A Theory of the Relativistic Fermionic Spinrevorbital

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The Little Rule and Effect describe the cause of phenomena of physical and chemical transformations on the basis of spin antisymmetry and the consequent magnetism of the most fundamental elements of leptons and quarks and in particular electrons, protons and neutrons causing orbital motions and mutual revolutionary motions (spinrevorbital) to determine the structure and the dynamics of nucleons, nuclei, atoms, molecules, bulk structures and even stellar structures. By considering the Little Effect in multi-body, confined, pressured, dense, temperate, and physicochemically open systems, new mechanisms and processes will be discovered and explanations are given to the stability of multi-fermionic systems for continuum of unstable perturbatory states with settling to stable discontinuum states (in accord to the quantum approximation) to avoid chaos in ways that have not been known or understood. On the basis of the Little Effect, the higher order terms of the Hamiltonian provide Einstein's missing link between quantum mechanics and relativity for a continuum of unstable states.

Introduction:

The Little Rule by R.B. Little determines that the spin states of radical reactants, radical catalysts, electrons, protons and neutrons allow and induce revorbital rehybridization, acceleration and asymmetric dynamics for important transformations to determine asymmetric reaction trajectories to specific products. Such aspects of the Little Rule can cause spin frustration of the orbital symmetry of Woodward-Hoffmann reaction dynamics [1,2]. The implications of the Little Rule will lead to novel chemical reaction dynamics of solute in paramagnetic and ferromagnetic media and the useful control of these transformations by external magnetization. Such novel chemical reaction environments will contribute conditions such that radical intermediates can be controlled by external magnetic field so as to select between Lewis sigma bonds and Lewis pi bonds and various bond rearrangements. G.N. Lewis first determined electron sharing as the basis of covalent bonds within molecules and he first suggested that radicals may be studied by using external magnetic field [3]. M. Kasha developed theories for energizing molecules and molecular energetic redistribution within molecules {Kasha Rule}[4]. M.A. El-Sayed determined that optical absorption between certain orbitals may induce intersystem crossing due to the intrinsic orbital interactions between the excited electron and its ground state partner {El-Sayed Rule} [5]. The Little Effect determines spin induced revorbital asymmetric mechanics that can result from radical interactions in densely reacting media. Whereas the El-Sayed Effect considers Lorentzian Effects of electrons going into different orbitals for promoting intrinsic intersystem crossing, the Little Effect involves phenomena whereby the Lorentzian Effects by dense spin environments cause altered electronic revorbital motions. Moreover on the basis of the Little Effect an external magnetic field may orchestrate desired reaction trajectories. On the basis of the Little Effect, not only can radicals be analyzed by external magnetic field according to G.N. Lewis but their reactions may also be controlled by external magnetic field. In addition to chemistry, such spin, revorbital and magnetic phenomena associated with these fermions provide a basis for understanding physical transformations. It has been stated that magnetism organizes the universe [6]. Beyond galactic dynamics, the Little Rule demonstrates such magnetic ordering even on the minute scales of molecules, atoms, nuclei and nucleons. For instance, spin is intrinsic to the existence of fermions: n, e^- , p^+ [7-11]. Spin is an aspect of the most fundamental particles: quarks and electrons. On the basis of the Casimir Effect [12, 13] and the Meissner Effect [14, 15], the spin is thought to contribute to the stability of such point particles from their self internal repulsion and self disintegration. The Little Effect explains the Meissner Effect. The spin and resulting magnetic field of the charge in motion generates a magnetic field that holds the charge together, thereby organizing the internal structure of the universe on the scale of point particle. The same spin motion that holds the electron together causes its revolution about protons and affects its fusion to the proton to form a neutron. On the basis of the Little Effect, fermionic spin on the grander scales accounts for the statistics and organization of nucleons, nuclei, atoms, molecules and bulk materials and even stellar and galactic material assembles. As a result of spin and the resulting magnetism causing order, the synthesis of materials on these various scales must take spin effects into consideration. Moreover spin and revorbital motions contribute to symmetric aspects for various transformations such as beta, reverse beta, fusion, fission and chemical dynamics. For example, asymmetric spin induction of asymmetric revorbital dynamics (the Little Effect) has provided the foundation for a comprehensive mechanism of carbon nanotube formation [16] and also the resolution of the diamond problem [17]. Novel properties of CNT such as H storage and its electrochemistry [18] may be explained by spin phenomena and revorbital motion according to the Little Effect. The puzzle of reducing the atmosphere (nitrogen) by the Haber process ($N_2 + H_2 \rightarrow NH_3$) [17] is better understood and advanced based on spin induced revorbital effects of rehybridization as outlined by the Little Effect. The Little Rule also applies to important reaction effects associated with singlet oxygen with explanations for its distinct reactivity relative to triplet oxygen. Singlet oxygen has distinct reactivity relative to triplet oxygen [20, 21] due to the different spin induced rehybridization in its reacting partner for accessing different structural products.

The Hamiltonian:

The Little Rule includes higher order terms of the Hamiltonian that contribute significant kinetic factors to reaction dynamics for discriminating various product bond symmetries and statistics. Obviously, for some thermodynamic systems the higher order spin, revorbital and magnetic interactions of the Hamiltonian cannot contribute to thermodynamic stable state as does the columbic factors (also possibly dominating Newtonian gravitational interactions, weak interactions and strong interactions in some systems), but in many systems the spin effects and revorbital motions may discriminate and select between various metastable states and even dictate the transformations [22, 23]. F.A. Cotton has demonstrated some of these spin and magnetic effects in some 3d metal compounds [24]. Also in some dense systems (with great charge, with large kinetic energy and with high spin densities and consequent rapid organized motion), the magnetic fields, spin and revorbital interactions can be tremendous with significant and possibly dominating influences on the Hamiltonian. But even with thermodynamic instability, the transient formation of revorbital variety by spin inductions may cause important ultrafast catalytic effects within such systems [16, 17]. On the basis here of the Little Effect, such ultrafast catalytic effects is a future area for femto-chemical analysis by current femtolaser spectroscopy [25]. Such higher order terms can contribute to antisymmetric and non-preservation of orbital dynamics during chemical reactions in paramagnetic and/or ferromagnetic environments so as to compliment the Woodward Hoffmann Rule [1,2] of orbital preservation during chemical reaction dynamics. These kinetic effects on chemical reactions according to the Little Rule are most obviously discerned in chemical systems involving atoms associated with the Russell Saunders coupling scheme, rather than the jj coupling scheme.

With more terms of the Hamiltonian, Einstein's missing part [26] is determined as the complex revolutionary and correlational (spinrevorbital) motions of dense, confined spins and charges in rapid motion for a continuum of unstable states with nonclassical quantum states determined by the stationary states relative to perturbative induced unstable continuum states by spinrevorbital complicated fermionic motion. On the basis of the Little Effect, here it is suggested that the important crucial revolutionary e^- --- e^- (spinrevorbital) motions (determining the fermionic correlation) are missing in the Hamiltonian of atoms and other of densely confined, temperate systems. These missing fermionic revolutionary (spinrevorbital) motions and interactions contribute to ultrafine structure of such systems such that the finer structures determine more of a continuum. This continuum caused by the missing revolutionary (spinrevorbital) motion results from and involve states of unstable perturbation that readily and efficiently transform to the stable quantum mechanical discontinuum states for explanation and determination of such mysteries as tunneling effects [27], Raman effects [28], fractional quantum Hall effect [29], superconductivity [30], ferrimagnetism [31], solar neutrino problem [32], neutrino oscillations [33], Josephson Effect [34], tautomerism, pyconuclear [35] processes and other oddities not fully captured by Schrodinger's and Dirac's equations. Without these higher order missing parts, the discontinuity of states manifest; this discontinuity is actually the stable states that exist between perpetual ever-present reversible perturbations to this ultrafine continuum of unstable states.

Such continuum unstable states of perturbation are the basis for Planck blackbody and quantization phenomena [36]. The oscillations of the blackbody can execute a continuum (hence its blackness) of oscillations, but on the basis of the quanta certain vibrational energy distributions are more probable and thereby more statistically stable. Quantum mechanics was born by Planck on the basis of this seeming energetic discontinuity. In essence, there is a continuum of oscillations but the discontinuum is actually an approximation reflecting the statistical stability (higher probability) of these quanta of oscillations and also reflecting the infinity of states between quanta such that conservation of energy would not allow the statistical oscillation of all such continuum (between quanta) of oscillations. So the continuum exists, but the oscillators just distribute the energy among specific modes (for a discontinuum) on the basis of the temperature. On this basis, the quanta do not reflect the possible mechanics but the more probable mechanics and dynamics (and hence the probabilistic nature of quantum mechanics and Born's subsequent interpretation). Here it is interesting to note this dependence of the quanta on the total energy and how the distribution changes with temperature. As the energy of the system increases the possible energetic states approach more of a continuum. Thereby here it is wondered if in the limit of infinite energy if all or more of the continuum is manifested. The oscillations of the atoms depends directly on the oscillations of electrons. Thereby a continuum of atomic oscillations would determine a continuum of electron motion on the basis of the Rutherford type atom [38] and a discontinuum would determine electron motion on the basis of a Bohr type atom [37] with Schrodinger [39] and Heisenberg [40] implications. Here it is suggested that a continuum exists but not as in the Rutherford atom but the continuum exists with order within the orbit configured by Bohr; with order within the orbital as configured by Schrodinger and Heisenberg and their shells, subshells and orbital; and with order within the spin as configured by Pauli [41], Fermi [9] and Dirac [11] with their electron spin; and moreover based on the ultra-hyperfine order by the hyperconfiguration by this Little Effect of electron --- electron revolution superposed on spin and orbital motions for spinrevorbital motion. This complex superposed revolutional motion within orbital motion is coined here revorbital motion, which in combination with spin becomes spinrevorbital. The here proposed spinrevorbital motions of fermions cause a continuum of ordered unstable states with a few stable modes (quanta) that rapidly develop from relaxation from perpetual disturbances to these virtual continuum unstable states (for the quantum mechanical approximation). So here it is demonstrated that quantum mechanics is not wrong, it is a great approximation of some higher but unstable, relativistic order. Such order in instability (far from equilibria) has been demonstrated in science [42]. The extreme, ultra-fine structure of instability develops by the Little Effect on the basis of spin induced revolutional motion based on relativity that is superposed on orbital motion for spinrevorbital motion.

Here it is suggested that the continuum and its instability are the results of relativistic effects of the correlated revolutionary nature (spinrevorbital) of the fermionic electrons. Upon perpetual excitation to these continuum unstable states from discontinuum stable states, the unstable continuum rapidly relaxes back to the stable discontinuum states. The instability of the continuum states has to do with statistical improbability of distributing the energy in such states. It is on this basis that here the Raman Effect [28] is explained within a discontinuum of states such that the unstable quanta of the Raman state involve the unstable (statistically unprobable motion and interaction) spinrevorbital motions of electron pairs such that the spinrevorbital of this instability determines an acceleration that offsets there coulomb repulsive force and pulls them back into stable stationary spinrevorbital states of lower energy by photon release. The photon can disrupt the stable quanta to a higher energy unstable continuum state but within this continuum unstable state the revolutional motion is not broken so the electrons rapidly relax back to the lower energy discontinuum stable state by releasing the photon for the Raman Effect. The exciting photon accelerates the electrons counter to their mutual acceleration within the stable spinrevorbital state. If the photon acceleration is less than the spinrevorbital accelerated motion then the photon causes a virtual state of the spinrevorbital and is immediately released so the lower energy stable spinrevorbital reforms. If a photon of sufficient and matching energy is absorbed by the correlated stable spinrevorbital motion of the electrons a lower energy state, then the relativistic electron ---electron spinrevorbital motion can be transformed such that the one electron is excited to upper level stable quanta for different spinrevorbital motion and mode. On the basis of the Little Effect, it is important to consider the nature of this spinrevorbital transformation. The unmatching Raman photon excited the electron pair into different revolutionary motion with possibly similar orbital motion (Born-Oppenheimer and Franck-Condon Laws). Here it is important to note that the kinetics of spin dynamics exceeds e – e revolutional dynamics and the e – e revolutional dynamics exceed the kinetics of orbital dynamics for the superpositioned spinrevorbital. It is by this dynamical effect by the Little Effect that spin is so important for certain disequilibria and structural changes. But now the Raman photon cannot alter the spin multiplicity but it alters the e --- e revolutionary mode for fixed orbital modes. The statistical improbability of the resulting continuum revolutionary modes leads to its reformation by photon release for relaxation to the more probable e --- e revolutionion of the lower energy stable discontinuum state. However if the Raman photon has high enough energy, then it can excite a large enough e – e revolution such that the revolution couples to the orbital modes of high orbital state to transform the lower orbital mode to an outer orbital for different spin revorbital in an upper level stable discontinuum mode. These explanations by the Little Rule account for violations of the $\Delta l \neq 1$ for many photo-physical processes. Furthermore the different spinrevorbital motion of the excited stable state relative to the ground state may allow spin transition (El-Sayed Effect) [5]. Here the Little Effect explains the El-Sayed Effect. It is important to note that in addition to the El-Sayed Effect, an external magnetic field can change the Hamiltonian for triplet formation within this upper level stable state. By the Lewis Rule, phosphorescence [3] requires spin change for the electron to relax from the triplet state by photon to the spinrevorbital bosonic ground state. In such a case, the external magnetic field disrupts the bosonic spinrevorbital changing the statistics to fermionic states. But stronger magnetic fields are needed to break the bosonic spinrevorbitals of the lower energy virtual states. It is on this basis that the bosonic spinrevorbital motions repel magnetic fields. The field created within the bosonic spinrevorbital pair by relativistic motion (current) is too strong to be aligned by the weaker external magnetic field so the external field causes an opposing circulation within the bosonic spinrevorbital for repulsion. It is important to note that the strength of the spinrevorbital motion depends on the bond strength of the boson. So the energetic ordering of bosonic spinrevorbital motion is sigma > pi > delta for the order of increasing spiral strength and correlation. Phonons and high temperature can assist the external magnetic field breaking the bosonic spinrevorbital state to transform it to a fermionic pair. It is on this basis that R. B. Little breaks pi bonds of graphite at 900 ^{o}C in hydrogen atmospheres and Fe media with 20 tesla magnetic field for diamond formation in the open atmosphere. So this account of the Little Effect explains the Meissner Effect [14, 15] as a relativistic stabilization of electron --- electron spinrevorbital motions that will not allow magnetics disruption by weaker external currents relative to the greater internal current of bosonic spinrevorbital current. On the basis of the Little Effect, here it is suggested that the spinrevorbital motions and the consequent relativistic effects and revolutional statistical effects cause the instability of the continuum virtual states and the quanta effects for disrupting the lower energy revolutional motions into higher energetic stable excited revolutional correlated states of fermionic distribution within shells, subshells, orbitals and multiplicity. The photoelectric effect and Einstein's photon quanta [43] are consistent with this view of the Little Effect. The electromagnetic radiation behaves as quanta because only chunks of sufficient energy are able to instantaneously (within the speed of light) disrupt the stable electron -- electron spinrevorbital motion into a different state of electron --- electron spinrevorbital motions or eject the electron from the orbital (photoelectric effect). If the photon chunk has insufficient energy then a continuum of unstable states (virtual states) are excited, which (within the speed of light) rapidly relax to the stationary state due to relativistics and revolutional statistical factors of the spinrevorbital motion. The beauty of this explanation by the Little Effect is revealed by its consistency with light-matter interactions, as well as laser effects on matter. Unlike incoherent light, laser light is coherent, polarized and in phase [44]. Such properties of laser light allow multiphotons of coherence and synchronization to simultaneously act on virtual continuum states in a way not possible by incoherent light such that the laser photons can compete with relativistic motion within the spinrevorbital virtual state so as to excite the unstable intermediary virtual state of the spinrevorbital to upper level stable spinrevorbital states or even cause ionization before the virtual state can revolutionally relax and release its photon. Intense incoherent light is not likely to do this with any significant probability because the photons although of the same frequency are very improbable of the same polarization and phase for proper phase relation and timing with the unstable virtual state caused by the first photon.

