} \tag{13}$$

which comprises an eight-dimensional representation. Elsewhere, we have examined the symmetry conditions and Lorentz invariance in five and eight dimensional geometries in which the group elements of the five dimensional space is a subset of the group elements of the eight dimensional space. The twister algebra of the eight-space is mappable to the spin or calculus of the five space [41,42,43] (See Appendix II, a brief description of some data.)

One of the outgrowths of this procedure is the formulation of the relationship of the transverse and longitudinal components of the E̲ and B̲ fields. The existence of actual longitudinal components of E̲ and B̲, non-Hertzian waves, entails modification of gauge invariance, which we presented in detail elsewhere. [14,44] Extensive evolution of multidimensional models have been made including the application to the design of specific parameters for emission and reception antenna.

Exciting possibilities of a new picture of explaining, understanding and utilizing earth resonance modes may emerge from our five and eight dimensional wave equations. Our theoretical work and experimental data has allowed us to predict earthquake and volcanic activity with approximately 84% accuracy. [4] Future research should lead to more accurate predictions and predictive methods.

Specifically, we can define an orthogonal set of dimensions x,y,z,t,τ. In general, we can express a form of the five dimensional generalized wave equation from the Laplacian form

$$\underline{\Uparrow}^2 \psi = [\,]^2\psi - 1/c_\upsilon^2\, \partial^2\psi/\partial\tau^2 \tag{14}$$

where we define a new five dimensional operator $\underline{\Uparrow}^2$ and where $[\,]^2$ is the usual D'Alembertian operator

$$[\,]^2 \equiv \nabla^2 - 1/c_\omega^2\, \partial^2/\partial t^2 \tag{15}$$

and ∇^2 is the del operator representing the spatial part of the equation as $\nabla^2 = \partial^2/\partial x^2 + \partial^2/\partial y^2 + \partial^2/\partial z^2$. We define the wave amplitude as dependent on the five space independent parameter as $\psi(x,y,z,t,\tau)$. We define a velocity c_w associated with the time variable τ and frequancy μ and c_ω is the velocity associated with the time variable t.

Assuming a functional dependence of w on $w(t,\tau)$ and ω on $\omega(t,\tau)$ and where w and ω are "locked" so that the time frequency domain simultaneously display a similar wave form, where amplitude versus time t and power spectrum versus frequency υ are similar forms.

We express these conditions in a form of a general wave equation as

$$\underline{\Uparrow}^2 \psi = \frac{1}{c_\omega^2}\frac{\partial^2\psi}{\partial t^2}\,\frac{1}{c_w^2}\frac{\partial^2\psi}{\partial t^2} - \frac{1}{2\pi}\frac{1}{c_o^2}\int\!\!\int\!\!\int\!\!\int_{-\infty}^{\infty} A\psi\, e^{i(kx-\omega t+q\chi-wt)}\, d\omega\, d\upsilon\, dt\, d\tau \tag{16}$$

Here we consider ω and w being in the same units (we are not using the usual definition $\omega = \upsilon/2\pi$ but $\omega \neq w$ where ω and w are distinct frequencies). The velocity c_o is associated with wave emission in both time and frequency domain where c_o can be a function of c_ω and c_w and the wave function ψ is a function of the five dimensional space, as $\psi(x,y,z,t,\tau)$. The variable amplitude A has a dependence on variables as $A(\omega,\upsilon,c_\omega,c_w)$ to insure Lorentz invariant conditions are obeyed.

The usual relations can hold $c_\omega = \omega/k$ and $c_w = w/q$ for wave numbers k and q. But from the above generalized wave equation, we can consider the possible form of a dispersion relation which is a complex form involving the relationship of ω, w, c_ω, c_w and c_o with the associated wave numbers k and q.

In order for the time and frequency waveforms to appear to be of similar forms, the form of dispersion relation is such that the generalized wave equation is dispersion-free, or of a nonlinear form in terms of the integral term in terms $A(x,y,z,t,\tau)$ which overcomes dispersive terms.

For some general problems, the appropriate dispersion relation can assume a complex statistical form and may take on a nonanalytic form which is unsolvable except by Noval computer analysis techniques. As we suggested in our discussion of the sine-Gordon equation, it may not be most efficient to proceed from a dispersion relation. The determination of the form of the term *A* depends on the form of the dispersion relation and the insurance of Lorentz invariant conditions for the wave generalized equation in some applications which are relatively invariant.

Let us examine a possible form of the wave equations and solutions in a first approximation as follows. We rewrite our nonlinear equation so that the linear terms appear on the left and the nonlinear terms on the right.

$$\underline{\Uparrow}^2 \psi - \frac{1}{c_\omega^2}\frac{\partial^2\psi}{\partial t^2} = \frac{1}{c_w^2}\frac{\partial^2\psi}{\partial t^2} - \frac{1}{2\pi}\frac{1}{c_o^2}\int\int\int\int_{-\infty}^{\infty} A\psi e^{i\omega t} e^{iw\tau}\, d\omega\, d\upsilon\, dt\, d\tau \qquad (17)$$

We can treat the term $(1/c_w^2)(\partial^2\psi/\partial\tau^2)$ as either linear or nonlinear. If we choose a linear form for this term then t and τ are additive and this tensor can be combined linearly with $(1/c_\omega^2)(\partial^2\psi/\partial\tau^2)$ so that the term in τ adds only a coordinate shift. Hence we are reduced to the trivial case where we need only consider a single frequency term ω related in a simple manner to the time t. Since the trivial case is not useful, we will resume our consideration of the term $(1/c_w^2)(\partial^2\psi/\partial\tau^2)$ in terms of its nonlinear form.

We can define a complex form of a coupling constant that defines the relationship of the times t and τ and frequencies ω and w. We denote this term as $g^2(\omega,t,w,\tau)$. The relationship of the quantities in the term $g^2(\omega,t,w,\tau)$ determine, in part, the term $A(\omega,w,t,\tau,c_\omega,c_w)$ and can be derived from the five dimensional Fourier transforms.

We can write the usual Fourier Transforms for frequency and time in four-space as

$$\theta(t) = \frac{1}{\sqrt{2\pi}}\int_{-\pi}^{\pi} \phi(\omega)\, e^{i\omega t} \qquad (18a)$$

and

$$\phi(t) = \frac{1}{\sqrt{2\pi}}\int_{-\pi}^{\pi} \theta(t)\, e^{i\omega t} \qquad (18b)$$

In five dimensions, the Fourier transforms are expressible in terms of a 4x4 matrix array, $\phi(\omega,t,w,\tau)$ and can be written in a form as follows:

$$\theta(t,w,\tau) = \alpha \int \phi(\omega,w,\tau) E\, d\omega\, dw\, d\tau \qquad (19a)$$

$$\theta(\omega,w,\tau) = \beta \int \theta(t,w,\tau) E\, dt\, dw\, d\tau \qquad (19b)$$

$$\xi(w,\omega,t) = \gamma \int \zeta(\tau,\omega,t) E\, d\tau\, d\omega\, dt \qquad (19c)$$

$$\zeta(\tau,\omega,t) = \delta \int \xi(w,\omega,t) E\, dw\, d\omega\, dt \qquad (19d)$$

where α, β, γ and δ are constants including a 2π factor and E is the exponential $E = e^{\pm i(\omega t + w\tau)}$.

