The Application of Little's Effect and Ferrochemistry
for New Approach for Extraction of LiOH from Salar Geothermal Brines

Abstract

A prior theory of Ferrochemistry and its Laws for Little's Rules 1, 2 and 3 are applied to systems of nuclear spins and nucleon angular momenta for using applied static magnetic field, static electric field, ultrasonic vibrations, and radio frequency waves for stimulating, separating and extracting various cations from geothermal salar brines. Down the group and families of alkali, alkaline earth and halide ions, considerations are given of variations in $e^- e^-$ --- $e^- e^-$ --- e^- interactions and $e^- e^-$ --- nuclear interactions from s to p to d to f subshells with complex inter and intra orbital, subshell and shell interactions. The unique symmetry of s orbital for reversibly collapsing on nuclei and vice versa nuclei fractionally, reversibly fissing for nuclear pressures into s orbitals and from s subshells into outer subshells of higher azimuthal quanta are given. The alterations of the electronic shells and variations among elements and their isotopes are disclosed to cause the novel mechanics for separating the alkali cations and lithium, specifically. An analogy is draw between extractions of Li^+, Na^+, K^+, Mg^{2+} and Ca^{2+} cations in graphene-nanodiamond nanofiltering membrane and variations of these ions in ion channels of brain and nervous systems in animals and humans for determining new mechanics of diseases like mania, depression and bipolar disorder with treatments by Li^+ is considered. Advantages of this graphene- nanodiamond nanofilter relative to current methods are considered. Details of the mechanics on basis of varying sizes of s orbitals, symmetries of s orbital, varying rotation rates of the cations, varying spins of the cations, and varying nuclear magnetic moments (NMMs) of the cations are presented. The originality of the author's theory of invoking NMMs for differing interactions is contrasted with prior nuclear spin effects of prior investigators. Complex spin and angular momenta interactions of the cations, anions, protons and halides are considered. A novel method of using the static magnetic field, static electric fields, radio frequency waves and ultra sound for selective precipitations of LiOH (s) with retarding Li_2CO_3 (s) is presented. On the basis of separation factors (ξ) as by ratios of various NMMs of the cations in geothermal salar brines, the separation factor varies from: $\xi\ (\mathrm{Li}^+/\mathrm{Na}^+) = 1.45$; to $\xi\ (\mathrm{Li}^+/\mathrm{K}^+) = 8.35$ to $\xi(\mathrm{Co}/\mathrm{Li}) = 0.607$ to $\xi\ (\mathrm{Co}/\mathrm{Mn}) = 0.635$. The similar, large NMMs of Li with Co and Mn with small differences in spins may by the theory here be the explanation and cause for more difficult separation of Li from Co and Mn and the current empirical affinity of Li for Co and Mn as indeed Co and Mn have been observed as sorbents for Li.

Keywords: Lithium Extraction; Geothermal Salar Brines; Nuclear Magnetic Moments; Radio Waves; Ultrasound; Static Magnetic Fields; Static Electric Fields

Introduction

The theory of the Little's Effect is further developed for nucleon spins and orbital momenta relativistically accelerating in interacting with the surroundings by the tiniest perturbations (relative to huge energy and momenta densities of nucleons and nuclei) for fractional, reversible fissing of nucleons into nuclei and of fissing nuclei into surrounding electronic shells. Such development in general explains quantum mechanics as by fractional, reversible fissing and fusing of electrons (leptons) and nucleons (hadrons) and nuclei (with complex superpositions of resulting waves and fields) for wave-particle duality and the formations of wavefunctions as composite complex electric and magnetic fields and waves as fractional, reversible transmuted from nuclei, hadrons and leptons. The divergent differentiation is mathematically computing fractional, reversible fissing relativistically and the divergent integration is computing fractional, reversible fusing relativistically. See Eqns 1 and 2. The alterations of the transient, fissed fields by varying nuclear magnetic moments (NMMs) of isotopes of elements is further developed here leading to novel isotope effects on transportations, transformations, thermodynamics, particles/fields and transmutations as computed and reasoned by negative (dark) NMMs twisting the surrounding space counterclockwise verses the positive (bright) NMMs twisting the surrounding space clockwise. The author thereby introduces new idea of added superpositions by clockwise and counterclockwise spatial motions. On basis of such different NMMs, alkali cations are considered for inventing novel method of separating alkali from salar, geothermal brines and the larger positive NMMs of Li^+ cations relative to Na^+, K^+, Rb^+, and Cs^+ cations (See Table I) are used to employ strong electric fields, strong magnetic fields, intense ultrasonic waves and radio-frequency fields for Little's Effect and Ferrochemistry for extracting LiOH (s) from the geothermal salar brines in novel way.