For consistency, it is important to demonstrate on the basis of the Little Effect, the application of the spinrevorbitals even to the one electron hydrogen atom. One can easily image complex revolutionary orbital motions (spinrevorbitals) of multi electron systems, but even the single electron of the hydrogen atom is better understood on the basis of spinrevorbitals. Niel Bohr provided a great model of the hydrogen atom [37] on the basis of mixing classical mechanics with certain quantum hypotheses motivated by Planck [36]. Bohr's model accounts for Rydberg's curves fitting of optical spectra of the hydrogen atom. But Bohr's model failed for multi-electron atoms. The hyperfine structure of hydrogen in magnetic field [45] due to Zeeman Effect and Lamb shift require a different Hamiltonian than the Bohr model. Here on the basis of the Little Effect, other properties of the hydrogen atom beyond the Zeeman Effect [46] and Lamb Shift [47] are not accounted for by the Bohr, nor Schrodinger [39] and not even Dirac's [11] Hamiltonians. Certain chemical properties of hydrogen (such as h-bonding, acidity, hydrogen in metals) are not captured fully by Dirac's [11] relativistic quantum mechanics. A more thorough account by the Little Effect involving relativistic of both electron spin, revolution, orbital and relativistics of electron --- proton correlated motion (spinrevorbital) gives better perspective of hydrogen's properties. On the basis of the Little Effect, although the electron orbits the proton in orbital, the electron also revolves in its orbital motion. Here it is suggested that the electron spinrevorbital motions are caused by its self interactions within its own orbitals. The electron spirals in its orbital motions on the basis of its spin interactions with its own orbital motions so as to stabilize its orbital existence near the nucleus. These self interactions cause greater complexity of hydrogen beyond Bohr's model and even Dirac's model by higher order complex interactions: e^- spin --- p^+ spin interactions, e^- orbit --- p^+ spin interactions, e^- revolution --- p^+ spin interactions, e^- spin --- e^- orbit interactions, e^- spin --- e^- revolutional interactions, e^- orbit --- e^- revolutional interactions. These higher order self interactions of the electron cause the unstable continuum of possible states and the consequent probabilistic behavior. On this basis, the electron's position and motion phenomena manifest probabilistically in wave pattern described by the wavefunction and Born's interpretation. On this basis, the Zeeman Effect, Lamb shift and unique chemistry of hydrogen are understood as a modification of this Dirac Hamiltonian such that the spin, orbital and revolutional effects contribute more spinrevorbital for different wavefunctions and energies. Here on the basis of the Little Effect, it is demonstrated that strong external magnetic fields and spin --- spin exchange environment lead to novel chemical, physical and catalytic properties and systems for hydrogen as in novel CNT and diamond formations, novel lower temperature metal eutectic, unusual electrolysis, protolysis, hydrogen bonding and anomalous pycnonuclear fusion.

These implications of the Little Effect for more complex revolutionary electron --- electron motions and correlations provide the ultrafine structures that explain the wavefunction and its probabilistic determination of particle position (Δx) such that different positions of the confined particles would exhibit different revolutionary motion (Δp) on the basis of this ultrafine structure. Here by the Little Effect on the basis of this missing part (spinrevorbital), the Hamiltonian becomes more subject to relativistic effects due to relative motion of pairs of revolutionary and spinning particles relative to other particles. This consideration more thoroughly links relativity and quantum mechanics with dramatic implications concerning the approximate nature of quantum mechanics. Pauli [41] and Dirac [11] began this linkage of quantum mechanics and relativity with their experimental and theoretical determination of the electron spin motion. Here by the Little Effect, this integration of relativity and quantum mechanics is furthered by introducing an even finer internal electron-electron revolutional dynamics, superimposed on electron pair orbitals for spinrevorbitals about nuclei. Here it is suggested that excluding such (missing) revolutionary spinrevorbital motion of the correlating pair causes the uncertainty principle. The exclusion of the missing revolutionary motion (Δp) of correlation and the consequent less known interactions (Δx) limit the knowledge relative to the more detailed (revolutional) Hamiltonian for consequent greater uncertainty. Therefore on the basis of the Little Effect, the spins, fermions, and charges cause revolutionary (spinrevorbital) motions for pairing for correlation and higher order terms of the Hamiltonian that determine a nonstationary continuum with novel implications concerning the exactness of the discontinuous, probabilistic nature of quantum mechanics. On the basis of the Little Effect, the inclusion here of novel revolutionary spinrevorbital motion in the Hamiltonian is analogous to the inclusion of spin and high order magnetic interactions by Dirac [11]. By doing this with relativistic inclusion, the spin naturally popped out by Dirac's relativistic [11] modification of the Schrodinger equation [39] which led to a better description of atomic, molecular and matter-light interactions and accounted for Pauli's exclusion principle [41]. Here of the basis of the Little Effect, an analogous addition (as by Dirac) to the Hamiltonian of this revolutionary motion (superposed orbital and spin motions for spinrevorbital motion) results in more accurate (but unstable) detailed continuum of states (but unstable states) that will explain such effects as tunneling, Raman effect, superconductivity, low temperature fusion and more. On the basis of such complex revolutionary internal motion of fermions and its absence in the Hamiltonian the wave nature of the confined fermions arises in terms of the wavelength which corresponds to the length scale (Δx) of the uncertainty in its position which arises due to the missing correlated revolutionary bosonic (fermionic) pair motion (Δp). The neglect of the correlated revolutionary motion (Δp) causes an approximate location (Δx) for uncertainty. On this basis of the Little Effect and correlated revolutionary motion of fermions, the experimental de Broglie wavelength [48] is explained on the basis of the nonlinear motion and revolutionary (spinrevorbital) tension impressed on electrons, neutrons and/or protons by an atom or many atoms in molecules or by a diffracting crystal lattice as observed by Davisson and Germer [49]. It is quite remarkable that the experiment of Davisson and Germer [49] employed a Ni crystal with its ferromagnetism, which made it easier to discern what appeared in the quantum approximation to be electron waves but here it is determined as higher order scattering of the incident fermions by the fermionic lattice spinrevorbitals. The wavelength of diffracted fermions is more a complexity of ultrafine temporal and spatial dependent lattice states that nonlinearly accelerate the fermions. The uncertainty involves the complexity of such ultrafine effects and the extreme difficulty with measuring and observing the dynamics.

Nucleon Configuration:

The nucleus consists of protons and neutrons. Protons and neutrons are fermions with spin of ½. The proton consists of quarks. The neutron also consists of quarks. The quarks are subject to the strong force. The strong force holds the nucleons together and residually holds the nucleus together. The strong force is on the order of a hundred times greater than the electric (Coulomb) force. Quarks possess both charge and spin. The electron has charge of -1. The up-quark has charge of 2/3 . The down-quark has charge of -1/3 . The electron has mass of 0.000511GeV/c^2. The up-quark has mass of 0.003GeV/c^2. The down-quark has mass of 0.006GeV/c^2 . The proton consists of two up-quarks and one down-quark for a net charge of 2/3 + 2/3 – 1/3 = +1. The neutron consists of two-down and one up-quark for a net charge of -1/3 -1/3 + 2/3 = 0. The leptons and quarks have the property of spin. They have spin such that they are fermions. Fermions have spin of ½ . Bosons have spin of 1.

What is spin? It denotes symmetry according to rotation. Zero spin behaves like a point. Spin of 1 has symmetry of rotation 360 degrees for indistinguishability. Spin ½ has symmetry of rotation 720 degrees for indistinguishability. Spin of two is indistinguishable after rotate of 180 degrees. Leptons have spin of ½. Quarks also have spin of ½ . The electrons and quarks must be rotated 720^o (rotate twice) for indistinguishability. The spin is an aspect of subatomic particles and their possible constituents. Because of the charge of these particles and their internal motion, the spin attributes magnetic properties to these fundamental entities [7, 9, 10, and 11]. Such spin magnetism is an essential aspect of the statistics, the order, the structure and (as here reported) the dynamics of these fundamental particles even in their assembly into complex structures of nucleons, nuclei, atoms, molecules, bulk matter, planets, stellar, galactic and larger systems thereof.

Measurements at CERN have demonstrated that the proton spin is not a simple result of summation of its quark spins [50]. This research has demonstrated that the proton and its spin are a lot more complicated. Here it is suggested that the quarks move relative to each other. On the basis of the Little Effect, here it is suggested that the two up-quarks of the proton revolve (correlate) relative to each other to minimize their electric repulsion. This revolution of the up-quarks in their relative spins and magnetisms causes a magnetic attraction that opposes the electric repulsion of the two up-quarks of the proton. According to the Little Effect, this effect of the revolution (correlation) (spinrevorbital) on the pairing of the up-quarks is a spin induced revorbital motion that compensates the coulomb repulsion of the two up-quarks of the proton. The two revolving up-quarks also revolve about the down-quark in the proton. Here it is suggested that the quarks are bound relativistically together on the basis of these relative revolving accelerating motions (correlation) in their spin-magnetic and coulomb fields. On the basis of the Little Effect, the strong force is explained as relativistic revolutions (spinrevorbital) (correlation) of the quarks. On the basis of the Little Effect, the weak force is explained as a relativistic revolution (spinrevorbital) (correlation) of a lepton about a quark. The strong force has been evoked to explain the existence of the nucleus against the repulsion of like positive Coulomb charges of the protons of the nucleus. Here it is suggested that this strong force is actually an aspect of electromagnetic effects associated with the relativistic revolutions (correlation) of quarks to miminize their coulomb repulsions. In the proton, such relativistic revolutions of the up-quark about the other up-quark creates magnetic attractive interactions to counter the electric repulsive interactions of the two quarks. According to Einstein [51], acceleration is as a loss of mutual gravity (force). On the basis of the Little Effect, here it is suggested that the resulting acceleration from the relativistic quark revolution (correlation) is equivalent to a loss of coulomb electric repulsion of the two quarks. The two up-quarks in their mutual relativistic revolution (spinrevorbital) also relativistically revolve about the down-quark. This is consistent with Rosenzweig's theoretical quark confinement as a chromomagnetic Meissner Effect [52]. On the nuclear scale, two protons exhibit relativisitic revolutionary motion such that the down-quark is accelerated to the second proton and the second proton releases its down-quark of the other proton so there is complex revolutionary motion which confines the quarks to the two protons with residual confinement of the protons. The relatistic effect associated with the spinrevorbital motion by the Little Effect explains the mass-energy equivalence and such changes during nuclear and chemical transformations. Birnair [53] also hypothesized a coriolis antipairing theory for nuclear rotations by Meissner Effect. On the basis of the Little Effect, here it is suggested that the relativistic revolutions (correlation) of the quark fractional charges in their spin-magnetic fields are the source of the gluon! It is on this basis that the Little Effect explains neutron instability and proton stability.

The structure of the neutron is likewise of the proton's structure, but the neutron structure involves the mutual revolutions (correlations) of two down-quarks to overcome their electric repulsion with the further revolution (correlation) of the down-quark pair about the up-quark. The proton can transform to a neutrons via capturing an electron. But the capture of the electron would involve it associating with an up-quark. On the basis of the Little Effect, here it is suggested that the association of the electron with the up-quark is the basis of what is called the weak interaction. The Little Effect suggests that this weak interaction is actually a relativistic revolution (correlation) (spinrevorbital) of the electron about the up-quark. According to the Little Effect, the relativistic revolution (correlation) of the electron charge and spin about the up-quark charge and spin causes an electro-weak interaction that forms the down-quark. On the basis of the Little Effect, during the reverse beta process such relativistic revolution (correlation) of the electron about an up-quark within the proton causes the up-quark to form a down-quark which then undergoes transformation in revolution so it revolves about the other down-quark of the nucleon rather than its prior revolution about the remaining up-quark. The two down-quarks now revolve (correlate) each other to glue together and mutually revolve (correlate) about the up-quark to form the neutron. This process of reverse beta between an electron and a proton requires revolutional (momental) changes of the electron and quarks of the protons. These revolutional (momental) changes are complex and cause the low cross-sections of reverse beta and the need for neutrinos for such processes. The complex momenta processes of the reverse beta on the basis of the Little Effect explain why bare neutrons are unstable yet bare protons are stable. Such effects are consistent with Fermi's realization of the ghostly neutrino particle [54]. Such effects are also consistent with the observed handedness of the weak interaction [55]. On the basis of the Little Effect, here it is suggested that extremely strong magnetic field can cause increased cross sections for reverse beta. These extreme magnetic fields exist in neutron stars and magnestars [56]. On the basis of the Little Effect, magnetic field can organize and influence the electron-quark and quark-quark correlations during reverse beta, nuclear fission and nuclear fusion processes. Many of these effects of electron and quark pair revolutions (correlations) in their mutual spin and charge fields to form lepton and quark revorbitals are demonstrated in this manuscript.

Atomic Electronic Configuration:

Just as charge in motion and the resulting magnetism cause the internal structure of nuclei and nucleons, they also determine the structures of atoms. Electrons are coulombically drawn to nuclei. Electrons also interact with each other in their mutual proximity to nuclei. These electron --- electron interactions cause the configuration of electrons into electronic shells, subshells and spinrevorbitals about nuclei. These electron – electron interactions include e^- – e^- coulomb repulsion and e^- – e^-spin --- spin, e^- – e^-spin --- orbital, e^- – e^-spin – revolution, e^- – e^-orbital – revolution, e^- – e^-orbital – orbital, and e^- – e^-revolution - revolution interactions. Electrons pair in orbitals because of their mutual attraction to the nucleus causes them to exist in a close state that overwhelms their repulsion. The pairing of electrons in orbitals against their coulomb repulsions is further facilitated by the spin --- spin, spin – revolution, orbital – revolution, orbital – orbital, revolution – revolution, and spin --- orbital interactions within the electron pair, which leads to the spinrevorbitals. The Coulomb attraction of the electron pair to the nucleus causes their revolutionary (spinrevorbital) (correlation) motion about each other, which magnetically (relativistically) lowers their coulomb repulsion. On the basis of the Little Effect, the electrons of the pair go into revolution (correlation) so as to create magnetic attraction and the relativistic loss of their repulsive coulomb energy with their increase mass. This pairing of electrons in orbitals is analogous to the pairing of quarks in nucleons. They are both caused by spin induced revorbital motion of charges on the basis of the Little Effect. On the basis, of Einstein such relativistic acceleration [51] of the electron pair in their revolution (correlation) diminishes their coulomb repulsion. Here on the basis of the Little Effect, it is noted that even during chemical reactions nuclear effects and reactions occur although the energies are very minute. The pairing of electrons by the nucleus for a given shell number is greatest in the order: s orbitals > p orbitals > d orbitals > f orbitals. It is quite interesting that on this basis of the Little Effect that the correlation of electrons is time dependent based on the orbital motion of the electron pair about the nucleus with greater variation in the order: s < p < d < f ect… The Little Effect results in the electron charge and spin in relativistic revolution (correlation) (spinrevorbital) about the charge and spin of the other electron causing magnetic interactions and relativistic effects that stabilize the pairing so the two electrons can be in a state of proximity near the nucleus.