The above applies for any relationship of t, τ, ω and w, and simplifies for our particular case. Consider a specific example of our data for the polarity shift phase and amplitude modulated 30 Hz Wave, with rotational vector frequency 1.54 Hz. This waveform can be described as a rotational or a screw wave in an (x,t,τ) coordinate space where the amplitude or power is expressed in the x dimension. We define a wave function solution which is related to ψ for psi (x,y,z,t,τ) in the above equations as U(x,t,τ) in terms of one spatial dimension only. The nonlinear terms of our wave equation are expressed as

$$-\frac{1}{c_w^2}\frac{\partial^2\psi}{\partial\tau^2} - \frac{1}{2\pi c_o^2}\int\!\!\int\!\!\int\!\!\int A\psi E\, dV = \frac{g^2}{2\pi}\int\!\!\int\!\!\int\!\!\int P(A,\psi)E\, dV \qquad (20)$$

where dV is the form differential dV = dω dw dt dτ and E is the exponential function $E \propto e^{\pm i(\omega t + w\tau)}$. Then we can write U(x,t,τ) which is a viable solution to the above wave equation

$$U(x,t,\tau) = 4\eta_o\, sech\left(\frac{x - V_\omega t}{l_\omega}\right) sech\left(\frac{x - V_w t}{l_w}\right) \qquad (21)$$

where η is a constant and where the terms in ω and w separate out since the 1.5 Hz rotational wave (as the Foucault pendulum demonstrates) represents a five dimensional rotation of the 30 Hz Wave. If the rotational effect did not exist then the above form would reduce to the usual solitary wave form.

$$U(x,t) = 4\eta_o\, sech^2\eta \qquad (22)$$

where $\eta = (x\text{-}vt)/l$ and where v is a simple function of v_ω and v_w and τ represents a linear coordinate transformation of t. The terms in v_w and τ then just add an arbitrary phase shift to the term $\eta = (x\text{-}vt)/l$ and represents a unit length normalization so that the argument of the hyperbolic function is dimensionless.

All measurements of the 30 Hz waves and some of the 10 Hz waves couple to the earth's rotational velocity of about 1.5 Hz so that the above simple case does not hold in general.

The integral P(A,ψ)E of the wave equation is derived from the coupling constant expression involving x,ω,t,w,τ. [44]

Detailed computer analysis from our data will better determine the allowable forms of P(A.ψ)E. [44] We see that the solutions to these wave equations will be similar to the sine-Gordon equation with soliton solutions. See Appendix II for discussion of geometric conditions on spatial, time and frequency dependence of some of our data.

Possible Activation of Earth and Earth-Ionospheric Resonance States by Solar Wind Activity

We speculate on some additional causes for seismic and volcanic phenomena as well as activation of major storm systems. Seismic activity produces physical movement of the earth in its own steady-state magnetic field and produces charge and acoustic coupling which modifies the earth's field locally. Major field coupling effects can occur due to solar wind effects, particularly during heavy particle interactions which follow major solar flares.

Planetary magnetic field organize ionized matter. The resulting magnetospheres are unique domains or "cells" of plasma that are semi-isolated and considerably different from neighboring plasma regions. The earth's magnetosphere and that of other planets are affected by planetary rotation and ionic flows from the sun and its rotational dynamics and we suspect that the diurnal cosmic bombardment also plays a significant magnetospheric role. Co-rotational plasma flows, production of plasma waves, radio emissions, and ion acceleration of thermal electrons to hundreds of MeV occur within the magnetospheres. Plasma processes can involve the usual plasma instabilities related to ionic interaction with the earth's magnetic lines of force.

Primary driving forces of magnetospheric features involve the solar wind (and its induced changes from solar flare processes) and the earth's rotation (including the steady state magnetic field as well as disturbances within this field due to the earth's physical "adjustments" such as seismic activity and volcanoes). Planetary and stellar magnetic fields are believed to organize ionized matter in stellar and galactic systems.

The deformation of the earth's magnetosphere occurs as the solar wind (an internal expansion of the solar corona) interacts and mixes with the intrinsic magnetic field generated by or intrinsic to the earth. The solar wind at the earth's orbit has an ion density of about 10 ions/cm^3 with an energy density of a few times 10^{-8} dynes/cm^2.

Some General Comments on Theoretical Prediction of Seismic and Volcanic Activity: Research Conducted 1979-1990

Our data and records indicate that earthquakes and volcanic activity seem to be able to be modified by sunspot/solar flare activity and cycles in a manner similar to the effect of tidal action (caused by the gravitational pull of the moon) except that this sunspot/solar flare/earth interaction produces electromagnetic activity in the earth environment. Weather processes also appear to depend on solar cycle patterns. As is known, sunspot magnetic "storm" activity produces changes in the solar wind. The heavy particle interaction with the ionosphere produces charged state changes within the E layer and other charged layers of the atmosphere which creates induced magnetic fields. These fields and current flows interact with, affect, modify and perturb the earth's "steady state" magnetic field. As the lines of force of the earth are affected and "wiggled," the core mantle interface is affected. Extreme effects produce energy releases in the form of earthquakes and volcanic activity. Upper atmospheric effects can drive the jet streams and modify their paths and structures and thus affect the weather. Concurrent with major seismic and volcanic occurrences is the production of lightning which also affects weather. As is well known, increased atmospheric gases and particulate matter can affect global weather patterns.

Large earthquakes can also "wiggle" the lines of force of the earth's magnetic field and hence, in turn, affect ionosphere ionization states, thus affecting weather and other reverberatory seismic modes of excitation. Lightning strokes and piezoelectric releases in rocks in the earth produce electromagnetic field spike-like impulses which are measurable with suitable instrumentation. All these phenomena produce characteristic electromagnetic wave signatures which we can and do record and analyze.

Earthquake tables containing predicted location and estimated magnitude can be constructed in a manner analogous to tide tables. Predictions of possible volcanic activity can also be generated. These and other data might also be utilized to generate long term weather profiles.

Conclusion

The earth and the life forms upon its surface vibrate and resonate in harmony in such a manner that radiant energy from the sun and materials and vibrations of the earth support this life and its evolution. Some of the major normal oscillatory modes of the earth are in the 9-13 Hz range which, interestingly enough, is about the power spectrum peaking for most people's alpha frequency.

It is clear that we depend on "Mother Earth" for our life, but whether, in some sense, the earth itself depends on the life forms on its lands and in its seas and atmosphere, is another matter; ie. is there a symbiosis between the earth and the life it supports?

We know that man can create great changes, some of which have polluted the air, land, streams and seas with chemicals, radioactivity and electromagnetic waves. Some changes wrought by man can be repaired by the earth but others may not be so easily repaired. The question of why man should pollute his life support system continues to go unanswered. Some of the electromagnetic waves generated by man may have global significance for the earth and the life forms upon it.