The nuclear magnetic moment is a magnetic dipole arising from angular momentum of nucleons in nuclei and nuclear spins. The NMM is not observed from quadrupole magnetic moment which pertains to the moments of two polarized spins at the quanta. The nuclear magnetic moment varies from isotope to isotope. See Table I. Isotopes with nuclei with even number of protons and neutrons will have zero NMMs. Isotopes with nuclei with odd numbers of protons and/or neutrons will have nonzero NMMs. The net NMM is not computed from the sum of NMMs of the nucleons in the nucleus and is rather complicated to couple to spin by current calculations. The author hopes to note in his idea such complications are due to the huge energy density and the coupling of nuclear magnetic moments to infinitesimal thermal space beyond the nucleus for the perpetual agitation of the NMM and is reversible fractional fissing and fusing with release of the fragmented fields into the surrounding electronic shells and subshells and orbitals. The NMM is calculated by some permutations of the combined magnetic moments of the unpaired, outer and last proton and neutrons within the nucleus. Such NMMs for the nuclei as cations in this work may approximate a separation factor { ξ } to the first order by the ratio of the gyromagnetic ration or (g-factor * NMM/reduced Planck's constants); where NMM (μ) of like parities (all Br [clock] or all Dk [Counterclockwise]), which determine ratio of gyromagnetic ratios $\gamma = g\mu/\hbar$ for free atoms with g factor (g) and Plancks constant ($\hbar$). By the authors theory the nuclear magnetic moments of opposite parities (Br and Dk) tend to bind in new ways.

$$\xi = [\{ \gamma (Li^+)/ \gamma (M^{n+})\}]$$

For ξ (Li^+/Na^+) = 1.45; ξ (Li^+/K^+) = 8.35 ; ξ(Co/Li) = 0.607 and ξ (Co/Mn)= 0.635. The author notes the easier separations of Li from alkali cations and alkaline earth cations. But separation of Li may involve stronger needed external magnetic fields as the separation factor for Li from Co and Mn is much smaller. But the author notes consistence of his proposed separation here with known intrinsic binding and deposits of Li with Co in mines and Li and Mn as Li with Co and Li with Mn has in past been empirically determined as good sorbents for Li. But here the sorbing power of Mn and Co for Li is attributed to their mutually large nuclear magnetic moments (NMMs) of similar magnitudes and slightly different different spins for small gyroscopic ratio differences in external electric and magnetic fields for limited more difficult separations.

The author previously presented novel math for calculating fractional, reversible fissing and fusing of superluminous irrational spaces as by divergent differentiation and divergent integration as give by Equations 1 and 2, respectively:

$$\frac{\partial F(\mu)}{\partial \mu} = f(\mu);\ \ where\ \partial\mu\ \rightarrow 0\text{ ; Equation (1)}$$

$$\int f(\mu)\ \partial\mu = F(\mu)\ ;\ \ \mu\ from\ n\ to\ m\text{ ; Equation (2)}$$

Such infinite and infinitesimal differentiations $f(\mu)$ are different from Newtonian and Leibnitz Calculus as the divergent differentiations are not as by finite but infinitesimal, infinite spaces and times and the divergent integrations $F(\mu)$ are not over finite but infinitesimal, infinite spaces and times. Therefore by $f(\mu)$ and $F(\mu)$, the author can calculate hidden infinititesimal superluminous hidden spaces, fields and waves (of Br and Dk gravities) dividing quanta particles for fractional fissing and the reverse of fractional fusing as infinitesimal superluminous hidden space, fields and waves (of Br and Dk gravities) summing and multiplying into denser spaces, quanta and particles for fractional fusing. In 2014, RBL disclosed 4 Laws of Ferrochemistry: Law 1 involves the Woodward Hoffman Rules; Law 2 (Little Rule 1) involves possible energetic coupling between a system and surroundings for activating dynamics; Law 3 (Little's Rule 2) involves high field, high energy and/or few particles (hence low entropy) for coupling to surroundings by Little Rule 1 for quantum dynamics; and Law 4 (Little Rule 3 involves low fields, low energy and/or many particles for coupling to surroundings by Little Rule 1 for classical dynamics.