Molecular Electronic Configuration:

Just as the charge in motion and resulting magnetism cause internal structure of atoms and nuclei, they determine the structure and bonding in molecules. In molecules, electrons are coulombically pulled to multi-nuclei structures. The electrons interact with each other in their mutual coulomb attractions to many nuclei. Electron – electron interactions cause the electrons to configure into molecular orbitals with various symmetries (sigma, pi, delta ect…) in molecules. The electrons pair in molecular orbitals in spite of their mutual repulsion due to their e^- – e^- spin --- spin interactions, e^- – e^-spin -- revolution interactions, e^- – e^- orbital – revolution interactions, e^- – e^- orbital – orbital interactions, e^- – e^- revolution – revolution interactions, and e^- – e^- spin --- orbital interactions. The electrons pair in the molecular orbitals because their attraction to the multi nuclear centers overwhelms their coulomb repulsion. On the basis of the Little Effect, electrons pair by their mutual relativistic revolution (correlation) (spinrevorbital) so as to create magnetic attraction and relativistic effects that overwhelm their coulomb repulsion so they may exist closer to the multi-nuclear centers. The mutual attractions to the nuclei cause the e—e pair to revolve. The coulomb attractions of the two electrons to the nuclei cause their relative rotation. The strength and energy of the revolutionary spinrevorbitals depend on the coulomb attraction to the nuclei with greater acceleration of revolution by greater effective nuclear charge from the centers. The e --- e pair revolutional correlation (spinrevorbital motion) lowers their e --- e coulomb repulsion by the consequent induced magnetics attraction and relativistic effects. On the basis of Einstein [51], such acceleration in their revolution diminishes their coulomb repulsion such that the repulsive coulomb energy is transformed to spinrevorbital motions and mass. The relativistic revolutionary (correlation) (spinrevorbital) motion of the pairing electrons is accelerated by the multi-nuclear centers. On the basis of the Little Effect, chemical bond rearrangement therefore involves nontrivial spin, revolutional correlation, orbital and magnetic dynamics and relativistic effects although minute. It is on this basis that the Little Effect explains pycnonuclear phenomena, were in the bosonic pair of spinrevorbital motions is electrons and protons which (under acceleration by the lattice nuclear centers) form neutrons. Multi-nuclear centers accelerate electrons into and out of revolutions of pairing into molecular orbitals. The electron correlations involve electron revolutions. The electron correlation and revolution is stronger in sigma bonds than pi bonds and is stronger in pi bonds than delta bonds. It is on this basis that the Little Effect determined that external magnetic fields lower temperature for breaking pi bonds of C, N, O, and Si and delta bonds of Fe and Mo (especially in hydrogeneous atmospheres and magnetic fields) for causing diamond formation and other novel syntheses. The dynamics and kinetics of chemical reactions are determined by these aspects of electron correlation into pair bonds. On the basis of the Little Effect, the magnetic field can organize and influence the electron correlation during chemical bond rearrangement. Many of these effects of electron pair revolution (correlation) in their mutual spin and charge fields to form molecular revorbitals are demonstrated in this manuscript.

Bronsted-Lowery Acid-Base Reactions:

The reaction dynamics of Bronsted-Lowery acid-base reactions are in accord with the Little Rule such that spin effects of protons induce electronic orbital dynamics (spinrevorbital) on bases for the ready bond breakage for the ionization and the acidity of strong acids (HCl, H_2SO_4 , HNO_3, $HClO_4$) and the ready bond formation of protons (and other acids) to strong bases (OH^-, OR^-) by the efficient electronic rehybridization during these bond rearrangements by spin induced effects of the entering proton (and other acids) according to the Little Rule on the diamagnetically revolving electron pair of the Bronsted-Lowery base [57]. By the Little Rule, the proton spin induces important electronic revorbital dynamics for important kinetic factors in addition to the underlying electrostatic thermodynamic driving force. On the basis of the Little Effect, the proton is a unique nuclear center based on the spinrevorbital nature of its 1s state and nuclear proximity. On this basis, the proton is active not only in pairing the electrons into bosonic covalent bonds but also and more so in providing a countering spin effect that disrupts the bosonic pairing of electrons of the covalent bond. It is this basis for hydrogen’s unique chemistry and catalysis and its unique nuclear phenomena. Such paradoxic coulomb binding and spin disruption of covalency lend the special solvency importance and properties of water. On this kinetic basis of the Little Rule, acidic solutions provide catalytic environments for facilitating many aqueous reactions even of monumental importance in the biosphere and the geosphere. It is this basis that water plays a central physical role to life. The observed effects of protium and deuterium during acid catalyzed reactions of $Cd_5H_2\,(PO_4)_4 \bullet H_2O$ by Madsen [58] is evidence of the Little Effect. According to the Little Effect, spin dynamics of the proton allow electronegativity effects so the electron pair is pushed out (diamagnetically repelled) from the proton with the acceleration of the electron pair into new orbital states on the newly forming weak Bronsted Lowery weak base (Y^-) for $H^+ + Y^- \leftrightarrow HY$. The Little Rule accounts for the different acidities of HY and DY [59]. On this basis, important proton transfer dynamics are accounted for by the Little Rule. These spin induced revorbital effects also resolve the dilemma of classical versus nonclassical accounts of the hydrogen bond. Classically [60], the hydrogen bond is conceived as an electrostatic effects of a dipole – dipole interaction that causes binding as in X - - H – Y. But nonclassically, the H bond has been modeled considering the nature of revorbitals and the resulting molecular revorbitals. On the basis of the Little Rule, the nonclassical [61] perspective of H bonding is enhanced due to the proton spin causing the needed spinrevorbital dynamics of two electron pairs (bosons). The two electron pairs may condense about the proton for Bose-Einstein condensation about the positive charge. The correlated electron pairs are coulombically attracted to the proton but diamagnetically pushed away from the proton spin. Here the Little Effect suggests a tautomeric effect of the proton on the two electron pairs from the two hydrogen bonded bases. The proton coulombically and efficiently pairs the electrons for correlation into bonds, but the proton also pushes the bosonic pairs away (diamagnetically). This type of coulomb pairing and diamagnetic repulsion on the basis of the Little Effect provides a basis for tautomerism. The bosonic electron pair condensation may involve 2s, 2p frontier revorbitals of the proton as well as the 1s spinrevorbitals. The H-bond thereby involves a 3 centered 4 electron bond. The electron repulsion may cause a state wherein the 4 electrons of the H-bond exist with 2sp bonding revorbital and 2sp antibonding revorbitals for zero bonding and an electrostatic interaction. The complicated chemistry of water clusters [62] is further evidence of these unique proton spin induced revorbital mechanics for bonding kinetics. Such aspects of the Little Effect in water clusters and phases have been manifested in high pressure high temperature water [63]. The bonding in hydrogen cluster ions [64, 65] and the fleeting existence of these molecules also involves important spin induced revorbital dynamics based on the Little Effect. Bridge bonds and banana type bonds of hydrogen with boron in borides [66] are a manifestation of proton spin induced revorbital effects on the bonding. The (4c,2e) bonding in $Li_4(CH_3)_4$ and (3c,2e) bonds in $Be(CH_3)_2$ and $Mg(CH_3)_2$ are weaker aspects of this spin induced orbital effect of 2s orbital of Li and Be and 3s orbital of Mg relative to 1s orbital of H. It is here that the Little Effect determines a crucial correlation of spin and orbital and revolutional (spinrevorbital) dynamics of chemical bonds with superconductivity. Mg can bridge bond boron as hydrogen does but Mg has 3s electrons that can be excited into boron's hybrid conjugated states by spin induced revorbital processes that causes superconductivity. Furthermore, the Mg center is less able than hydrogen to spin disrupt the bosonic pair of superconductivity associated with the bridged boron structure. The chemical shift of proton NMR [67, 68] is evidence of the ability of proton spin to influence electrons in spinrevorbital motion and vice versa. The distinct chemical and physical properties of ortho and para hydrogen [69, 70] are also evidence of the Little Effect. The mass isotope effects of protium, deuterium and tritium during chemical reactions [71] have spin effects according to the Little Rule.

Lewis Acid- Base Reactions:

Within the general frame of the Lewis acid/base definition, the Little Rule also provides a kinetic basis for reactions in terms of Lewis acids providing spin effects for revorbital dynamics (spinrevorbital) of accepting the electron pair from Lewis bases. This effect is exhibited in some isotopes of boron [72-74]. With its nuclear spin moment boron allows spin induced revorbital dynamics for their kinetics of electrophilicity and Lewis acidity of boron compounds. On the basis of the Little Rule, this spin induced revorbital dynamics (spinrevorbital) in boron compounds explains the high temperature superconductivity in magnesium diboride [75-79] as will be considered more below. Furthermore, the Little Rule accounts for the decreasing Lewis acidity down the boron group and the inert pair effect for Tl (also Pb and Bi). In general, on the basis of the Little Effect the heavier atoms down the groups need less catalytic effects due to the weaker internal atomic spin exchange associated with their various bonding modes (at least for families prior to the carbon group where there after pi bonding becomes important). The lesser need for catalytic intervention for heavier cogeners is a result of the weaker internal atomic spin exchange of electrons via the nucleus of the heavier atoms. Internal atomic spin exchange with impact on revorbital motion is strongest for boron and diminishes from Al to Ga to In to Tl. The stronger spin exchange for the lighter cogeners leads to kinetically more difficult self-spin induced rehybridization in boron relative to the heavier cogeners. By the Little Rule, the weaker spin induced revorbital interactions contribute faster internal rehybridization of Tl^{3+} to Tl^{1+} for a magneto-electronic kinetics contribution and explanation of the lone inert pair effect and efficient disproportionation reactions of heavier cogeners.

This kinetic explanation of the relative ease of rehybridization of revorbitals based on internal spin effects by the Little Rule also explains different high pressure induced electronic rearrangement of Ge, Si and carbon [80, 81] such that Ge and Si more easily undergo high pressure induced metallic transformation but diamond does not. On the basis of the Little Rule, high pressure causes more atom --- atom interactions with consequent spin --- spin interactions that contribute to easier revorbital rehybridization in Ge and Si but difficult rehybridization of revorbitals in diamond due to the prior mentioned stronger internal e – e exchange of the lighter carbon. On the basis of the Little Effect, the greater effective nuclear charge of carbon causes greater correlated motion of electron pairs in the bonds and the inability to break the correlation as in Si and Ge for metallic phase for motion. The temperature must be raised to break the correlation in the carbon thereby causing paramagnetic liquid carbon of density greater than diamond. Via the carbon nuclei, the electrons of 2p experience much stronger exchange interactions. The relative difficulty in high pressure metallizing diamond also follows from carbon being described by Russell Saunder coupling where as Ge and Si are more describe by jj coupling. This kinetic explanation by the Little Rule further applies to the lone pair effects of Pb and Bi with the underlying thermodynamic driving force of greater effective nuclear charge of the Tl, Pb, and Bi due to the emergent effects of the lanthanide series. These explanations provided by the Little Rule account for the metastability of Tl^{3+} , Pb^{4+}, and Bi^{5+} and there tendency to disproportionate.

Superconductivity:

Here it is predicted that such facile asymmetric orbital dynamics of these heavier p block cogeners provide explanations to superconductivity. The first observation of superconductivity in Hg at low temperature [82] is evidence of this account. The position of Hg in the periodic table and its electronic configuration is consistent with it being the first observed superconductor. Hg has a special electronic configuration such that it has frontier revorbitals of s, p, d, and f symmetries. The large effective nuclear charge due to the lanthanide effect and the 5d series also contribute important nuclear coulomb attraction of frontier electrons for pairing electrons into relativistic spinrevorbital states that can withstand temperatures associated with superconducting Hg. Below this superconducting temperature, bosonic electron pairs may be excited as relativistic spinrevorbitals into delocalized continuum unstable states wherein the spinrevorbitals rapidly reversibly release the phonon to relax back to the superconductive bosonic pair. This reversible phonon scatter into unstable continuum spinrevorbital states by Hg and p block elements differs from the more irreversible scatter into the high density of stable discontinuum states within the d block elements. Unlike the high density of discontinuum stable states of d block metals (which allow for longer lived excited stationary states for other phonon, magnon dynamics that lead to breakage of e---e spinrevorbital) the lower density of discontinuum states with higher density of intervening unstable continuum modes result in greater probability of reversible phonon scatter into continuum unstable spinrevorbital states (which relativistically do not allow time for other phonons or magnons to further disrupt the spinrevorbital before it relaxes back to the superconductive spinrevorbital). The d block metals and their higher density of discontinuum stable states facilitate phonon inversion about these lower energy phonon (for creating a phonon version of the laser internal to the solid), which provides intense coherent, correlated phonons that easily irreversibly disrupt bosonic spinrevorbital states in d block metals such that these d block metals require much lower temperatures and maybe higher pressures for superconductivity. However the p block materials have lower densitites of stable discontinuum modes with consequent higher energy phonons to match their discontinuum modes with consequent higher energy phonons to match their discontinuum of stable spinrevorbitals. The p block materials therefore require higher greater kinetic energy (higher temperature) to invert their phonons for phonon amplification and stimulated emission so as to provide intense, coherent, correlated phonons that are needed to disrupt the superconductive spinrevorbital in these p block materials relative to d block materials. On the basis of the Little Effect, here it is predicted that inhomogeneous temperature gradients may interfere with phonon inversion and allow higher temperature superconductivity.

The phonon scattered superconducting spinrevorbitals may undergo revolutionary dynamics, orbital rehybridization and change in spin. In order $d < p < s$, the revolutions and orbitals are subject to spin frustration and spin induced dynamics such that the higher temperature superconducting phases of p block materials exhibit more magnetic intermediates relative to d block materials. The phonon scattered spinrevorbital states of p block materials are likely to undergo spin changes to develop fermion pair from the superconducting bosonic pair. The stronger electron exchange in p block materials relative to d block materials allows for correlations of the scattered fermionic pair. On the basis of the Little Effect, these high spin intermediates may by spin induced rehybridization to reform the delocalized bosonic superconducting mode. Therefore the superconducting spinrevorbital of delocalized discontinuum states may be scattered by low energy phonons into unstable continuum spinrevorbitals, which rapidly relativistically relax back to the superconducting mode. Changes in multiplicity of the spinrevorbital upon its phonon scatter causes fermionic pairing with consequent high spin induced revolutional and rehybridization back to the delocalized superconducting modes.