In this project and in this paper, we have explored the earth's magnetic field emanations, those that are natural and those activated by man. There are a multitude of natural modes, such as the earth's mechanical rotation, seismic activity, volcanoes, solar wind and solar broadband noise activity and many others.

Also impressed upon the environment are many man-made sources disturbing both the atmosphere and the earth. Some of these emissions may be reaping irreparable damage to the ionosphere and earth which, in turn, threatens our very existence. We must examine what we are doing as people, as societies and as nations!. If we do not develop a new consciousness and awareness, destruction of life will inevitably result.

When the earth and the life upon it is in harmony, the system is mutually life enhancing. Man has (or has had) great abilities and potentials and yet, most of his recent technologies have been to strip nature away from us--to shield us from nature, to "conquer" and control her while designing ever more dangerous weapons systems with which to more efficiently strip all life from the planet. We must examine why man has moved toward such insane motivation, toward mutual destruction and whether mutual life enhancement and sanity can again become the noble objective of pursuit which desperately need implementation today.

Acknowledgements

The authors appreciate the assistance of Harold Faretto in helping us with some of the measurements and engineering work on TRL projects and thanks to Hal Treacy for his assistance in providing us some necessary equipment for TRL projects.

Fundamental Excitatory Modes of the Earth and Earth-Ionosphere Resonant Cavity

APPENDIX I
Measurements Of Seismic Precursor Excitation Modes

Earth mechanical or seismic oscillations produce longitudinal excitations in the earth itself. These oscillations produce local and global disturbances which involve local field coupling which perturb the earth's global steady-state magnetic field. The seismic excitations produce pressure and stress waves which have acoustic components as well as "wiggle" the Earth's lines of force producing a magnetic fluctuation component. These acoustic and magnetic components are related, albeit, in a complex manner. The magnetic field oscillations associated with seismic and volcanic activity all lie at the low end of the EMR spectrum (0.3 to 300 Hz). Also, the associated acoustic modes lie in a similar frequency range to that of the ELF activity.

As we have explained elsewhere, ELF magnetic field oscillations have transverse as well as longitudinal modes of excitation and the longitudinal modes appear to be acoustic-like, at least as considered in "four space." Most of the earth-activated ELF modes are non-sine wave-like, having a number of Fourier components.

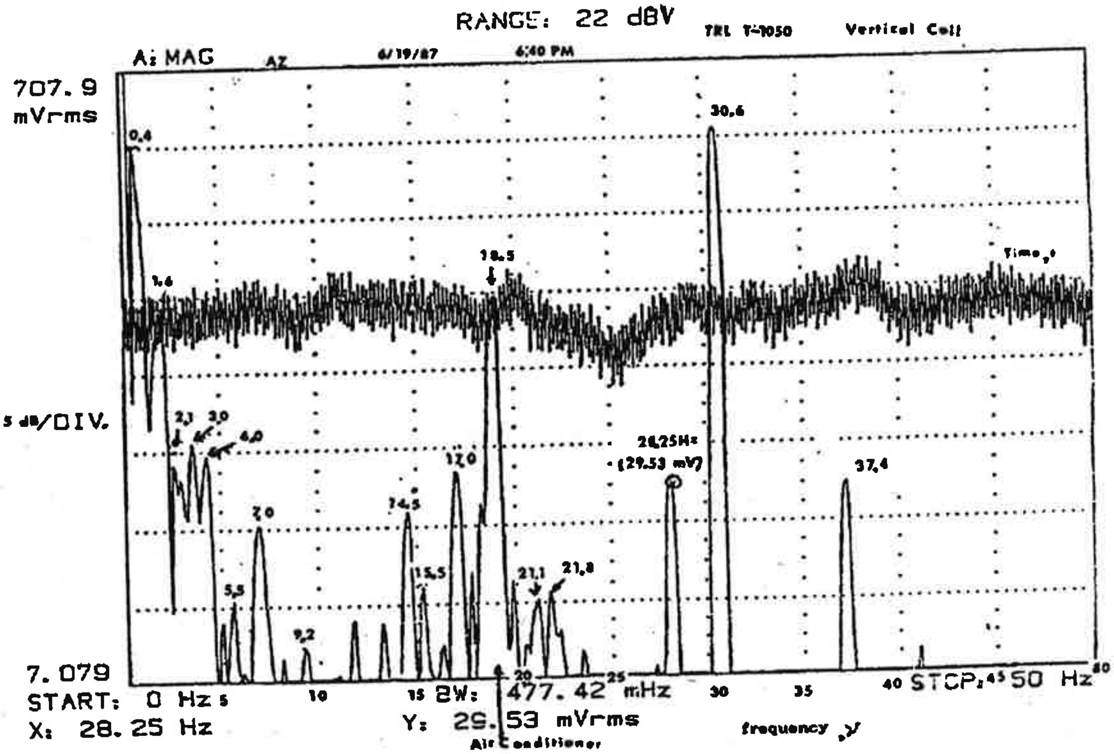

Figure 1. Typical frequency and time domains of magnetic field oscillations which are dominated by the approximately 30 Hz signal. The about 1.56 Hz signal heterodynes with the 30 Hz signal as seen in the time domain. Most of the frequencies below about 11 Hz are natural geologic and atmospheric oscillations.

The 0.4 Hz is the Earth's fundamental magnetic rotational component and the 1.56 Hz is its standard rotational vector and the 3.0 to 3.2 Hz magnetic pulsation component is the seismic precursor signal.

The 5.5 to 5.9 Hz signal is usually associated with excitation in the ionospheric D layer and the 9.2 Hz signal appears associated with heavy particle interactions from solar flare activity bombarding the ionosphere. Frequencies of 12 Hz and above are primarily from man-made sources. The 17 and 18.5 Hz are from the air conditioner compressor near the building where the data was recorded and disappeared when the air conditioner was shut off. The 30 Hz signal with 28.25 Hz side lobes is probably a spurious emission of Project ELF.

Precursor frequencies of magnetic field oscillations, observed before the onset of seismic activity, are usually the third and fourth harmonic of the earth's rotational excitation. The difference between the earth's steady state magnetic field and the earth's mechanical rotational axis is 22.5 degrees at the poles. Hence, the first oscillation of the actual rotational vector is 0.4 Hz (= 3.14 x 360/22.5). The second harmonic is 0.8 Hz and the third harmonic is 1.6 (more precisely, 1.56 for the nonlinear progression) and around 3.16 to 3.2 is the fourth harmonic. [45]

As the earth rotates, the Coriolis force is stored in the earth's body. We observe this energy storage as a build-up of a magnetic signal of about 3.16 to 3.2 Hz. From about 24 to 72 hours before an impending event, the approximately 3.2 Hz signal disappears. Triangulation on the maximum magnetic amplitude of the 3.2 Hz signal is used to locate the future or impending event. If the 3.2 signal reappears within the 72-hour time frame, then the time line starts running again for another 24 to 72 hours.

The 1.56 Hz signal is almost always present and, from this signal which we term *rotational vector*, we can estimate the magnitude of the future event. The percentage of deviation from the normal value of the rotational vector gives an approximate magnitude, depending also upon the distance from the measurement instrumentation and the epicenter of the impending event.