By considering and using such fractional, reversible fissing and fusing, the varying interactions of nuclei with $e^- e^-$ and e^- lattices relative to $e^- e^-$ --- $e^- e^-$, $e^- e^-$ --- e^-, and e^- --- e^- lattices interacting with nuclei may be reasoned. The co-shell $e^- e^-$ interactions affect the electrons of p, d and f block elements and subshells in comparison to e^- --- nuclear interactions. Surrounding thermal agitations cause the fractional, reversible fissing and fusing of nuclei of null, positive and negative NMMs [1]. The surrounding thermal space in its irrational feebleness can couple to the dense energy/mass of the leptons, hadrons, nucleons and nuclei by Little's Rule #1 from Laws of Ferrochemistry [2] for disrupting the particles of leptons, hadrons, nucleons and nuclei against themselves for transient fractional, reversible explosions of the nuclei with seeping energy and fields into surrounding electronic shells and L-Continua with classical reversibility, but not all components of the fissed fields are recaptured and new surrounding fields are pull into the nuclei during reversal of fusing by classical nature of nuclei [2,3]. The reverse is by fractional divergent integrations. The seeping from fractional, reversible fissing of NMMs and nuclei cause alterations of wavefunctions and productions of novel transient states (as by quantum fluctuations) for a here explanation of quantum fluctuations. The seeping of positive and negative NMMs may be out of rhythm for causing Br and Dk fields [1,4]. The Br fields twist with same symmetry of electronic orbitals in space. But the Dk fields twist with opposing counter-clockwise symmetry relative to the twist by Br fields from nuclei. Here it is further stressed that the e^- and $e^- e^-$ of covalent and metallic bonds can exchange, correlate and cohere nucleon NMMs and spin polarizations for collective effects of fractional fissing and fusing nuclei on band, molecular, and atomic orbitals, vice versa.

The $e^- e^-$ interactions involve e^- Coulomb fields, magnetic fields and quantum fields with electrons pushing and pulling each other from quantum fields of spinrotorbitals and spinviborbitals into L continua for spinrevorbitals and spintransorbitals via lepton --- lepton interactions in noncentral ways and nonspherical, quantal symmetries [3]. But the NMMs, nucleons and nuclei are hadronic, denser, central fields and mixed of classical and quantum fields acting on s orbitals [1]. The s orbitals are spherical also and more classical [7,8]. Many nuclei are spherical and therefore more overlap with s orbitals/subshells relative to p, d, f, g subshells. This leads to distinct interactions of e^- --- NMMs in s subshell relative to e^- interactions in more quantum mechanical p, d, f … subshells of higher angular momenta [1]. Nuclei cause surrounding quantum fields and wavefunctions by fractional, reversible fissing and fusing [2,5]. So by Little's theory, nuclei can alter surrounding wavefunctions and electrons within such wavefunctions and nuclei dictate where electrons are likely found and these probability density functions are not static but dynamic and even have hidden dynamics [1-4]. For instance, the fields about the alkali and alkaline earth are more spherical and uniform relative to fields outside p, d and f subshells [8]. The NMMs may seep from nuclei to push electrons and fields into surrounding p, d, f, g … subshells reversibly for 'nuclear pressures' of Little [2, 5, 6].

The fractional, reversible fissing and fusing of the nuclei seep fields outward and the rarefactions produce dense symmetries that transform s to p to d to f symmetries locally and then to rarefied f, d, and p symmetries to form bigger s orbital symmetries in some limits [1]. So nuclei create fields that lack electrons that by convention would have been created by electron --- electron interactions [1]. Nuclei create complex quantum fields and electromagnetic fields from denser p^+ and n^0 quanta of hybrid classical - quantum interactions, which are ultra-relativistic, quantum field. And electrons move in these quantum fields and electrons alter these quantum fields released by nuclei [1]. For instance negative NMMs fractionally, reversibly fiss and fuse to cause strange metals [1] by Little's Rules 1, 2, and 3. The nuclei may produce s type fields and greater fractional, reversible fissing produce dense s subshells which transmute to p subshells and p subshells transmute to d subshells and d subshells of denseness transmute to f subshells [1]. And the electrons cause the perturbations of the nuclear fields and assist the nuclear fields producing the p subshells and the nuclear fields producing the d subshells and the nuclear fields producing the f subshells [1]. This is why the order of energies can shift as subshells fill with electrons. The electrons alter the QFs released from nuclei. Vice versa the e^- e^- lattice produce dense counter fields that cannot completely collapse on nuclei due to rarity and motions of e^- sources [1]. Prior scientists have observed by NMR electronic fields acting on nuclear spins to alter solvations [9-12]. But here the author introduces and develops more his prior notion of the reverse in concerted ways as many nuclei concertedly via intervening electronic exchange polarize their spins, angular momenta and charges for new ways (as reasoned by the author) for multiple nuclei to act on surrounding electronic lattices and to focus on specific orbitals and their electrons for relativistic alterations for novel chemical dynamics [1,2, 4].