Since Onnes' discovery, superconductivity has been observed in other materials even at higher temperatures [83-86]. On the basis here of the relative strength of spin induced orbital dynamics for various elements, the Little Rule predicts future higher temperature superconductivity discoveries in Ga, In, Ge, Tl, Pb, Bi, In, Sn and Sb wider gap compound semiconductor materials. Even higher temperature superconductivity is predicted in carbon, sulfur, phosphorus, silicon and nitrogen, germanium and arsenic compounds. Gua-meng Zhao et al. report hot superconductivity in multiwall CNT [87]. Zhao's observations and other observations of 2p elements [88] are consistent with the Little Effect.

Some of these effects are consistent with the Dresselhaus Effect [89, 90] and the Rashba Effect [91, 92] in materials like InAs/GaSb [93] and InSb/GaAs [94]. But the Little Rule differs from the band edge splitting of Kramer pair states by the two mechanisms of the Dresselhaus Effect and the Rashba Effect. The Little Rule differs in that the Dresselhaus Effect involves excited orbitally induced spin effects (bulk inversion asymmetry) during electrical conduction in these materials. The Rashba Effect involves band-edge voltage induced asymmetric transition (structure inversion asymmetry). The Dresselhaus and Rashba Effects focus on how the orbital motion effects spin of conduction electrons. However, the Little Rule involves spin and how motion of spins causes revorbital dynamics. The novel effects associated with the Dresselhaus Rule and the Rashba Rule follow from these compounds formed from p block elements wherein phonons scatter more nonclassically relative to phonon scattering of electrons in d block metals. Furthermore as already considered for p block atoms, the internal spin exchange in p block elements is greater relative to d block atoms. A mix of s, p, and d orbitals allow for more order of electronic motion in coupling with lattice motion, including spin ordering by motion into different revorbitals during conduction and scattering. Many important spintronic devices now result from these effects [95].

On the basis of the Little Rule, here it is demonstrated that the first observed superconductivity by Onnes in Hg involves the spin induced revorbital dynamics available by 6s, 5d, 6p, 4f revorbitals for this Hg element. At the extremely low temperatures, Onnes was able to observe a superconducting phase in Hg wherein low energy phonons scatter electron pairs into high spin excited hybrid states. The stronger spin exchange between the excited electron pair of p block atoms causes resilience to classic phonon scattering and a resilience to the resulting classic phonon induced loss of correlated, coherent motion. Phonon motions of high spin excited states by the Little Rule cause efficient revorbital rehybridization and relaxation to superconducting bosonic pair correlated states. The Little Effect causes the high spin scattered pairs to efficiently relax by spin induced revorbital rehybridization back to the bosonic superconducting state. For consistency, on the basis of BCS theory [96], phonons may scatter electrons into these orbitals wherein Dresselhaus and Rashba Effects may cause high spin scattered states. The Little Effect would involve high spin induced scattering back into the superconducting modes.

High Temperature Superconductivity:

The Little Effect accounts for high temperature superconductivity. The Little Effect with Kasha Rule [4] and El-Sayed Rule [5,97] predicts for the HOMO-LUMO states a reversible phonon induced excitation of superconducting electron pairs into orbitally induced high spin excited states for Fermi pairing of the resulting excited pair with the reversible asymmetric relaxation (Little Effect) back to boson pairing of the superconductive state. By the El-Sayed Rule, the excitation into LUMOs may contribute orbitally induced spin transitions and changes in multiplicity. By the Kasha Rule, the electrons rapidly relax to the lower levels. The relaxation to lower vibronic high spin states by Kasha Rule and El-Sayed Rule further involve spin induced revorbital rehybridization (Little Effect) for relaxation from these high spin states according to the Little Rule to the low spinrevorbital states that reforms the bosonic superconducting pairs. This mechanism involving phonon scattered bosonic and fermionic pairs for explaining superconductivity is consistent with recent discoveries of E. Demler [98] of triplet superconductivity and others observing fermionic superconductivity [99,100]. Here it is important to note how these effects of Kasha, El-Sayed, Dresselhaus and Rashba in conjunction with the Little Effect are more feasible in the p-block semiconductors due to the better balance between stronger spin exchange of p revorbitals relative to d revorbitals and the greater revorbital extention of p revorbitals relative to s revorbitals. The electronic structure of Hg is consistent with this perspective due to the ready availability of s,p,d,f as frontier revorbitals of Hg and the electronic structure of Hg corresponds with the first observed superconducting phase being observed in Hg [82].

The feasibility of these electronic states (s,p,d) is related to the inherent electron-electron interactions and electron-nuclei interactions and natures of s, p, d and f type revorbitals with multiplicity of electrons. The currently observed high temperature superconductivity in complex structures like $CeMIn_5$ [101], $PuMGa_5$[101], $CePt_3Si$ [102], Sr_2RuO_4 [103], $CeCoIn_5$ [104], $Na_{0.5}CoO_2$ [105], $TeBa_2CuO_6$ [107], and $LaBaCuO_4$ [106] is supportive of the explanation here. These complex structures involve atoms with these various assessable s, p, d, f frontier revorbitals. The s subshell provides greater electron --- nuclear exchange and nuclear coulomb interactions. The p subshell has less exchange and nuclear coulomb interactions with its electrons with more revorbital extension and faster electronic motion relative to the s revorbital. The d subshell provides even less exchange and nuclear coulomb interactions of its electrons relative to the p revorbitals with greater electron – electron interactions of d relative to p revorbitals due to more orbital extension and faster electronic motion. The f revorbitals are under stronger revorbital motion and exchange with less extension than the d revorbitals. As a result, the s p d, f revorbitals in pure metals (of the d and s block) exhibit Ohm's conductivity with HDOS phonon assessable conductive modes with efficient classic scattering of electrons by phonons and weaker binding of these conduction electrons (spinrevorbital) by spin interactions due to the weaker electron exchange in the d block metals. In essence, this reflects the greater polarizability of heavy d block metal atoms relative to heavy p block metal atoms. As previously noted the effective nuclear charge has an important influence on the pairing and exchange energy of frontier electrons and the consequent spinrevorbital properties for superconductivity and the temperature, pressure conditions of superconductivity. Mn, Fe, Co, and Ni exhibit exceptions to this weak exchange of d block metals because the localization of lone electrons and coulomb integrals are larger for these metals [108,109] so their Cooper pairing is not applicable. On this basis, high pressure may increase orbital overlap for stronger nuclear ---- electron pairing in these ferromaterials for superconductive phases that scatter by phonons reversibly into strongly coupled fermionic or bosonic pairs. Such explanations by the Little Rule explain the recently observed superconductivity in HPHT Fe [110]. Such effect of pressure on orbital overlap has been observed in other materials like cadmium chalcogenides [111], Xe [112], and even elemental materials [113].

The s block metals have weaker overlapping revorbitals and fewer electrons than p and d block materials. The heavier p block metals involve the more efficient use of p revorbitals for conduction, wherein the exchange between electrons via nuclei is greater and the coulomb interaction with the nucleus is greater relative to d block atoms. The p block metals may also hybridize with s and d revorbitals for novel band structures and resulting physicochemical effects. On the basis of the Little Rule, the s, p, d hybrid conduction electrons may undergo spin induced promotion and rehybridization among these various states. These states of p block elements have lower densities of state relative to d block metals so the electronics are more nonclassical on the basis of the quantum approximation. Furthermore, the stronger coulomb interactions of p block frontier electrons cause less stable intermediary continuum states. The greater instability of the continuum modes of p block relative to d block materials causes less probable destructive scattering and uncorrelation. On the basis of the Little Effect, here it is suggested that these hybrid superconduction and phonon scattered states include pi bonds, conjugation and resonance and possibly aromaticity on larger length scales, which cause the superconductivity. On the basis of the Little Effect, these orbital differences with spin induction in p block metals and their compounds relative to d block metals and their compounds give better explanation of the p block fractional quantum Hall effect [29] relative to the integer quantum Hall effect [114] in d block metals, respectively. The fractional quantum Hall effect in confined semiconductors is a result of its p type frontier revorbitals which exhibit lower density of states and much stronger e --- nuclei interactions and e – e exchange interactions for stronger bosonic and possibly fermionic pairing relative to the integer quantum Hall type d block metals. This stronger electron interaction of p block causes a more liquid-like conduction electron phase. However, the d block metals exhibit much weaker coulomb and exchange effects to their conduction electrons thereby the conduction electrons behave more like gassy phases.

The greater exchange and coulomb interactions between electrons in p subshell lead to stronger bound bosonic and fermionic interacting pairs. Such stronger e --- nuclear interactions and e --- e interactions via nuclei for the p block elements and their compounds contribute greater binding and stability of correlated states relative to those of the d block. Here it is suggested based on the Little Effect that such stronger interactions will eventually lead to even higher temperature superconductivity. This prediction is demonstrated by the observed superconductivity in CNT with magnetic scattered phases [87]. The stronger coupled bosonic and fermionic pairs for the p-block materials cause more liquid like behavior of conduction electrons for fractional quantum Hall Effects relative to the gassy phase behavior of electrons of more weakly interacting d block metals, which exhibit the integer quantum Hall Effect. These stronger interacting bosons and fermions in p block materials are here predicted to contribute to higher temperature superconductive phases. In general on the basis of the Little Effect, the lattice is bound by electron pairs that are correlated as a revolving pair of electrons so as to magnetically oppose their coulomb repulsion. The lattice nuclei pair, revolve and correlate (spinrevorbital) the electronic bosonic pair. Phonons or lattice vibrations cause the electron pairs to correlate to oscillate rhythmically between stable discontinuum and unstable transient continuum spinrevorbital states in orchestration to lattice vibrations. The oscillation in electron pair correlation involves changes in revolutionary (spinrevorbital) modes of electron pair. The Little Effect thereby demonstrates the reversible coupling of lattice phonons with correlating electron pairs of macro-delocalized conjugation, resonance, aromaticity and superconductivity. Higher energy phonons cause greater compression and rarefaction of the electron revolutions (spinrevorbitals), which if strong enough can cause spin flip the electron with excitation of pairs into fermionic states. The resulting fermionic excited states of the electron pair obey a different statistics, motion and structure relative to the ground state bosonic phase. But the fermionic excited state still correlates the electron pair. The fermionic excited coupled state can reversibly relax to the bosonic state by releasing phonons, but for the reverse, a change in spin multiplicity is required. The Little Effect allows such spin induced the orbital dynamics and spin asymmetry. On the basis of the Little Rule, the stronger the nuclei correlate the electron pairs as bosons or fermions, the stronger the coherence and organization against higher energy phonons of higher temperatures. On the basis of the Little Effect, the stability of the bosonic superconductive phase and its phonon scattered fermionic intermediary depends on coulomb interaction with the nuclei (lattice) and also the consequent exchange interactions between the fermionic pair. Higher temperature superconductivity will involve stronger bonds of the Cooper pair and Demler pair to the lattice with consequent stronger exchange. Here it is predicted that the light p block elements and their compounds will meet the high temperature conditions for super currents.

A great example of these revorbital effects of s,p,d, f and the spin exchange, spin polarization, coulomb binding to the lattice nuclei and nonclassical density of states is given by MgB_2 . Although MgB_2 does not involve d and f revorbitals, the frontier revorbitals include 2s and 2p of B and 3s and 3p of Mg. The bond (spinrevorbitals) may be described as partly ionic and partly covalent. Here it is interesting to compare elemental superconductors with compound superconductors. In the elemental superconductors, the electric field and phonons influence the spinrevorbital. In compound states, the spinrevorbitals are determined based on different electronegativities of the nuclei as well as electric fields and photons. In this compound case, the spinrevorbital involves states mostly associated with the more electronegative boron with various conjugations for delocalization of the spinrevorbital. The bonding in Mg compounds has been known to lead to excellent thermal transport properties with poor electrical transport properties. Below 39 K, the phonons of MgB_2 are limited to nonclassically scattering the Copper pairs {associated mostly with polyanionic conjugated bonds of boron (B^{2-}) chains and sheets ($B-B=B-B=B-B=B-B$)$^{n-}$ with attached n/2 Mg^{2+} ions for charge compensation } into coherent, correlated (spinrevorbital) high spin antibonding states (B-B=B-B• --- •B-B=B-B)$^{n-}$ wherein B=B pi bonds are tautomerically broken and reformed along the chain into (B-B=B-B• --- •B-B=B-B)$^{n-}$ high spin radical parts. The chain –sheet polymeric boron anionic structure involves a polyanionic boron with Mg^{2+} cations to decoratively balance the charge along the boronic backbone or sheet. The 3s revorbital of Mg^{2+} cation allows 3 centered, 2 electron bond between boron anions. The Mg^{2+} cations facilitate via its 3s revorbital the rehybridization and bond rearrangement dynamic of boron's pi bond rearrangement that is associated with superconductive modes. The Mg^{2+} cations allow tautomerism that causes superconductivity along the polyanionic boron chain or sheet. Furthermore on the basis of the Little Effect, at low enough temperature the Mg acts as alkali and alkaline earth cations centers for crowns and crytates so as to shuttle spinrevorbital electron pairs in and out of its 3s revorbital to bridge B during superconduction. At below 39K, phonons scatter Cooper pairs of this pi bonds in this superconducting state into high spin $s^1p^1p^1p^1$ fermionic states (B-B=B-B• --- •B-B=B-B)$^{n-}$ {El-Sayed Effect, Dresselhaus Effect, Rashba Effect}. Based on the Little Effect phonons in conjunction with the $s^1p^1p^1p^1$ (B-B=B-B• --- •B-B=B-B)$^{n-}$ high spin intermediary state readily rehybridize this high spin state back to the sp or sp^2 (B-B=B-B=B-B=B-B)$^{n-}$ superconducting state. At low enough temperatures, the weaker vibrations allow electrons of $s^1p^1p^1p^1$ revorbitals of (B-B=B-B• --- •B-B=B-B)$^{n-}$ anions to cooperatively interact to reform hybrid sp, sp^2 revorbitals. The weak vibrations of high spin $s^1p^1p^1p^1$ (B-B=B-B• --- •B-B=B-B)$^{n-}$ units of the polymeric MgB_2 structure cause spin induced rehybridization of the $s^1p^1p^1p^1$ to sp or sp^2 (B-B=B-B=B-B=B-B)$^{n-}$ hybrid revorbital states such that by resonance and conjugation along the chain, the anionic B-B=B-B=B-B=B-B determine the superconducting state. Low density of states and Pauli antisymmetry of the $s^1p^1p^1p^1$ (B-B=B-B• --- •B-B=B-B)$^{n-}$ limit the phonon induced scatter of the high spin state into incoherent states. The large coulomb interaction of the Cooper pair with the nuclei because of sp type revorbitals and the resulting large spin exchange stabilize the coherent correlated high spin scattered excited state allowing its relaxation back to the correlated superconducting state with release of phonons. Therefore the superconductivity is a delocalized high spin excited state in MgB_2 structure facilitated by low temperatures wherein vibrations reversibly scatter Cooper pairs into correlated high spin states (spinrevorbital) which relax back to the superconducting phase. The observed diminished superconductivity of MgB_2 with Al doping is consistent with this delocalized polyatomic description of superconductivity [77]. Third row elements are less able to pi bond than second row elements. Furthermore, the third row elements have weaker coulombic interactions of Cooper pairs with nuclei and weaker spin exchange for polarization of electron pairs. The innovation by the Little Effect is that the reversible scattering involves spin induced orbital dynamics with consequent rehybridization and then the reverse spin induced revorbital rehybridization. On the basis here of the Little Effect, superconductivity involves bond rearrangement and tautomeric chemistry of excited states. This is the first effective explanation of correlation and coherent scattering during superconductivity.