We observe a range of "rotational vector" values between 1.26 Hz and 1.80 Hz. The smaller the deviation from the normal value of the rotational vector, the smaller the quake will be. The deviation of the rotational vector is proportional to the impending quake magnitude. For example, 1.26 Hz or 1.80 Hz can be associated with over 6.5 to 7 on the Richter scale depending on the distance from the detection point to the site of the impending event.

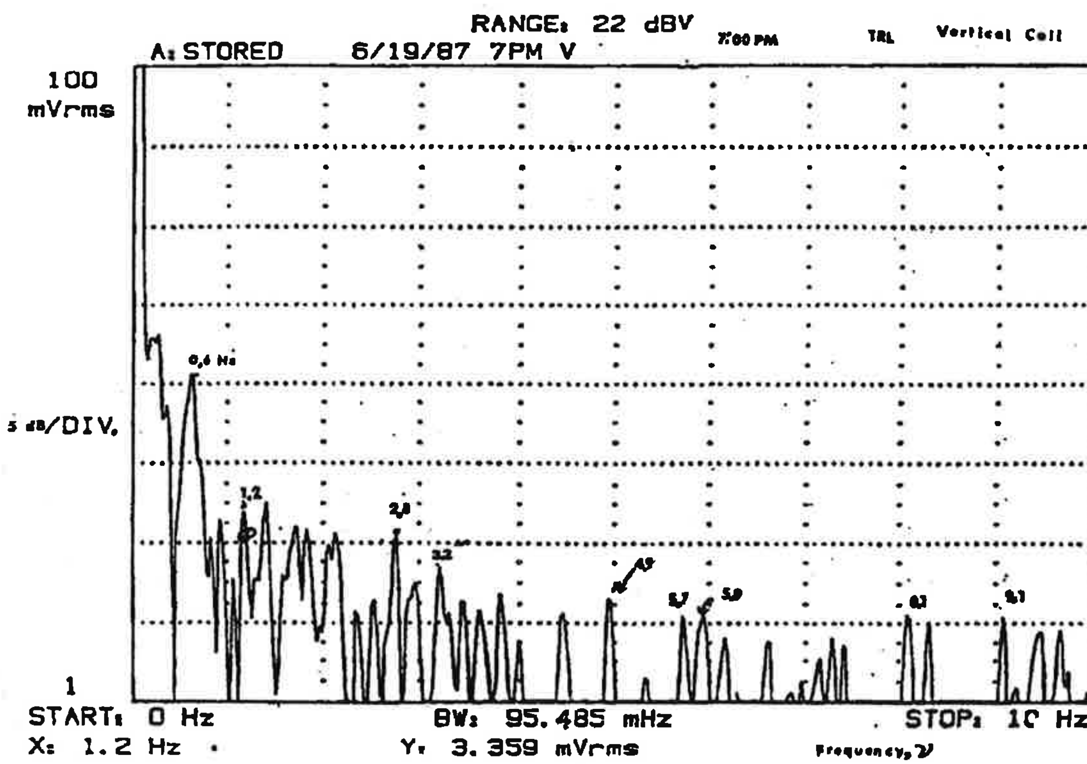

Figure 2. Again a typical display of natural magnetic frequency emissions is given in the "geologic frequency range." Both Figure 1 and Figure 2 data were collected from the vertical orientation of the coil antenna.

The earth and sun have oscillatory modes which we can treat in a manner analogous to that of a ringing bell. These acoustic modes are actually the mechanical motion and they perturb the earth's steady-state magnetic field of 0.5 gauss at the San Francisco Bay area latitude, giving rise to magnetic field oscillations and electromagnetic waves. Hence, magnetic and acoustic modes are related to each other.

The longitudinal modes of ELF waves can be detected by a coil of about 17 miles of AWG #44 wire wound on a spool. These modes travel at about $v_B = 3\ (10^5)$ cm/sec as compared to $c = 3\ (10^{10})$ cm/sec, so that for transverse electromagnetic radiation for a 7.80 Hz signal wavelength, $\lambda = 25{,}000$ miles--approximately the circumference of the earth. For the longitudinal modes of excitation traveling at v_B for a wavelength, λ is about 1/4 mile at a frequency of 7.80 Hz. The coil detection system responds well to the nonlinear ELF waves and the coil containing about 52,800 feet of wire which is very adequate to measure down to the frequency of the thrust waves associated with Love and Rayleigh wave activity of about 0.2 Hz with a wavelength of about 10 miles. We have observed the 0.20 Hz thrust waves associated with on-going seismic events on numerous occasions.

The nonlinear coil response acts like a "giant resonant" (as in nuclear physics) detection (without the circuit amplifying and smoothing elements) and has a peak primary response at 48 Hz for $f_R = 1/(2\pi\sqrt{LC})$ for the coil system currently in use at this frequency range acts as if it has a large cross section (or giant resonance) for ELF detection.