Here on the basis of the Little Effect, it is suggested that superconductivity is delocalized bonding effects on a macrolength scale. So on this basis, superconductivity involves delocalized hybrid (spinrevorbital) electronic states where in phonons excite transitions between these states and strong spin and revorbital exchange (of the resulting phonons scattered electronic states) induce efficient relaxation and transition between these superconducting (spinrevorbital) hybrid states. Phonons can cause scattering from these superconducting hybrid revorbital states, but the lower density of states, the stronger electron exchange for pairing, rehybridization and spin scattering (Little Effect), and the resulting spin polarized electron pair in the superconducting media, allow for higher probable reversible relaxation to the superconducting mode for p block compounds. Revorbital effects during phonon scattered transitions cause spin transitions optically by El-Sayed Effect and during conduction by Dresselhaus Effect and Rashba Effect. The Kasha Rule allows efficient relaxation of higher energy phonon scattered modes to the lower energy modes of the spinrevorbital. On the basis of the Little Effect, the resulting phonon scattered states of high multiplicity cannot relax to nonsuperconducting modes because of antisymmetry. However by the Little Rule, the resulting high spin states scattered phases from the superconducting state can relax back to the superconducting phase by spin induced revorbital rehybridization. On this basis, the multiplicity of the scattered phase limits dissipative relaxation to non-superconductive. This theory of high temperature superconductivity on the basis of the Little Effect is consistent with observed low temperature superconductivity by BCS theory [96], pressure induced superconductivity in some substances [110-113] and the recent magnetic disruption [115] of superconducting phases, magnetic and high pressure induced breakdown of superconductivity[116], high field (60T) abnormal states [117], and spin stripe phases of superconductivity in magnetic field [106].

On the basis of the Little Effect, these conditions of high pressure and external magnetic field on superconductive phases are understood and explained. The spinrevorbitals of the superconducting phase undergo ever-present phonon scatter into various excited spinrevorbital modes of the unstable continuum. But the relativistic coupling of the spinrevorbital causes rapid reformation of the lower energy superconducting mode. This relativistic effect of organized spinrevorbital motion for correlation has been seen by others as Meissner Effect [118-121]. Under high pressure [122] the higher atom – atom collision frequency contribute high frequency rehybridization of revorbitals and alteration of frontier band structures that can destroy or sometimes form superconducting phases. Strong magnetic external or intrinsic field may alter the Hamiltonian such that the scattered superconducting modes (spinrevorbitals) forms either dynamic virtual states or undergo change in multiplicity of the perturbative virtual state of phonon scatter with the breakage of the superconductivity. The high spin scattered state may also be superconductive depending on the exchange energy. On the basis of the Little Effect, the strong external magnetic field disrupts the efficient reversible transitions between the bosonic spinrevorbital phases of the superconduction and the high spin scattered fermionic spinrevorbital phases. The resulting high spin phases may cause revorbital rehybrization in the external magnetic field with loss of pi bonds and conjugation and resonance that cause the superconductivity.

Complexes:

In addition, here it is demonstrated that this effect of lone electrons on (spinrevorbital) dynamics by the Little Rule accounts for the properties of transition metal complexes and many catalytic phenomena. The spin magnetic exchange between the unpaired electrons in d spinrevorbitals and the spinrevorbital motion of electrons of ligands can induce spinrevorbital dynamics of the electrons of the ligand for the catalyzing ligand chemical transformations. In most transition metal complexes, the ligands act as donors by providing electron pairs (coordinate covalently) and not by providing lone electrons (regular covalent) to the metal center. Ligands with lone electrons may bind the lone electrons of the metal center for regular covalent bonding. But even for these two types of ligands (the coordinate covalent type and the regular covalent type ligands), the metal centers {with lone electrons of d spinrevorbital symmetries, or even p spinrevorbital or f spinrevorbital symmetries (but less so) may via exchange interactions by these d spinrevorbital lone electrons} influence the electrons on the ligands according to the Little Rule so as to affect the chemical transformations of the complex and the chemical transformations of the ligands. The Little Effect is most obvious (during such chemical and catalytic transformations of the complexes) when the metal center is a 3d atom and the ligands are either 3d, 2p, or 4f atoms. These type metal centers and ligands are under Russell Saunder coupling and exhibit stronger spin polarization and exchange. The lone electrons on the metal center via exchange provide spin induced revorbital dynamics and rehybridization of electrons of the ligands to facilitate bond rearrangements for binding entering ligands or pushing out leaving ligands. Such spin induced revorbital dynamics according to the Little Effect also facilitate chemical transformations of ligands.

These manifestations of the Little Rule toward the kinetics of transition metal complexes are beautifully demonstrated by considering well known rates of water exchange. The oxygen of water is the donor atom and it is described by Russell Saunders effects. First of all, the s block ions, except the smallest (Be^{2+} and Mg^{2+}), are very labile toward aqua exchange. The lability of s block ions to water exchange is consistent with the Little Rule, just as the proton and protolysis are consistent. The s spinrevorbital (for p block and s block metals) allows the strongest interaction of ligand donor electrons to the nucleus of the metal centers for nuclear spin induced revorbital effects that facilitate ligand entering and leaving dynamics for lability. On the basis of the Little Effect, the nuclear spin (of the metal center) or the protons (during protolysis in acidic media) perturb the motion of the electron pair during the coordinate covalent bond rearrangement between the metal center and the ligands during the exchange reactions. The s block also via exchange through the nucleus allows strong spin interactions of lone electrons of an atom. The s orbitals also via such large exchange couple electron pairs of crown and cryptate ligands for their Bose-Einstein condensation around alkali and alkaline earth cations. Most of the s block elements have odd numbers of protons and neutrons in their nuclei so the odd number of nuclear spins via efficient interactions with donor electron pairs of the ligands via the s spinrevorbital allow the nuclear spin induced spinrevorbital change of donor electron pair to facilitate ligand exchange kinetics and cause lability. There are some alkaline earth cations with even number of nuclear spins and these correlate with slower exchange kinetics relative to Ba^{2+} and Sr^{2+}. Ba^{2+} has the fastest exchange rate, which by the Little Rule may be explained by the greater number of neutrons to protons in its nucleus and the higher possible nuclear spin moments. This effect by the Little Rule is different from the Buchachenko Effect of magnetic isotope effect (MIE) [123]. Whereas MIE considers nuclear magnetic spin exchange with electron spin with the antisymmetric prevention of chemical bonding, here the Little Effect involves the nuclear spin causing spinrevorbital changes of the electron for affecting the kinetics of chemical reactions. The Little Effect is different from the Buchachenko Effect [123] or the radical pair effects of Stein [124], Turro [125] or Hayashi [126]. The Little Effect is the first rule that reveals how spins transform revorbital motion and other spins so as to affect asymmetric chemical and physical transformations. Buchachenko [123], Stein [124], Turro [125] and Hayashi [126] Effects do not involve these dynamical aspects of physical and chemical transformations.

Furthermore, the Little Effect accounts for the kinetic trends in water exchange of aqua complexes of d block metals. M(II) cations of the first d-series exhibit moderate lability, which is accounted for by the Little Effect on the basis of the strong spin electron -- electron exchange of these metal centers with the electrons of ligands for accelerating donor electron pairs in and out of the metal center. Although the 3d metal cation attracts the lewis base ligand electrostatically, the its lone electrons present fermionic spinrevorbitals that perturd the diamagnetic electron pair of the coordinate covalent bond for facilitating kinetics of bond rearrangement. Furthermore, the observed effect that strong ligand fields on d^3 and d^6 metal centers of the first series exhibit inertness provides more excellent account by the Little Rule because in the strong field the lone electron pairs on the metal center become paired loosing their spin moment and consequent ability to induce spinrevorbital dynamics of bond breakage and formation during ligand exchange. The stronger ligand field thereby slows water exchange. The consistency is further demonstrated by considering that d^{10} cations (Zn^{2+}, Cd^{2+} and Hg^{2+}) are also labile, which follows from there use of s spinrevorbitals just like the alkali and alkaline earth cations for faster ligand exchange dynamics. Considering the prior considered alkali, alkaline earth and group 10 cations, it is important to note that the Little Effect explains the great abilities of these cations to ligate crytate and crown ligands based on the ability of their nuclear spin and s spinrevorbitals to push ligand electrons in and out of donors of the crowns and crytates with reversible Bose-Einstein condensation of the pair with s spinrevorbitals about the metal centers. The observed trend that the 3d complexes with the largest ligand field stabilization energy (LFSE) exhibit more inertness is consistent with the explanation by the Little Rule. The large LFSE causes more pairing of electrons on the metal center for less spin induced revorbital effects for ligand exchange. The Little Rule even explains the greater inertness of complexes with 4d and 5d metal centers relative to 3d metal centers. The 4d and 5d metal atoms have smaller internal electron --- electron exchange and spin polarization. The angular momenta coupling of 4d and 5d metal centers is of the jj type rather than Russell Saunders type. Therefore spin induced effects for 4d and 5d transition metals are less forceful for changing spinrevorbital motion associated with ligand exchange. So aqua exchange reactions for 4d and 5d metal centers are slower. For completeness of this account, it is important to note that f block metal centers exhibit lability which is consistent with the given Little Effect on the basis that the f spinrevorbitals are more buried and the exchange dynamics are determined by the 6s and 7s empty spinrevorbitals.

In considering these relative effects of water exchange in the various metal centers, it would be remissed if the self-exchange is not considered to account for structural, chemical and physical properties of bulk and nanoparticulate metals and also the exchange of important ligands other than water, for example carbonaceous (organometallic) and nitrogenous ligands. The 3d transition metals would be weak field self ligands of the Russell Saunders type with consequent smaller ligand field stabilization and high spin states. As previously considered, such large exchange and spin polarization result in the ferromagnetism of Fe, Co, and Ni by their self ligation. Whereas for $M – (OH_2)$ with M = Fe, Co, Ni, the complexation involves 3d and 2sp type spinrevorbitals, the pure metals would involve weaker electron --- nuclear coulomb and electron --- electron exchange interactions of M – M atoms with 3d spinrevorbitals. This causes weaker pairing of electrons into correlation within Fe, Co and Ni such that they are unpaired for more fermoinic spinrevorbitals and ferromagnetic properties. This comparison is consistent with the diminished ferromagnetism with carbon, nitrogen and oxygen dissolution into the bulk Fe, Co and Ni metals. The unusual low melting temperatures of Fe, Co and Ni relative to other transition metals is explained on the basis of the lower activation energy for breaking M-M bonds due to the lone electrons of the 3d spinrevorbitals and their disruption of bosonic spinrevorbitals of the M-M bonds. These effects as predicted by the Little Rule also explain the unusual melting points of Fe, Co, and Ni and their carbides and nitrides [127]. R.B. Little observed an unusual lowering of the eutectic temperature of metals in hydrogen in strong magnetic field and explained this effect based on the Little Rule. These differences in ligand binding to Fe, Ni and Co metal centers explain the lower melting of the pure metal in comparison to the carbides, nitrides and oxides. The unusually lower melting temperature of the metals and their hydrides in external magnetic field is also explained by the Little Effect. The Little Effect also explains the unusual BCC structures of Fe, Co and Ni [128]. On the basis of anomalous low melting points and structural dynamics, RB Little realized unique catalytic properties of molten Fe, Co, and Ni relative to other transition metals. Just as for oxygen of H_2O, the liquid Fe, Co, or Ni exhibit labile exchange of carbonaceous and nitrogenous ligands, which facilitates the catalysis by these metals of reactions involving these atoms. These metals exhibit according to the Little Effect unique catalytic effects to C, N, O atoms due to the large spin polarization and spin exchange which transforms electron pairs to lone electrons and high spin radicals on the ligands containing C and N donors, for catalyzing the chemical rehybridization of revorbitals and fixation of C, N, and O into higher bond order hybrid states for greater hybrid bond order. On the basis of the

Little Effect, these ferrometals due to their lone electrons and consequent high spins disrupt the e --- e correlation of the spinrevorbitals in bonds of the ligand atoms associated with pi bonding C=C , O=O, N=N. The lone electrons of the Fe, Co and Ni and the large spin exchange of complexation disrupt the ability of C, N, O atoms to correlate their electrons into pairs for pi bonding. The unique ability of these ferrometals to catalyze formation of diamond and CNT and NH_3 is evidence of these unique dynamics of complexation and the consequent exchange spin induced recorrelation of pi bonds of bosonic pair to nonbonded fermionic radical pairs. The 4d and 5d transition metal atoms exhibit weaker self exchange and spin polarization so they are not ferromagnetic. Furthermore the 4d and 5d transition metals have higher density of discontinuum stable states that facilitate the kinetics of trapping ligands into metastable bound states. The 3d Fe, Co and Ni metals have lower density of discontinuum states and higher density of unstable continuum states such that the unstable continuum states do not affords kinetics to trap ligands into metastable bonds. Likewise 4f transition metals have weaker exchange in spite of the high spin per atoms so they are not ferromagnetic. For similar reasons according to the Little Effect, the 4d, 5d and 3f metals are not able to catalyze similar nitrogeneous, carbonaceous and oxygenaceous reactions ligands as do Fe, Ni and Co.

Now considering the ability of these ferrometals to uniquely ligate other Russell Saunders ligands like carbon and nitrogen donors has been the basis of R. B. Little explaining diamond and carbon nanotube formations. Carbonaceous and nitrogenous ligands are under Russell Saunders coupling so they would interact favorably with Fe, Co, and Ni. The C and N bonds are strong so that under proper high temperature conditions the ferro-metals can catalyze breaking the carbon and nitrogen bonds. Such catalytic activity of Fe, Co and Ni in bond transformation of carbon and nitrogen according to the Little Rule would involve spin induced revorbital dynamics for rehybridizing the electrons of the carbon and nitrogen into complex states of high multiplicity and further spin induced revorbital rehybridization upon releasing the carbon and nitrogen atoms to various products. Such spin induced revorbital dynamics by the Fe, Co, and Ni on the carbon and nitrogen result in the accelerated asymmetric transformation of the carbon and nitrogen into high spin electronics states. The resulting spin induced asymmetry slows the kinetics of chemical bonding back to reactant symmetries on the basis of Woodward-Hoffmann Rule [1,2]. Whereas the previously considered aqua complex transformation and catalytic activities occur at room temperature, these activities of Fe, Co and Ni on carbon and nitrogen donors require high temperatures. Under such extreme conditions, it is feasible to speak of an inverted complexation wherein the 2p atoms are now the centers and the metal atoms are the ligands. During CNT formation Fe, Co and Ni nanocatalysts complex carbon with the lone electrons of these metals causing diminished ferromagnetism for spin density wave. This change in magnetic properties with carbon adulteration has been demonstrated experimentally [129,130].

The complexation of Fe, Co, and Ni by carbon also causes structural changes in the metal nanoparticles. The structural changes cause rearrangement with spinrevorbital changes and resulting spin density dynamics. The electronic, magnetic, thermal and structural dynamics associated with ligation by carbon atoms allow carbon to diffuse through the metal particles and on the surface of the metal particles. The process by which the metals absorb/adsorb carbon, transports carbon and release carbon therefore involves electronic, magnetic, thermal and structural dynamics associated with complexation [16]. At the cooler regions of the catalyst, the carbon is released to graphitize under the electronics of the spin density wave. The Fe, Co, and Ni metal atoms via spin accumulation release carbon atoms into sp^2 hybrid spinrevorbitals according to the Little Effect. Under higher pressures and high temperatures the ferrometals exist as ferro-liquid crystal medias that release carbon atoms into sp^3 hybrid spinrevorbitals to form diamond rather than graphite. Unlike the low pressure lower temperature solid Fe, Co and Ni catalysts, the high pressure high temperature liquid catalysts retain spin order and ferromagnetism such that the metal centers orderly and concertedly release high spin carbon to higher order sp^3 hybrid bonds [17]. Hydrogen atoms in these medias provide added spin with the lone electrons of the d spinrevorbitals of the catalysts to induce spinrevorbital dynamics for sp^3 hybrid release of carbon atoms to the growing diamond lattice according to the Little Rule. The high pressure high temperature (HPHT) induced ferromagnetism [131,132] of the catalyst also creates a dense state of bonding (the compressed state allows more exchange for magnetism) and exchange with the forming diamond so as to stabilize surface carbon radicals to prevent pi bonding and graphitization. Here it is important to note that the Little Effect again employs the Meissner Effect on the subatomic scale for bond transformations between sp^2 graphite and sp^3 diamond. The high pressure high temperature induced ferromagnetism in the metal-carbon media and the high spin has a larger impact on disrupting pi (spinrevorbital) bond formation than the disruption of sigma (spinrevorbital) bond formation such that the magnetic field disrupts pi bosonic bonding and correlation more readily with less consequent magnetic field effect on the stronger sigma bosonic bonding and correlation. It is important to consider the different magnetic field strength and their impact on pi and sigma bonds. Stronger external magnetic fields are needed to disrupt sigma (spinrevorbital) bonds relative to the fields needed to disrupt pi (spinrevorbital) bonds. It is on this basis of the Little Effect that different magnetic field strengths cause different kinetics of sigma bond and pi bond rearrangements and transformations. It is also on this basis that R. B. Little discovered [17] diamond formation in strong magnetic field (15T) with dramatic distinction from Druzhinin and coworkers [133] a decade earlier. Druzhinin and coworkers [133] applied ultrastrong pulsed magnetic fields (several hundred tesla) to diamagnetically compress graphite on the basis of old HPHT themes for forming diamond. The ultrastrong magnetic pulses of Druzhinin and coworkers [133] affected both kinetics of pi as well as sigma bond formation. However, R.B. Little [17] applied weaker magnetic field of steady duration for affecting mostly the pi bond formation so as to discriminate and select diamond crystallization and prevent graphite formation. The ultrastrong magnetic fields of Druzhinin and coworkers provided the diamagnetic compression for forming diamond but the size was not much different from the older mechanical methods of HPHT synthesis. Druzhinin does not realize the lower field selectivity to sigma over pi bonding, but Little does discover selectivity. On the basis of the Little Effect, the pi bond exhibits more stable discontinuum states whereas the sigma bond exhibits more unstable continuum states. The higher density of discontinuum modes of the pi bonds provides easier kinetics of disruption of the pi bond relative to the sigma bond. Unlike the pi bond the sigma bond involves unstable discontinuum spinrevorbital modes that relativistically rapidly relax back upon perturbation, which makes it kinetically more difficult to break the sigma spinrevorbital relative to the pi spinrevorbital. The beauty of Little [17] is that the growth rate, quality and size of the lower pressure steady field synthesis is much improved relative to older the arts of Hall and Derjaguin. Similar effects occur with the catalytic transformation of N_2 and H_2 to NH_3 by the Haber process. The HPHT of the catalyst induce ferromagnetism of the catalyst for creating an exchange with the N and H to stabilize N and H radicals until they can bind for NH_3

to desorb and protons and lone electrons in d orbitals of the catalysts also disrupt N=N pi bonding and transform sp and sp^2 N to sp^3 N via spin induced revorbital rehybridization.

Ferromagnetism:

Ferromagnetism exists in a few metals like Fe, Co, Ni and Gd [134]. Some elements exhibit novel ferromagnetic effects on the nanoscale and in alloys [135,136]. The Little Rule accounts for this ferromagnetism. The Little Rule explains the intrinsic ferromagnetism of Fe, Co, and Ni and induced magnetism in other substances. On the basis of the extention of revorbitals and the 3d subshell, spin induced revorbital motion (Little Effect) of 3d electrons facilitate hybrid states with 4s and 4p revorbitals with the consequent reduced 3d extension and localized lone electrons in 3d revorbitals for unpairing spins for magnetism of the atoms with the consequent inherent ferromagnetism via exchange interactions in clusters, nanoparticles and bulk Fe, Co, and Ni [108,109]. The consequent higher spin induced revorbital states according to the Little Rule lead to the 3d revorbitals falling lower in energy than the 4s revorbital with the bonding via spd revorbital hybridization causing such exchange for the spin correlation between atoms and the consequent ferromagnetism. The pairing energy associated with the chemical bonds of Fe, Co, and Ni metal atoms is much greater than the splitting energy due to effects of the Little Rule whereby the parallel spin of electrons cause Pauli antisymmetry with fewer covalent bond and lower electronic repulsion due to the spin interaction of the electrons forcing then further apart in revorbital motion thereby lowering their coulomb repulsion. For such low splitting energies of metals centers like Fe, Co and Ni with ligands, the metal center and ligand have insufficient effective nuclear charge over the molecular orbital to pair the electrons thereby causing the bosonic revorbital state. The resulting lower splitting energy and higher pairing energy from the spin induced revorbital effects cause the lower bond order and ferromagnetism due to the exchange via the fewer bonds formed between atoms of Fe, Co and Ni. Such spin induced hybrid bonding with lone unpaired electrons in accord with the Little Rule lowers the energy of the Fe, Co, and Ni relative to higher bond order states with fewer unpaired electrons of lower spin and magnetism. The spin polarization and exchange energy are so great that the trends in bond structure and properties of Fe, Co, and Ni are anomalous relative to other transition metals. In addition to the unusual ferromagnetism, other anomalies include unusual melting points, carbide properties and hydride properties of Fe, Co and Ni relative to other transition metals [127,128]. The greater extension of 4d revorbitals relative to 3d revorbitals and the greater e --- e repulsion of 4d result in the diminished spin induced hybrid bonding by the Little Rule in 4d transition metals. These predictions and explanations of the Little Rule are consistent with the observed magnetic properties of some nano-size 4d metals which have no ferromagnetism in bulk sizes. The surface tension and compression on nanoscale compresses 4d revorbitals for novel spin effects associated with radical electrons on the surface. The emergence of the lanthanide series contributes different effects of greater electronegative for more pair bonding in 5d transition metals relative to the above noted effects in 3d Fe Co and Ni.

Another important consequence of the Little Rule is the observed properties of the lanthanides and the actinides. The huge spin induced revorbital motion in lanthanide atoms causes even greater localization of 4f electrons relative to 3d electrons such that the 4f electrons are buried beneath 6s and 5d subshells [137]. The Little Rule here accounts for the nature of the lanthanides and their chemical similarity. This effect of spin induced revorbital effects is diminished for 5f actinides due to the greater e -- e repulsion, which causes greater protrusion of 5f revorbitals and greater chemical diversity of actinides.

For completeness it is interesting to compare elements of 2p subshell (B, C, N, O, F, Ne) with the 3d and 4f elements. The 2p revorbitals do not extend as much as 3d revorbitals so the 2p revorbitals bonds are stronger covalent bonds (as with 5d transition metals) relative to 3d and 4f covalent bonds. The energetic are such that the pairing energy is small relative to splitting energy and strong interactions of 2p electrons with nuclei cause stronger covalent bonds relative to bonds involving 3d and 4f revorbitals. Spin induced revorbital effects are therefore not as important in 2p elements as in 3d and 4f elements under ambient conditions. However R.B. Little has determined exotic conditions for unveiling the spin induction of revorbital dynamics and rehybridization in 2p elements. Because of the huge splitting energies and strong covalent bonds of 2p atoms, on the basis of the Little Effect the bosonic electron pairs experience huge effective nuclear charges for tight correlation and binding of the electrons which causes more relativistic effects. The strength of the spinrevorbital is much greater than those of the bonds of 3d metals. Therefore much greater magnetic fields are needed to directly disrupt the spinrevobital of 2p covalent bonds relative to 3d covalent bonds. R. B. Little has employed higher temperature and hydrogen atmospheres to lower the needed external magnetic field for disrupting the spinrevorbital of the 2p covalent bonds thereby modulatig their chemical transformations. For example, the novel ferro-metal solution (or H atom solution) environments cause important spin induced revorbital effects on the basis of the Little Rule in 2p elements[16,17]. This novel ferro-liquid crystal environment is in accord with the resolution of the diamond problem by R. B. Little [17]. High pressure and high temperature can also cause conditions of 2p elements where in spin induced revorbital dynamics affect chemical reactions and properties [57] in accord with the Little Rule. The Little Rule thereby accounts for paramagnetism and the metallic nature of liquid carbon phase denser than diamond [138]. The Little Effect on the basis of the greater e --- nucleus coulomb interactions for stronger bonds and greater e --- e exchange via the nuclear interactions predicts that light 2p and 3p elements and their compounds will determine important superconductive structures even above room temperature. Here it is suggested that sulfur under high temperatures and high pressures will exhibit such technological useful superconductivity. The consideration here and comparison of 2p, 3d and 4f elements on the basis of the Little Rule accounts for various catalytic natures and physicochemical properties of H_2 , H_2O, CH_4, FeH and GdH mixtures and compounds. The H atom is able by spin induced revorbital rehybridization to affect orbital dynamics for various bonded states in these materials. As a result of its spin induced revorbital dynamics, H is the most unique element. It is very interesting to point out the unique spin induced revorbital dynamics of the H atoms and the proton (on the basis of the Little Effect account for such observations and phenomena as keto-enol tautomerism [139,140]. The Little Rule perfectly explains such efficient rearrangement by the ability of the proton via spin to efficiently drive revorbital rehybridization on the oxygen, α carbon and β carbon for $sp^2 \leftrightarrow sp^3$ rehybridization dynamics associated with the tautomerism.

Ferromagnetism in 2p elements:

The Little Rule also accounts for chemical changes associated with beta radiation, proton irradiation [141,142] and neutron irradiation [143]. The electron, proton and neutron are fermions, which can cause spin induced revorbital dynamics under proper activating conditions. The recent observations of radiation induced ferromagnetism of nanodiamond [142] and graphite [144] are evidence of proton causing bond breakage and the resulting exchange causing the resulting diamond to couple spins for ferromagnetic properties of the diamond. Electron irradiation of depositing carbon and its induction of diamond nucleation [145] is additional evidence of the ability of fermionic irradiation carbon allotropes to cause spin interactions that promote revorbital rehybridization according to the Little Rule. Neutron irradiation for the production of color centers in diamond [146,147] and other gems is a further example whereby spin interactions of neutrons alter spinrevorbital electronic states for optical changes. Intense laser irradiation has led to ferromagnetic states of carbon known as carbon nanofoam [148,149]. On the basis of the Little Rule, R. B. Little has discovered novel neutron induced changes in some materials [150]. On the basis of the Little Effect, the spin associated with these irradiations by fermions causes a disruption in revorbital correlation of electrons that break bonds and quench the resulting radical impurities into different states. For consistency on the basis of the Little Effect these novel spinrevorbital effects in carbon materials has lead to observed superconductivity in polycrystalline diamond and CNT. The Little Effect has already considered how superconductivity involves excited bosons in delocalized chemical bonds which by phonons scatter into reversible spinrevorbital states including fermionic states. On the basis of the conjugation, ferromagnetism and exchange in carbon allotropes, it is not surprising that these allotropes under proper conditions exhibit superconductivity.

Electrochemistry in External Magnetic Field:

The H atom within some transition metal is a spectacular phenomenon that has not yet been understood. The Little Rule provides explanation and understanding. Various hydrogenous phenomena within transition metals like high absorption [151,152], catalytic properties [153-156], hydrogen isotopic separation [157-160], absorption-expansion effects [161] and pycnonuclear fusion [162,163] have been pondered controversially. The Little Rule provides a basis for understanding these great mysteries. The weaker but yet important spin induced revorbital dynamics in 4d transition metals relative to 3d transition metals has been noted here and this explanation on the basis of the Little Rule accounts for the greater uptake of H atoms by late 4d transition metals like Pd and Ag. The higher electronegativity of these metals allows the ionization of H and the existence of high concentrations of protons within the metal lattice as suggested by Mott [164]. On the basis of the Little Rule, here it is suggested that spin induced revorbital dynamics cause pycnonuclear fusion phenomena [165]. Such remnant of spin induced revorbital states on the basis of the Little Rule results in unique catalytic activity of hydrogen desorbed from certain transition metals. The desorbed hydrogen from the metal exhibits unique catalytic activity relative to hydrogen unexposed to the metal [166]. Unlike 3d metals, the 4d metals (in particular Pd) have higher H absorption due to stronger bonding interactions of H with the lattice relative to bonding between metal atoms of 3d transition metals. For metal like Pd, the large uptake of H is so much with consequent stronger covalent and ionic lattice interactions by protons and deuterons that mobility is high and the confinement of protons and deuterons can occur within the Pd lattice. Here based on the Little Effect, it is suggested that the properties of rapid transport and confinement are a result of the tautomeric oscillations between ionic and covalent bonding between hydrogen and Pd lattice, respectively. The efficient s-d-p revorbital rehybridizations of Pd and spin dynamics of associated paramagnetic states are important aspects of the covalent-ionic bond fluctuations. Unlike 3d metals, 4d metals possess important both spin and orbital couplings with consequent important spin induced rehybridization effects within the Pd lattice. Pd and H ions facilitate such spin induced revorbital dynamics. The faster transport of d^+ (boson) relative to p^+ and t^+ (fermions) is an aspect of differing spin induced revorbital interactions of lattice electrons with the different hydrogen isotopes on the basis of the Little Rule. The different isotopes also exhibit different confinement effects on the basis of spin induced revorbital effects.