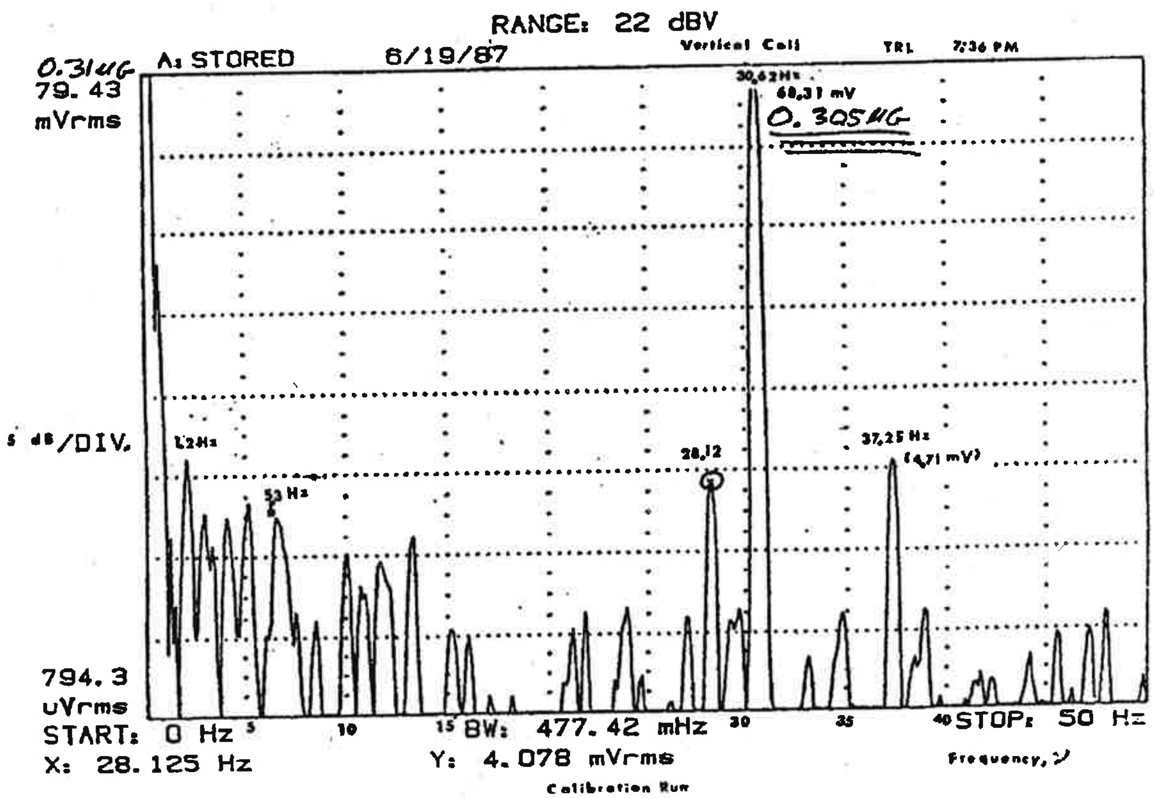

Figure 3. **Measurement is made for the 0 to 50 Hz range in which calibration of the 30.625 Hz signal is made as a secondary standard to NBS. Table 1 following this figure gives approximate relative magnitude of the 30 Hz signal measured at various times, as time averages in various locations. All data in these figures was taken prior to 1987.**

The T-1050 magnetic field detector has a series of amplifying, smoothing elements and notch filters which make for flat response from 0.1 to 50,000 Hz for magnetic field strengths only detection with a sensitivity of about 10^{-6} Gauss for the high pass circuit; 0.1 to 200 Hz for the low pass circuit with a sensitivity of 0.5×10^{-10} Gauss.

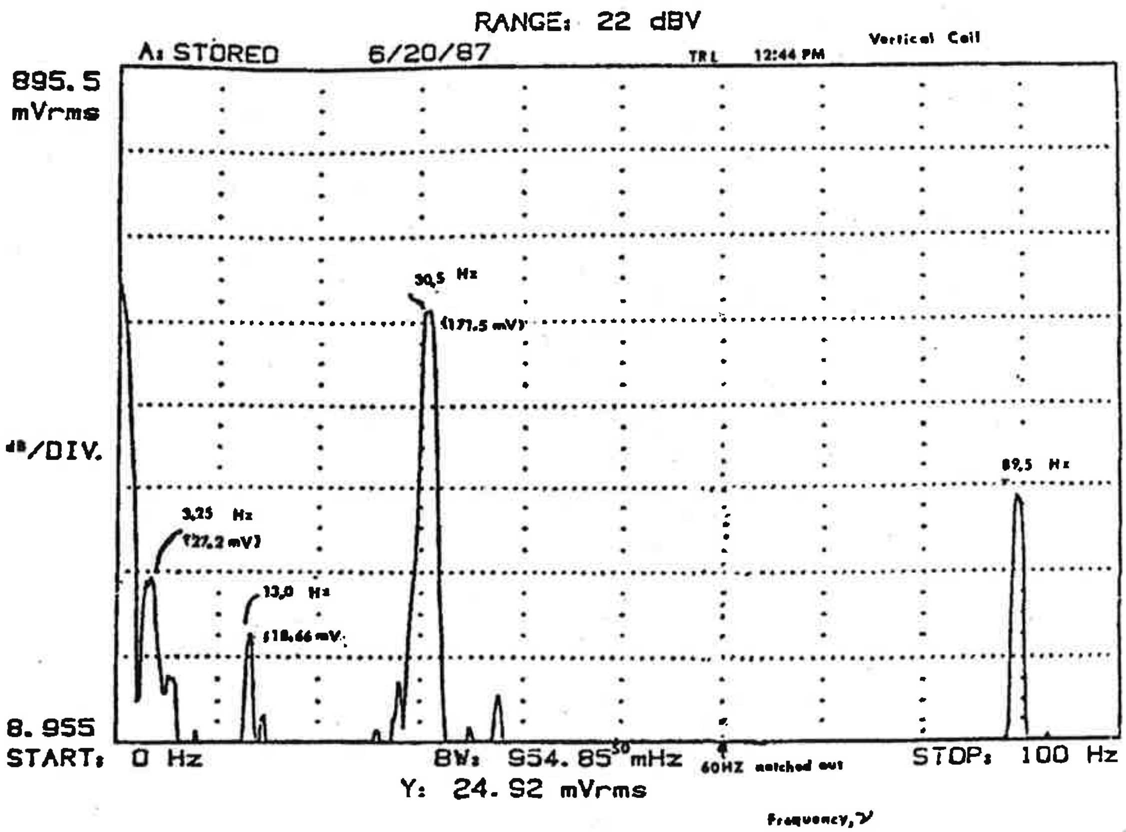

Figure 4. **In the 0 to 100 Hz range with 60 Hz notch filters to notch out the 60 Hz, we see the spurious side bands of 30.5 and 89.5 Hz from the center band of 70 to 76 Hz for Project ELF. The 30 Hz signal is nearly always larger than the 89.5 signal since it lies near one of the Earth's rotational resonant frequencies. In earlier measurements there were also some effects of coil roll-off.**

Table I.
Relative Magnitude of the Observed 30 Hz in Various Locations

Seattle, WA	90.00 µG
Phoenix, AZ	88.00 µG
Vancouver, BC	37.50 µG
Portland, OR	30.00 µG
San Leandro, CA	03.00 µG
New Orleans, LA	00.99 µG
Kirkland, AZ	00.30 µG

Fundamental Excitatory Modes of the Earth and Earth-Ionosphere Resonant Cavity

APPENDIX II

ELF Data Evidence Implying the Need for a Five Dimensional Geometry

Measurements for ELF frequencies in the region below about 300 Hz with a coil magnetic detection system indicate the need for a mathematical model consisting of greater than four dimensions (of space and time) in order to explain the observation that impulses in the ELF region appear as identical patterns both on the oscilloscope (time domain) and a spectrum analyzer (frequency domain).

Since a wavelength or wave impulse of say 7.8 Hertz (in Maxwell's theory) requires approximately 25 thousand miles for a complete excursion in the conventional electromagnetic theory, any person who is an observer of this frequency and the device employed to display the result are inside of the effect of the wave impulse. Therefore, either the observation of the event and the display of it are erroneous or a higher dimensional treatment of the results are necessary to explain our observations.