Many of these phenomena of H atoms in late transition metals have been observed by R. B. Little with the Cu-Ag coils and the cooling water in strong DC resistive magnets. The DC resistive magnets employ high volt and high current to generate strong magnetic fields up to 33 tesla. Such high currents generate huge heat loads that must be removed by ultrapure cooling water in order to ensure operation and prevent overheating of the magnets. The resulting Cu-Ag -- H_2O interface under such extreme catalytic surrounding, electric field, magnetic field, temperature fluctuations, and mild pressure provides a remarkable environment for predicting and observing some novel effects. It was predicted that this environment provides conditions for shifting the water autoionization:

$$H_2O \leftrightarrow H^+ + OH^-$$

The shift was predicted on the basis of the Little Effect due to the uptake of hydrogen by the coils to form metal hydrides.

$$d^+ + M \leftrightarrow d^+ \text{ (metal)} \leftrightarrow MD \text{ (covalent)} \leftrightarrow M^+ + d^- \text{ (ionic)}$$

$$h^+ + M \leftrightarrow h^+ \text{ (metal)} \leftrightarrow MH \text{ (covalent)} \leftrightarrow M^+ + h^- \text{ (ionic)}$$

R. B. Little observed high levels of hydrogen within used Cu-Ag magnet coils by SIMS. Furthermore, R. B. Little observed anomalously high deuterium/protium ratios in the used Cu/Ag coils relative to unused Cu-Ag coils. The high levels of hydrogen were attributed to the reduction and uptake of hydrogen from the water by the metal coils. The high d^+/h^+ is thought to be due to different spin effects of electron transfer between the metal and protium ions vs deuteron ions of the cooling water. Pycnonuclear fusion of absorbed hydrogen (e^-, p^+) to form neutrons may also be a reason. This whole mechanism of water decomposition is consistent with O_2 formation within the cooling water. The complete reduction of the hydrogen of the water would form O atoms which can react with the metals to form oxides or react to form O_2 (g). It has been determined an extended coil lifetime if a nitrogen blanket exist over the cooling water tank. Here it is suggested that this N_2 blanket (rather than the atmosphere) removes the generated O_2 during this H_2O magnetoelectrochemical decomposition. The observed build-up of black Ag_2O on the used coils is also consistent with this view. The cooling water was observed to be stripped of deuterium on the basis of isotopic analysis. Slightly higher levels of $^{18}O/^{16}O$ were measured in the recycled coiling water. In addition to the magnetic field effect on the relative h^+/d^+ uptake, the magnetic field effects on the relative Cu/Ag oxidation and dissolution were measured. It was observed that increased magnetic field increased and influenced Cu and Ag oxidation by the water. The magnetic induced oxidation effect was greater for Ag than Cu such that the Cu/Ag concentration ratio in cooling water decreased with increased magnetic field from 30T to 45T. This is consistent with the greater d^+ uptake with stronger magnetic field. The reduction of h^+ or d^+ from the cooling water requires e^- transfer from the Cu-Ag metal to the h^+ or d^+. In stronger magnetic field, the e^- of the metal and the nucleus of h^+ are spin polarized. d^+ has zero spin for a bosonic nucleus and no consequent polarization in the external magnetic field. So in order for the e^- to transfer to the h^+, the e^- spin must flip its spin. Ag is more able (relative to Cu) via spin induced revorbital effects to internal intersystem cross its electrons in order to transfer it's electron to the h^+. So Ag is more readily oxidized than Cu in the stronger polarizing external magnetic fields. Since d^+ has no spin, e^- transfer to d^+ is less dependent on magnetic field strength. This is one explanation of the accumulation of d^+ in the Cu-Ag coils. It is important to note that for zero magnetic fields, Cu has both thermo and kinetic advantages for undergoing oxidation relative to Ag. So it is quite remarkable that above 30 Tesla the Ag oxidation increases relative to Cu. This remarkable observation is explained by the Little Rule. Being of the 3d series, Cu has more internal spin exchange than Ag, so the electron of Cu is more easily and strongly spin polarized for affecting the electron transfer to H^+. Ag is more characterized by jj coupling whereas Cu is more characterized by Russell Saunders coupling. The stronger external magnetic field magnetizes Cu so as not to allow its electron to flip for electron transfer to the proton for the aqueous oxidation of Cu. Ag on the other hand, having spin-orbital coupling frustrates the spin forbidden transition due to s-d orbital flipping of electron spin. These analyses of both the Cu-Ag coils and the cooling water of the magnet provide consistent results. Extremely high levels of hydrogen were observed in the Cu-Ag metal as a result of being in aqueous environment and in the strong magnetic field for prolong times. The metals become more brittle with exposure to strong magnetic field for long time. The brittleness and hydrogen absorption by metal have been observed by others [168]. On the basis of Little Rule, the spin induced revorbital effects on the uptake of deuterium and the oxidation of Cu and Ag in the strong magnetic field are supportive of such spin revorbitals effects in pycnonuclear fusion.

Thermo Gravitational Magneto Fusion:

The Little Rule has cosmic significance, providing many new explanations for fusion phenomena in stars, for supernovas, for neutron star formations and for blackhole formations. It has been stated that magnetic fields shape the universe [6]. The internal structure and dynamics of our sun and other stars is determined not only by gravity, fusion, electric forces, weak forces and thermal energy. Here it is suggested that the magnetic fields in such environments also contribute immensely to stellar structures and stellar dynamics within these stars. Under stellar conditions, atoms are ionized. Hydrogen is the most abundant element in the universe so such ionization within stars results in plasma of mostly electrons and protons in rapid motion. These charges in motion generate huge magnetic fields. So the great gravity of the star holds the plasma together with fusion occurring internally to generate great thermal energy to sustain and energize the plasma, holding the plasma up against gravitational collapse. The tremendous thermal energy within these structures is not simply random, the magnetic field caused by the motion and interactions between ions of the plasma causes ordered motion and organized stellar structures. Therefore on the basis of the Little Effect order exists in spite of such far from equilibrium conditions due to the fermionic spin and charge in motion. Here it is demonstrated by the Little Rule how systems far from equilibrium are not necessarily chaotic[42]. Magnetic fields associated with stars may be as much as a hundred trillion times the earth's magnetic field. The charges in rapid motion cause these huge stellar magnetic fields and the resulting magnetic fields order the internal motion within the plasma of stars. The tremendous magnetic fields in stars, neutron stars, pulsars and magnestars are a result of gravitationally, compressed, densely, organized motion of ions and electrons within the outer layers of these stellar bodies. The huge gravitational fields resist electric and magnetic repulsion between the like charges of the super currents and the huge thermal energy resist condensation of atoms in the outer shells. However deeper within the interior of these bodies strong gravity may condense electrons, protons and neutrons into various phases. It is further important to note that such gravitational forces become even greater within the deeper interior of these bodies such that tremendous densities approaching the nuclear range are the prevailing conditions [169]. These great gravitational forces compress the neutrons, protons and electrons into various fluidic and solid phases even though the temperatures are millions of degrees. Such extreme motion, densities and interactions result in ordering of protons, neutrons and electrons. The fermionic ordering in shells, subshells, revorbitals and spin symmetries may be much different from that in terrestrial atoms. On the basis of the Little Effect, the statistics and structure within the stellar core are such that the quarks exist in pair revolution (correlation) for spinrevorbital motion with the pairs revolving a third quark for a three body nucleon. Furthermore protons, neutrons and electrons exhibit revolutionary (correlated) (spinrevorbital) motion for exotic phases, nuclei and compressed atoms and ions. The correlated revolutional (spinrevorbital) motions of protons, electrons and neutrons lead to spin modulated fusion within the stellar cores on the basis of the Little Effect. For instance on the basis of the Little Effect with such nucleon correlated motion, it is thought that such antisymmetry, compression and revolutionary (spinrevorbital) motion within the core of neutron stars cause superconductivity of protons for extreme high temperature superconductivity[170]. On the basis of the Little Effect, within the less dense outer stellar shells the magnetic ordering of the fermions by antisymmetry may also contribute to super currents and the resulting stellar magnetic field.

In addition to the magnetic field organizing the supercurrents in these stellar bodies, on the basis of the Little Rule the resulting magnetic fields may stimulate various physical phenomena occurring within these bodies. The magnetic fields from outer shell layers organize fusion within the stellar core. The fusion within the core drives the magnetism in the outer layers. The fusion processes within the core involve fermions which are governed by antisymmetry. It is currently thought that huge gravity and thermal energies within the core overcome antisymmetry for various fusion phenomena [171]. Here it is suggested on the basis of the Little Effect that the surrounding intense magnetic field from the shell currents can modulate the spins of electrons and protons and neutrons within the dense core and inner layers so as to flip spins for symmetry and boson states that allow fusion. On the basis of the Little Effect, here it is suggested that spin frustration of antisymmetry within the core drives fusion within the core and influence ion currents within the outer shells and the magnetic fields of the stellar bodies. The spin dynamics of fermions of the core are intimately coupled to the supercurrents and the consequent magnetic fields of the outer stellar layers. On the basis of the Little Rule, these spin interactions within the core are coupled with ion, electron, and proton motions in outer stellar shells so as to allow dynamic magnetic fluctuations that stimulate spin density within the stellar core for antisymmetry to symmetry phase transitions that allow fusion and modulation of fusion. As fusion occurs rapidly, the magnetic field intensifies so as to cause antisymmetry within the stellar core to slow the burning. As fusion slows, ion current diminishes to weaken magnetic field allowing more spin density within the core and symmetry phases for fusion acceleration.

The explanations of stellar events on the basis of the Little Effect are beautifully consistent with supernovas events and neutron star development and blackhole development. Currently, these stages during the life of the star are understood on the basis of the mass of the star and its resulting gravity [172]. Here it is suggested on the basis of the Little Effect that in addition to gravity the more massive stars have faster and greater fusion rates with the resulting more rapid internal electron, proton and ion motions and therefore the magnetic fields are stronger in more massive stars. The higher temperatures, stronger gravity and stronger magnetic fields allow burning to heavier elements with the release of energy. This exothermic fusion occurs up until the Fe nuclei are formed. Further fusion to heavier nuclei than Fe becomes endothermic. The elegance of this model by the Little Effect is not only does the thermodynamics of fusion beyond Fe determine the ultimate destiny of the star, but also the unique strong spin exchange and polarization that emerges with the Fe nuclei formation modify the kinetics of fusion. Here it is suggested that the magnetic properties of Fe play a role in slowing the kinetics of fusion. Although some believe that the high temperature conditions result in complete ionization of Fe atoms. It may be that the great gravitational compression within the stellar core leads to some internal electronic structure in conjunction with the high core temperatures of the star. The antisymmetry of the electrons, neutrons and protons may lead to important magnetic phases and large magnetic and spin domains that are not as relevant in atoms of smaller atomic number than iron. This development of Fe and the emerging magnetic properties may contribute strong spin exchange and polarization of the fermions that slow the fusion based on fermionic antisymmetry. Although in accord with the recent realizations on the basis of the Little Effect that lighter elements may exhibit ferromagnetism under proper conditions, the strongest exchange and spin polarization begins with Fe. With increase pressure and temperature the domain regions of Fe increase in size. In principle, a fermion feels the magnetic torque of many atoms in the large spin phases and magnetic domains. It is as if the magnetism via exchange is a long range force just as gravity. So as the star develops an iron core the strong exchange and spin polarization resist the external outer shell's magnetically induced spin density within the stellar core. Such magnetically induced spin density waves in the stellar core by the outer shell fields break the antisymmetry, which by breaking antisymmetry of protons and electrons allows further fusion within the core. The spin induced orbital effects on the fermions within the intense magnetic field from the outer shells cause the needed orbital transitions from free electrons to bound electron to protons, which form neutrons. On the basis of the Little Effect, such spin induced orbital dynamics and spin density phenomena of the fermions of the stellar core become modified as the core becomes ferromagnetic such that the spin density breaking of antisymmetry is slowed such that fusion cannot occur due to the electron, proton and neutron degeneracy. On the basis of the Little Effect, this emergence of ferromagnetism with Fe accumulation causes a change in stellar fusion kinetics. This change in stellar fusion kinetics compliments the thermodynamics of nuclear binding energy as Fe accumulates to give greater explanation of supernova formation. Therefore as Fe accumulates, fusion slows (due to the Little Effect) and the endothermicity of post-Fe fusion causes the star to suddenly lose its energy source such that it has nothing to oppose gravitational collapse.

The star therefore begins gravitational collapse. The increase in magnetic field within the core and the increase in density as the star collapse under gravity orient the fermions of the core such that fusion of electrons, protons and neutrons of the Fe core is not allowed based on degeneracy and antisymmetry. It is thought that during such collapse the bang of the outer stellar shell on its core causes a supernova[167]. On the basis of the Little Effect, here it is suggested that the bang causes cycles (based on elastic collisions of the shell with the dense core) of expansion and compression of the outer shells about the Fe core, which cause magnetic field ripples and oscillations in magnetic strength and directions. Here based on the Little Effect, it is suggested that more massive collapsing stars generate the stronger magnetic ripples and spin density waves within the stellar Fe core. These magnetic bangs break antisymmetry so that electrons and protons of the core may collapse to neutrons during the supernova such that a neutron star develops. The more massive stars create such intense magnetic ripples and compressions such that they may more thoroughly break antisymmetry and form blackholes. Therefore on the basis of the Little Effect spin motion coupled to revorbital motion breaks the antisymmetry of Pauli degeneracy to allow fusion under gravity.

Pyconuclear Fusion:

The use of strong magnets may accelerate pycnonuclear fusion phenomena and contribute to greater reproducibility. Although a few papers have mentioned the use of magnetic field to accelerate lower temperature fusion no accepted mechanisms are given [173-176]. Here the Little Effect provides a new mechanism whereby the magnetic field assists reverse beta. On the basis of the Little Rule, pycnonuclear fusion phenomena is in general explained as a spin induced revorbital effect that causes reverse beta processes. Such reverse beta eliminates the need for high temperature to overcome the coulomb barrier. The observed conditions associated with sporadic and difficult reproduction of pyconuclear fusion events is supportive of this mechanism. These sporadic conditions are produced by laser irradiation, rf and microwave radiation and interfacial effects, nanosize particles and history of thermal stresses, electric stress, pressure stress, and mechanical stress. Within these environments, the metal lattice absorbs large quantities of hydrogen. The absorbed hydrogen is likely ionized to p^+ and d^+ [164]. The p^+ and d^+ ions are coupled to the metal lattice by revorbital and spin interactions. The d^+ and p^+ ions are coupled to each other, metal ions and lattice electrons very strongly thru spin exchange. Pons and Fleischmann hypothesized a sort of fermionic to bosonic superradiance of the protium and deuterium within the lattice [177]. The Little Rule governs the details of spin and revorbital phenomena associated with such superradiance. On the basis of the Little Effect the discrepancy between the hot fusion ideology and new cooler fusion is resolved on the basis of spin, revorbital and magnetics of the fermions for catalytic pathways to fusion phenomena that require lower temperatures. Here on the basis of the Little Effect it is suggested that within the Pd lattice, the hydrogen atom undergoes oscillations between localized covalent bonds to Pd lattice and delocalized ionization for protium, deuterium and tritium ions within the lattice. On the basis of

Little Rule, these bond fluctuations determine a type of tautomerism. There are coulomb and exchange interactions between the d^+ and p^+ and lattice electrons.