It is possible to explain the observation of similarity of space and time displays by resorting to a five dimension geometric description of ELF phenomena. The five dimensions are composed of three spatial amplitude dimensions, one of time associated with the amplitude or usual time or A-t plane where $t = 1/\upsilon$ and a frequency associated with the amplitude frequency or A-μ plane where $\tau = 1/\mu$. We can call this "space" the x,y,z,t,τ space. (We define the amplitude variation as dependent on the usual parameters as $A(x,t,\upsilon)$ and the new amplitude dependent on the new parameters $A'(x,\tau,\mu)$.) Note that this five dimensional space with all macro-dimensions is not like Kaluza-Klein geometry with a compactified spatial dimension. [46]

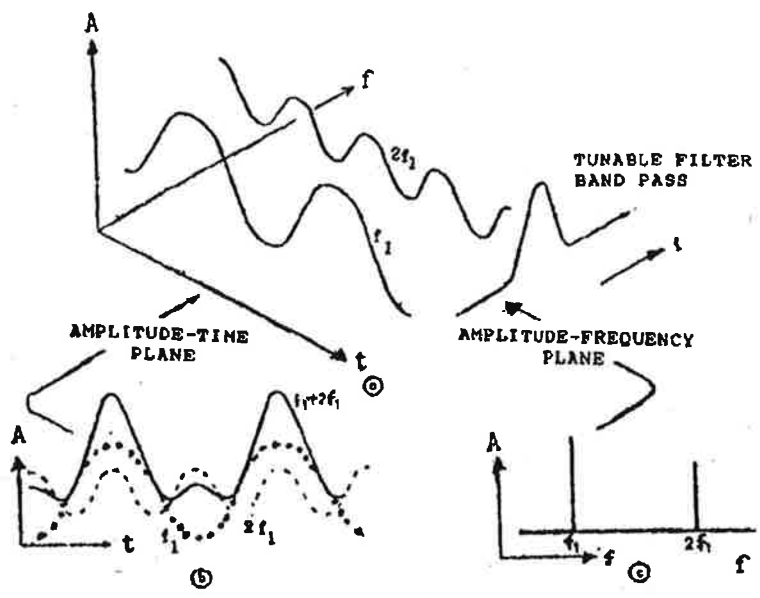

Figure 1. **a) Three-dimensional coordinates showing time, frequency and amplitude. The addition of a fundamental and its second harmonic is shown as an example.**
b) View seen in the t-A plane. On an oscilloscope, only the composite $f_1 + 2f_1$ would be seen.
c) View seen in the t-A plane. Note how the components of the composite signal are clearly shown.
The nonlinear coil response acts like a "giant resonant" (as in nuclear physics) detection (without the circuit amplifying and smoothing elements) and has a peak primary response at 48 Hz for $f_R = 1/(2\pi\sqrt{LC})$ for the coil system currently in use at this frequency range acts as if it has a large cross section (or giant resonance) for ELF detection.

Figure 2. Five second display from spectrum analyzer set at 100 KHz resolution and zero span gathered in Portland, OR. Top trace 10 Hz electromagnetic variable polarity waves.

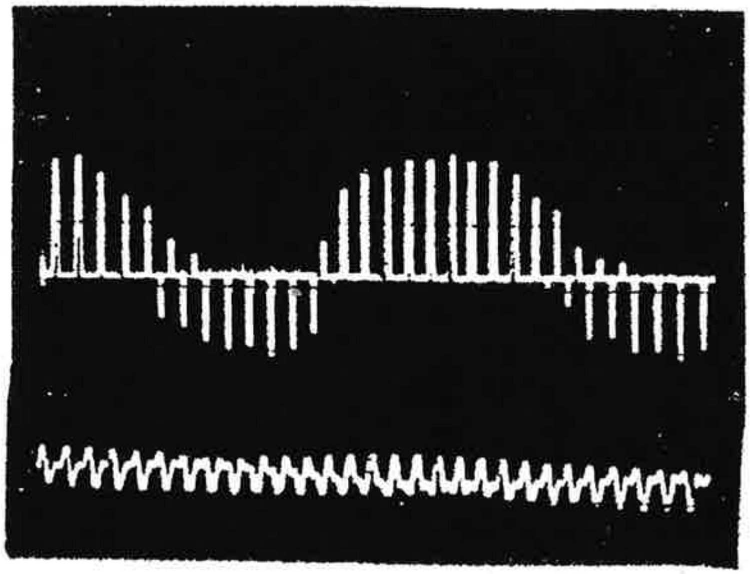

Figure 3. Two 1 second traces of ambient magnetic field impulses gathered in California with a coil detection system and displayed in the time domain on a storage oscilloscope. Top trace railed; bottom trace normalized headroom. Note the variabe polarity serpentine like characteristics similar to Figure 2.

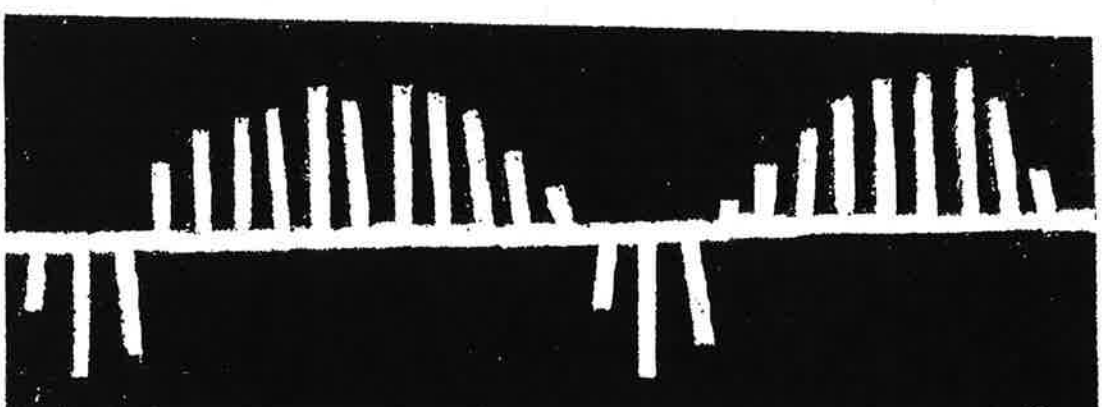

Figure 4. This diagram was taken from the cover of Reference 31, A.C. Scotts text "Active and Non-Linear Wave Propagation in Electronics." This figure is generated as a mechanical model to represent the wave output of a system obeying thes sine-Gordon equation. A series of small pegs or nails of equal length are placed on a wire (which would look like the proverbial white picket fence. To create the figure, the center flexible wire is rotated two and a half twists, creating the display observed and photographed in this figure. Observe the similarity between this figure and Figure 3 which is the time display of the 30 and 1.5Hz signals *hetrodyning*.

Maxwell's equations are only approximately valid in the ELF region when coil emitters and sensors are utilized and the results plotted by means of oscilloscopes and spectrum analyzers. Gauge invariant conditions are modified in the frequency range of ELF. [44]

We present examples of frequency and time domain measurements which lend support to the statements we have just delineated. Figure 1 shows the unusual relationship of a typical sine wave and its representation in the frequency and time domain. Figure 2 is an example of the serpentine-like appearance of the "Russian Woodpecker" in the frequency domain as demodulated by a spectrum analysis. Shown are the 10 Hz pulses on a high frequency "carrier."

Figure 3 is a representation of a magnetic field measurement of about a 30 Hz signal gathered with a coil detection system and displayed on an oscilloscope in the time domain. Although the frequencies are 10 and 30 Hz respectively, the ELF region of interest that they occupy are close enough to note that both of these displays are highly similar and serpentine-like, implying a comparative measurement in the frequency domain; and time domain at higher frequencies do not exist at ELF.