RB Little suggests that on the basis of the Little Effect that proton solvation (or electron solvation) of an $(e_a^- \bullet p_a^+)$ spinrevorbital pair (absorbed hydrogen atom) within the lattice causes spin induced electronic revorbital excitation by multi proton (or multi electron) interactions on the electron (e_a) of the $(e_a^- \bullet p_a^+)$ pair such that the intense motion of many surrounding protons (or electrons) and their associated spin exchange cause spin induced revorbital acceleration of the e_a into nuclear symmetry from the atomic symmetry of the 1s of the absorbed hydrogen, $(e_a^- \bullet p_a^+)$. The hydrogen atoms absorbed into a metal (like Pd) are subject to this because of the possible condensates of protons and deuterons within the Pd lattice's 5s, 5p and 4d revorbitals. The Pd affords a lattice with available 5s and 5p spinrevorbitals suitable for hydrogen ion condensation. Such 5s and 5p spinrevorbital symmetries allow the concentration of hydrogen ions and lattice electrons for internal hydrogen cluster solutes within the Pd lattice solvent. These lattice hydrogen clusters may have hydrogen surrounded by many protons or hydrogen surrounded by many electrons. Unlike the 4d of Pd, the Pd 5s and 5p spinrevorbitals manifest much stronger $(e_a^- \bullet p_a^+)$ spinrevorbital interactions with the Pd nucleus and much greater exchange interactions between $(e_a^- \bullet p_a^+)$ spinrevorbital pairs and exchange between the $(e_a^- \bullet p_a^+)$ spinrevorbital pairs and the lattice electrons and protons relative to such interactions within the Pd 4d spinrevorbital. These greater coulomb and exchange interactions cause the spin induced torque of the electron of the pair into the proton to form neutrons. The phonons of the Pd lattice vibrate such protonic (or electronic) torque of the e_a into the p_a of the $(e_a^- \bullet p_a^+)$ spinrevorbital pair. Within such a lattice, s bands and p bands of Pd with the surrounding proton (or electron) spins and motions accelerate the electron of the $(e_a^- \bullet p_a^+)$ spinrevorbital pair into the proton. Likewise electrons around the $(e_a^- \bullet p_a^+)$ spinrevorbital pair may by their motions and spin accelerate the electron into the proton to form a neutron. These are complex multi-body interactions in magnetic fields approaching that of the neutron star at least on the length scale of the 5s spinrevorbital of a Pd atom. It is important to note that the magnetic flux density experienced by the hydrogen within the Pd lattice is huge on the scale of a Pd 5s revorbital. Exchange between atoms for small domains further intensifies such magnetic fields. Hydrogen clusters in such fields are stabilized [64]. Such a lattice like Pd gives much greater stability to the hydrogenous clusters relative to the hydrogenous clusters in vacuum due to its electronic structure and electronegativity. Palladium's electronic structure allows the ready rehybridization of s,p and d revorbitals. As already considered, the electronic structure of Pd is such that the jj coupling applies with the importance of both spin and revorbital momenta so that these momenta provide oscillating effects on the hydrogenous clusters for such spin acceleration of revorbital motion of electrons of the hydrogenous pair into neutronic symmetry. In strong magnetic environment surrounding polarized electrons and protons can push on the bosonics diamagnetic $(e_a^- \bullet p_a^+)$ pair to convert it to a fermionic neutron. On the basis of the Little Effect, such multi proton spin or multi electron spin interactions on e^-_a excites it into nucleon type spinrevorbits on p^+_a to a radius much less than the Bohr orbit so that the weak interaction may occur to create a neutrino and hereby cause the reverse beta process to convert the $(e_a^- \bullet p_a^+)$ spinrevorbital pair to a neutron. The neutron uptake by surrounding protons (or electrons) creates deuteriums. The neutron uptake by surrounding deuteriums creates tritiums. Tritium was detected in the magnet coil by SIMS. Excess levels of ^{18}O were detected in the cooling water of the DC magnet. Tritium decays to He-3. Thereby on the basis of the Pd lattice (or Cu-Ag lattice), spin induced revorbital dynamics of the lattice on ($e_a^- \bullet p_a^+$) spinrevorbital pairs by surrounding proton condensates causes revorbital rehybridization of electrons from atomic revorbital symmetry to nuclear revorbital symmetry in the form of an (electron-proton) or neutron particle by the spin induced revorbital acceleration of the electron in the highly concentrated polarized proton (or electron) rich media. The motion in the proton media begins to take on symmetry of proton motion in the nuclei which causes revorbital states of the electron of the ($e_a^- \bullet p_a^+$) spinrevorbital pair to take on the electron motion as it exist within neutrons within the nuclei of atoms so that the electron can undergoes this catalyzed transition into the nuclear symmetry. This mechanism on the basis of the Little Rule explains some findings such as the novel vortices and superfluidity in strongly interacting Fermi gas[179].

This proton (or electron) media's spin induced fixation of the electron revorbital motion from the atomic symmetry to the nuclear symmetry is consistent with the handedness observed for the weak interaction during the beta process [55,180]. The handedness reflects the complimentarity of weak and electromagnetic interactions [181]. On the basis of the Little Effect, just as the electron accelerates in one direction in departing from polarized neutron to form polarized protons (and electrons) in a strong magnetic environment, the strong magnetic environment reported here would organize proton (or electron) media so that the e_a would be catalytically accelerated in a suitable direction [180] so that the specific handedness of the reverse beta process is met for a proton and electron to combine into a neutron. The rarity of reverse beta has to do with this selection rule. Neutrinos cause reverse beta in zero magnetic environment. On the basis of the Little Effect, magnetic interactions via spin induced acceleration of electrons in the proton (or electron) rich metal lattice allows such reverse beta with greater probability. This orbital motion of the electron tied to proton ($e_a^- \bullet p_a^+$) for neutron formation is stabilize under weak and coulomb effects within the nucleus so the neutron is more stable within the nucleus within the fields and motions of internal protons. But extranuclear neutrons lack such proton field and motion so they rapidly undergo beta decay within 15 minutes. The rich proton (electron) environment in the Pd lattice allows such spin-orbital interactions with protons for the reverse beta to occur. These effects depend on magnetic properties of the media, which have been observed important for metals like Pd on the nanoscale [182]. The magnetic and spin environment allow the torque of electrons from atomic electronic states to nuclear states. The existence of delocalized p^+ as fermions involves magnetic phases of the Pd lattice. Here it is suggested the strong magnetic field may contribute to more reproducible pycononuclear fusion events as in the strong fields of neutron stars, pulsars and magnestars [178]..

In addition to the here predicted proton acceleration of electron into nuclear motion for ($e_a^- \bullet p_a^+$) spinrevorbital pair, here it is suggested that the Pd lattice can also during phonons torque the electron into tighter orbits so as to fuse the ($e_a^- \bullet p_a^+$) spinrevorbital pair into a neutron. This process may occur due to the alkali, alkaline earth like excited electronic states of Pd which can by four Pd^+ ions bind an ($e_a^- \bullet p_a^+$) spinrevorbital pair for a multi-centered 2 fermion bonds involving a bridging hydrogen or ($e_a^- \bullet p_a^+$) spinrevorbital pairs between 4 Pd^{46+} centers.. The ($e_a^- \bullet p_a^+$) spinrevorbital pair may exist localized within the overlapping orbitals of four Pd centers. The motion of the Pd centers may accelerate electron and proton of the ($e_a^- \bullet p_a^+$) into tighter revorbits so as to form a neutron. The 4 Pd nuclei compress the ($e_a^- \bullet p_a^+$) spinrevorbital pair within their revorbital to form spinrevorbitals of ($e_a^- \bullet p_a^+$) pair just as atoms compress ($e_a^- \bullet e_b^-$) spinrevorbital pair into atomic and molecular orbitals in atoms and molecules. Such lattice phonons on the basis of the Little Effect cause revolutional and correlation (spinrevorbital motion) of e ---e pairs for superconductivity. Likewise on the basis of the Little Effect such lattice phonons cause correlation and revolutionary (spinrevorbital) motion of the ($e_a^- \bullet p_a^+$) pair that torque e_a^- into the p_a^+ for neutron formation. The Pd center experience huge coulomb repulsion so they may not approach the ($e_a^- \bullet p_a^+$) spinrevorbital pair as closely as the previously described protons and electrons. But the slight approach would create huge forces due to greater nuclear charge on the Pd center.

In addition to this mechanism of reverse beta in the magnetic and spin environments of proton solvent and Pd multi-centers, here it is suggested on the basis of the Little Effect that the delocalized bosonic states wherein the hydrogen ions with an electron ($e_a^- \bullet p_a^+$) exist in spinrevorbital motion within the metal lattice may also contribute to important pathways to neutron formation. In magnetic environment, the ionized hydrogen exist as fermionic p^+,d^+, t^+. But in low magnetic environments the hydrogen exists as pair bosonic spinrevorbital pair in revorbital motion within the Pd lattice just as an electron pair exists in revorbital motion within the lattice. Such ($e_a^- \bullet p_a^+$) bosonic spinrevorbital pairs may constitute a fusion mode in low external magnetic field environment. The ($e_a^- \bullet p_a^+$) bosonic spinrevorbital pair forms just as two electrons pair in revorbital motion such that the orbital revolutional (spinrevorbital) motion in the partners spin field causes a countering magnetic force to their coulomb interaction. By the Little Rule, the spin of the proton of the ($e_a^- \bullet p_a^+$) spinrevorbital pair induces revorbital motion of the electron about the proton so as to counter the coulomb repulsive interaction between the p^+ and the Pd^{+46} nucleus as the ($e_a^- \bullet p_a^+$) spinrevorbital pair approaches the Pd nuclei. The p and Pd nuclei repulsion is lowered by the stronger bosonic pairing of ($e_a^- \bullet p_a^+$) in the Pd revorbitals about the Pd^{46+} nuclei. For the ($e_a^- \bullet p_a^+$), the electron orbits the proton as they both move in the revorbitals of the Pd lattice. The electron and proton ($e_a^- \bullet p_a^+$) pair experience coulomb attraction. The spinrevorbital motion of the electron about the proton causes its magnetic repulsion by the spin of the proton. But the electron spin and proton spin causes magnetic attraction. Within the s orbital of the Pd lattice the ($e_a^- \bullet p_a^+$) pair has a probability of approaching the Pd nucleus. On the basis of the Little Effect, such an approach by the Pd nucleus is energetically feasible if the electron orbits the proton very tightly causing greater relativistic effects. On the basis of the Little Effect, as the proton approaches the Pd nucleus the electron is relativistically accelerated into smaller orbits so as to counter the repulsion of the proton by the Pd nucleus. The tighter electron orbit drives the electron into the proton to form a neutron under the force of the approaching Pd nucleus. This process provides a nonmagnetic route to reverse beta within the Pd lattice. On the basis of the Little Effect, it is also suggested that the ($e_a^- \bullet p_a^+$) spinrevorbital pair may be relativistically driven into tighter orbits by its interaction and close approach to many lattice electrons. Such close approach would drive the e_a^- of the ($e_a^- \bullet p_a^+$) spinrevorbital pair into the p_a^+ so as to lower its coulomb repulsion by close nearby lattice electrons. So both the Pd nucleus and the lattice electrons may coulombically force tighter orbits of ($e_a^- \bullet p_a^+$) spinrevorbital for neutron formation. The possible high spin states of the nucleons of Pd nuclei can also contribute spin-orbital and spin-spin interactions between the Pd nucleus and the orbiting ($e_a^- \bullet p_a^+$) bosonic spinrevorbital pair. Gamma rays and other photons may excite the Pd nucleus. The ($e_a^- \bullet p_a^+$) spinrevorbital pair are perpetually exchanging virtual photons. On the basis of the Little Effect, the spinrevorbital motion of the absorbed ($e_a^- \bullet p_a^+$) pair involves both stable discontinuum states as well as unstable continuum states. The electrons of the Pd lattice also undergo spinrevorbital motion to determine both stable quanta of discontinuum and unstable continuum states. On the basis of the continuum states of the ($e_a^- \bullet p_a^+$) pair spinrevorbital and the continuum states of the Pd lattice electron pairs, an internal gamma oscillator can develop about stable discontinuum gamma quanta involving core Pd electrons. This gamma oscillator with inversion about discontinuum quanta states of the Pd lattice may cause lasing of gamma rays of sufficient energy to be adsorbed by the ($e_a^- \bullet p_a^+$) spinrevorbital pair impurity. Here it is suggested on the basis of the Little Effect that these internal gamma lasing photons can simultaneously overwhelm virtual photons of the ($e_a^- \bullet p_a^+$) spinrevorbital pair so as to excite the ($e_a^- \bullet p_a^+$) spinrevorbital into tighter orbitals for weak exchange for neutron formation. Such internal gamma photons may be the basis of the so called burst observed in cold fusion phenomena. Magnetic phases may also cause internal triplet gamma lasing such that the gamma exchange between the Pd lattice electrons and the ($e_a^- \bullet p_a^+$) spinrevorbital pair causes spin flip and change in multiplicity of the ($e_a^- \bullet p_a^+$) spinrevorbital pair as it is driven into the neutron symmetry. The spin field of the proton and possibly the Pd nucleus and the electron orbit in this spin field cause spin induced orbital acceleration of the electron about tighter orbit about the proton. The relativistically tighter the orbit of the ($e_a^- \bullet p_a^+$) appears as a neutron to the Pd nucleus. It is important to note the great magnetic force on these subatomic length scales. So on the basis of the Little Effect, the trio of electron, proton and Pd nucleus develop a state within the s revorbital of the Pd such that the ($e_a^- \bullet p_a^+$) spinrevorbital pair forms a neutron due to motion within the Pd lattice involving close approach to Pd nuclei. The closer approach of the ($e_a^- \bullet p_a^+$) spinrevorbital pair to the Pd nucleus drives the reverse beta formation of a neutron. The gamma exchange between the electron of the ($e_a^- \bullet p_a^+$) spinrevorbital pair and Pd nucleus prevents gamma between the ($e_a^- \bullet p_a^+$) so electron barrels into the proton of the pair for weak interaction to form neutron. Therefore here it is proposed that an internal laser of gamma frequency develops in the Pd lattice such that coherent gamma photons overwhelm the ($e_a^- \bullet p_a^+$) spinrevorbital pair into weak interaction to form neutrons. It is important to note that within the nucleus gamma exchange keeps the beta process from occurring. This model explains Gimzemski's et al [183] recent fusion of deuterium within erbium deuteride lattice. They observed fusion by firing d+ into ErD_2. On the basis of the model and application of Little Rule, the neutron star and pulsar magnestar are put forth as further evidence for model such that the huge magnetic fields in these celestial bodies may accelerate reverse beta events [173,176]. In time stronger evidence mounts for pycnonuclear events in metal lattices even if currently at impractical rates [183,186]. Also the magnetic field, pressure and temperature conditions in the Fe core of the earth may contribute to cold fusion effects within the earth. Some evidence of geo-cold fusion has been put forth on the basis of He-3 tritium in lava of volcanoes [184].

Acknowledgements:

With external gratitude to GOD.

For Lillie Ruth on her birthday!

With love for Reggie Jr. and Ryan Arthur!

Special thanks to Dr. Bruce Brandt.

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