The trace in Figure 4 is generated as a mechanical model of soliton waves generated by the sine-Gordon equation which has periodic soliton solutions. Note the similarity to Figure 3 which is a magnetic signal observed with the T-1050 displayed in the time domain at about 31.5 Hz which can be decomposed into a 30 Hz signal *heterodyned* with a 1.5 Hz rotational vector. The amplitude is 2 volts/division for a one second trace. Pulse modulation at 3.33 Hz was observed. Normally one would describe this signal as a Heterodyne of 30 Hz and 1.5 Hz but the rotational wave characteristics are better seen in the nonrailed signal in Figure 3, the second trace. The signal in the top trace in Figure 3 is actually a slice in two dimension from a rotational wave in five dimensions or five dimensional rotor or screw wave which is like a five dimensional twister algebra related to a four dimensional spinor calculus.

In Figure 5 is a five dimensional representation of this screw or rotational wave. To represent it in a two dimensional figure on flat paper, we consider amplitude as a function of x only rather than x,y and z. The other variables of the wave amplitude are time, t, and frequency, μ, where $t \neq 1/\mu$ but $t = 1/\upsilon$ for $\upsilon \neq \mu$. This figure can explain the observation seen in Figure 2 and 3 and a great deal of other similar data with the model of the multidimensional soliton wave. Figure 6 is a schematic representation of the tube-like waveform in x,t,τ space which moves like a "slinky" toy. The "slinky" coils represent the Fourier of the magnetic field and can be seen as the wave with spikes in space and time.

Simple solutions to solitary wave equations can be found in terms of the usual conic section form of the trigonometric functions of sines and cosines built on the relationship to the sphere. Simple second order equations generate parabolic and hyperparabolic forms $x^2 +- y^2 = c$ as contour integration of exponential functions in the complex plane $z = x + iy$ for $i = \sqrt{-1}$.

We will examine the properties of Fourier and Laplace transforms and Lorentz invariants conditions and relate these to Gausses' theorem.

Consider a simple description of the waveforms and their relationship and the frequency and time domain to generate Figure 5. Consider the simple case where the cross-sectional area of the volume generated by and swept out in the frequency and time domain in circular so that more forms observed in the frequency and time domains appear the same. Also consider the envelope on the curve as seen as extended oscillation, in their amplitude dependence or frequency and time, obey sine waves such as $x = \sin(t/t_o)$ and $x = \sin(f/f_o)$ contained under the envelope of the curve. Note that in general, the five dimensional travelling wave can be elliptical, having different "periods" or extensions in time and frequency, for example, the extension in time could be associated with the major axis and the extension in frequency with the minor axis of the ellipse in Figure 5, w represent only one period cycle in the x-t and x-f planes.

In actuality, waveforms in space and time and frequency dependence extend out in the x-t (also termed x-υ) and x-f (also termed x-τ or x-μ) planes so that wave effects extend as amplitude disturbances in the five dimensions of (x,y,z,t,τ) for t association with υ and τ with μ or *f* in Figure 5. Then the t-f, x-t and x-f planes represent slices through the five dimensional space. Even though the figure looks like these planes are generated by a projective geometry, in fact we consider a mapping procedure which does not produce distortion. We will consider an example of this later. For the wave amplitude extension, we consider one dimension x of space only rather than x,y,z considering the relationship of frequency and time, the simplest case becomes t = 1/f (where we use f and υ interchangeably). The case where t = 1/f is given in Figure 1 in which we observe a sine like wave forms in the time domain and spike wave forms in the frequency domain. In Figure 5, we can associate f with υ (and t) or μ (and τ). This form in general obeys that for a rectangular hyperbola of the form $(t/t_o)^2-(f/f_o)^2 = 1$ asymmetrically bound to the upper quadrant t and f axis, with a lower image and symmetry exists for $t_o=f_oc_o^2$ so that $t^2-f^2 = t_o^2 = f_o^2c_o^4$ is a unit length space of c_o for velocity $c_o = l_o/t$ for l_n dimensionless, gives the gradient of the asymptotes gives $\tan\alpha = \pm 1$ for $\alpha = 45$degrees. Note also that $t = t_o \cosh\eta$ for $\eta = (fc_n)/(f_oc_o)$ which is dimensionless.

Returning again to Figure 5, the frequency and time relationship of τ and μ act as a rotational frequency in x, τ space. The general relationship x,t,τ can be represented as a circle or ellipse as a slice through the 3 space x,t,τ in the one dimension of space, x approximation in which we use to solve the sine-Gordon equation. Then we can write $(t^2/t_o^2) + (\tau^2/\tau_o^2) = I$ where $|t/(rc_o)|\leq 1$ and $|\tau/(rc_o)|\leq 1$ and let $c_o=1$ and where r is an average radius of a circle, $t/r = \cos\theta$ and $\tau/r = \sin\theta$ and $t+1'\tau=r(\cos\theta+i\sin\theta)$ where r is in units of t and τ (in seconds) for $C_o=1$ and $0\leq\theta\leq 2\pi$. Consider the case where v=30Hz "heterodynes" with the μ=1.5Hz signal, then t=0.033Hz and τ =0.667 (about 1 second). Then the rotational process in 5D spaces moves 1.5Hz as seen in our data in Figures 2 and 3. The value r is defined as $r=\sqrt{t_o^2+\tau_o^2}$ with eccentricity $e=\sqrt{(t^2/t_o^2)+(\tau^2/\tau_o^2)}$ or taking $t_o+\tau_o=1$ then we can write $e=1/t\sqrt{1-\tau^2/t^2}$ so that $t=e\ 1/\sqrt{1-\tau^2/t^2}$.

In general, proceeding with the Cauchy Integral theorem in the complex plane, we define an analytic function f(z) in a simple region of space bounded by a region, R of the Argand plane. Then on a simple closed path in R, we have $\oint f(z)\,dz = 0$ where $z = x+iy$ where the vector z makes an angle θ with x. For a circle $\oint dz/z = 2\pi i$ for $i=\sqrt{-1}$ and x, y and θ are real. For this example $z=Re^{i\theta}$ the real and imaginary exponential occupy a fundamental role in describing our sections and the geometry of electromagnetic waves.

Consider the conformal mapping from a linear space to an elliptic or hyperbolic plane. For W=u+iv, x=a sinμ coshμ and y=a cosμ sinhμ for v= a constant not equal to zero maps to an ellipse and μ= constant not equal to zero maps to a hyperbola in the z plane. If $W=\sin^{-1}(z/a)$ then z = a sin w. Note that these procedures generalized to the complex plane, generate the conic forms in terms of exponents such as $e^{ix}= \cos x + \sin x$ and $e^{x}= \sinh x + \cosh x$ and $\cos ix = \cosh x$. A number of the trigonomentric and hyperbolic functions can be generated from the real and imaginary exponents. Note that the hyperbolic functions sinh x and cosh x describe th path of a chain suspended at two points.

Turning our attention to what appears as a series of Fourier components, we consider Laplace and Fourler transforms. Consider the Laplace transforms of the Bessel function $J_o(t)=\sum_{n=0}^{\infty}(-1)^n/(n!)^2\,(t/2)^{2n}$ which gives the transform $\phi(P)=1/\sqrt{1-\rho^2}$; where P→0 and

$\int_0^\infty J_o(t)dt = 1$. Returning to the usual Fourier transforms written before for $\theta(t)$ and ϕ (w), we have ϕ (w) as e^{-w} transforming as $\sqrt{2/\pi}(1/(1+t^2)$ or e^{w} transforming as $\sqrt{2/\pi}(1/(1-t^2)$. Let us briefly turn our attention to invarient conditions.

Note simply that if $x^2/r^2 + y^2/r^2=1$ for $z=x+ib$ represents a parabola then the complex conjugate of z or $z'=x-ib$ generates the equation of a hyperbola $x^2/r^2 - y^2/r^2=1$ for $|z|=r$. Orthogonality of states can be defined here in terms of z and z'.

Forms such as $\int dx/\sqrt{1-x^2} = arc\sin x$ occur. For the proper time $t'=t\sqrt{1-\beta^2}$ for $\beta \equiv v/c$ which defines the "four vector velocity" $v=dx/dt$ and the time-like component is

$$P_4 = t = mv_4 = \frac{imc}{\sqrt{1-\beta^2}}.$$

An equivalent set of Lorentz conditions are made at a low velocity of propagation and these are the forms that we use in the theoretical soliton model presented in the text.

In the the usual four space representation we use the (+ + + -) signature so that x_4 or time = ict where a four vector space (space and time representation) requires a complex space description. Consider the example of a uniform magnetic field along the z axis when charged particles will move in a circle in this field. We will say a few words about the particle path of motion in the relativistic approximation detailing more in a future paper. In a uniform magnetic field, the particle velocity and momentum goes as $v \propto u \cos kt' + u \sin kt'$ where $k=(e\mu_o B)/mc$ and in a uniform electric field $v'=c \sinh Kt' + b \cosh Kt'$ for $K=eE/mc$ where the proper time, t' define the relativistic and invariant is given as $t = [(1+\mu^2+v^2)/c^2]t'$ and $dt/dt'>1$ which means that when the energy of the system increases, the orbital particle path becomes smaller which is the resonant principle of the cyclotron. Also this principle applies to the MASE process in ELF phenomena for the magnetic amplification of stimulated eletrons.

Invariance principles are statements of conservation laws. Gauss's theorem defines the conservation of flux or charge within a closed surface S. Applied to electric fields $\iint_S E \cdot dS = 4\pi Q/\varepsilon_o$ where Q is the algebraic sum of all charges inside the surface, S where the integral is taken over the surface, S. This condition expresses the manner in which a Faraday shield works and applies to the conditions on the operation of the shielded coil for the T-1050 detector. We can write Gauss's theorem in terms of the electric potential or $\iint \overline{E} \cdot \overline{dS} = -\nabla^2 V$ so that we have Poisson's equations as $\nabla \cdot E = -\nabla^2 V = (4\pi Q)/\varepsilon_o$ where units $\varepsilon_o=1$ are often used. We can apply Gauss's theorem to fields other than electric fields--such as the earth's gravitational field. Application of Gauss's theorem and a Poisson-like formalism can be applied to magnetic flux conservation on a hyper-dimensional surface defined in five dimensional space. This conservation principle leads to the great stability ELF flux phenomena that is well described by Soliton physics.

The usual form of Poisson's equation is $\nabla^2 v = 4\pi\rho$ in three dimensions, which Einstein expanded to four dimensions $[]^2\phi = 4\pi G/C^4$ in general relativity. We write a similar expression in x,y,z,t,τ space as $\underline{\|}^2 \phi = 32\pi\rho_\beta/C_o^4$ where ρ_β is the magnetic flux density in five dimensional states. We define the generalized Laplacian form as before as $\underline{\|}^2 \psi = []^2\psi - 1/c_o^2\, \partial^2/\partial\tau^2$.

The magnetic flux field, B in five dimensions acts as a bundle of the magnetic flux lines in a variable diameter cable tube. The magnetic flux potential is conserved in five dimensions forming Gauss's theorem in an analogous manner to that done in three dimensions, we define a surface integral over a four space S_4 and define a magnetic flux vector B_5 in five dimensional space having a flux density ρ_B of so that

$$\int\int\int\int_{S_4} = B_5 \cdot dS_4 = \frac{16\pi\rho_B}{C_o^2}$$

See reference 9 for a more detailed description of the model and its application to geophysical and other magnetic flux phenomena.

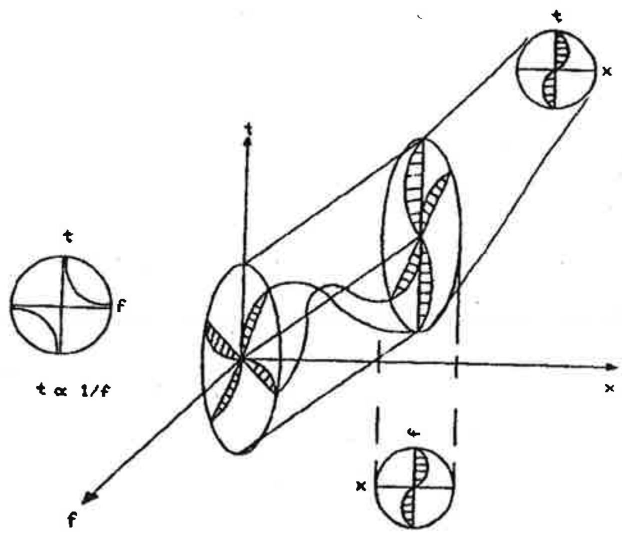

Figure 5. In this figure is displayed a symbolic representation of the rotational or twister wave in five dimensional space.

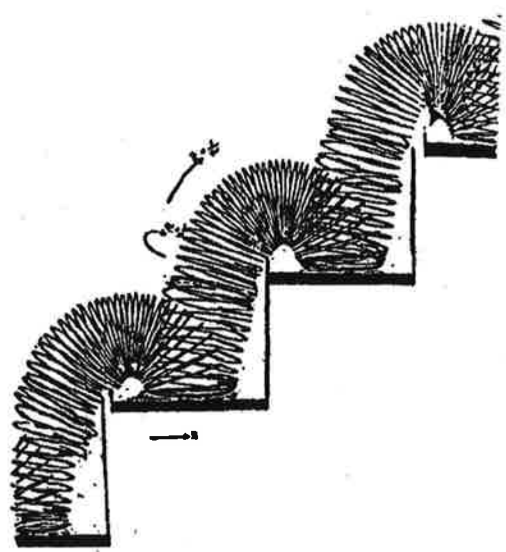

Figure 6. Representation of the Fourier components of an ELF wave in a Five Dimension Space in which the frequency and time domain appear to be similar to each other.

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(Together they hold US patents #4,724,390, #4,723,536, and #4,889,526. The first patent '390 is a non-superconducting ELF amplifier that triangulates the location of a pending earthquake, based on the well-known ELF signals that the piezoelectric rock emits while stressed, just before the impending movement we call "an earthquake." It is a masterful work that I highly recommend for those who want to learn more about the earth Schumann cavity, earthquake detection, and ELF waves, while being very readable and comprehensive. The USGS could be using the Rauscher/Van Bise invention to warn Californians, for example, before any major earthquake. Some of the patent content is discussed on p. 233-234 of this book. – Ed. note)

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