But now the non-zero nuclear magnetic moments (NMMs) alter these fields released by null NMMs [1, 2, 5]. Prior science has accounted for fields of spins of nuclei affecting the surrounding electronic lattices, shells, subshells and orbitals [13]. But the author notes that his work introduces (for the first time) the effects of nuclei and nuclear angular momenta with spins on the surrounding electronic shells, subshells and orbitals by fractional, reversible fissing and seeping interior nuclear shells, subshells and orbitals of nucleons with further outward seeping into surrounding electronic shells. And this is new isotope effect discovered by RB Little [1,3,5]. So scientists currently model the wavefunctions from point electrons and point nuclei. But relativistic fractional, reversible fissing and fusing of electrons as by the author can alter the produced wavefunctions. Masses, charges, spins of nuclei and NMMs can transmute fractionally, reversibly to energy in fields as nuclear fields → QF for altering the QF relative to conventional quantum mechanics. Currently this is unknown in science and newly disclosed here. The author discovers this and realizes that by high temperatures, radio frequency, ultrasound and static magnetic fields and stimulations, motions can be induced to cause nuclei fractional, reversible fiss to space with classical refusing of nuclei and nucleons during motions to momentarily produce huge quantum fields and alter wavefunctions in hidden ways [1, 2, 5, 6].

So now the electric (E) and magnetic (B) fields are dense thermal fields and so E and B also cause such fractional, reversible fissing and fusing of nuclei [1]. So by impose strong electric and strong magnetic fields, ultrasound and intense radio frequencies, then the nuclei fractionally, reversibly fiss to alter surrounding electronic lattices. Thereby RBL applies this to the geothermal salar brines by applications of strong electric and strong magnetic fields, sonic stimulation and intense radio frequency waves. Thereby RBL induces larger fractional, reversible fissing of the nuclei of the geothermal brines and graphene, nanodiamond membrane and the electronic lattices of Li^+ cations are more altered due to their larger NMMs than Na^+, K^+, Rb^+, and Cs^+ cations and their isotopes (See Table I), so Li^+ cations more easily bind to nearby magnetic fields and quantum fields of surrounding fermions, spins, atoms and ions. Li^+ more strongly binds new ligands in solvent and/or membrane nanochannels having NMMs. This may explain Mn binding of Li and also Co in inorganic sorbents as Mn, Li and Co all have large NMMs. See Table I. The author draws an analog between Li^+, Na^+, K^+, Ca^{2+} and Mg^{2+} in nanochannels of the graphene nanodiamond membrane and ion channels in living cells for explaining therapeutic effects of Li^+ by NMMs on mental illness and analgesic effects of ^{129}Xe and ^{131}Xe by its NMMs and more detailed basis for ^{31}P acting as qubit for quantum computing in brains (by its NMM in addition to its spin). [16]. The proposal that ^{31}P may act as quantum computer for operation of the brain [17] is based on nuclear spins. But here the author further develops angular momentum effects of nucleons and nuclei in addition to prior spin effects of Fisher [17] for contributing to computing in the brain.

The angular momenta of s electrons are less than p, d, and f … subshell electrons, but with denseness the s transforms to p, d, and f fields of more complex quanta momenta [1]. The convention has the greater nuclear charges with increase atomic numbers causing more electrons for more electron --- electron interactions for transforming s orbitals to p orbitals and p orbitals to d orbitals and d orbitals to f orbitals [7,8]. But via fractional, reversible fissing and fusing, the nuclei can fractionally, reversibly blast fields reversibly into surroundings to create these fields from protons, neutrons and/or nucleon orbitals and spins to concentrate the s orbitals to form p and d and f orbitals; or via neutrons (and their cause of negative NMMs) to rarefy the orbitals to transform f to d and d to p and p to s orbitals via dark interactions [1,2,5,6]. The positive and negative NMMs thereby alter the surrounding orbitals in different ways for different transport, transform, thermodynamics and transmutations [1], as the author introduced superposition of clockwise and counterclockwise wave patterns. Positive NMMs make the atoms more basic increasing e^- e^- dense and e^- e^- interactions; so subshells fuse from s → p → d → f orbital symmetries (by basicity the e^- e^- interactions increase and the shells and subshells are harder, but they can increase with softening if the magnetic fields stabilize dense, softer electrons [1]). Negative NMMs make the atoms more acidic decreasing e^- e^- denseness and decreasing e^- e^- interactions so f → d → p → s orbital symmetries (by acidity the e^- e^- interactions decrease and the shells and subshells are softer, but they can harden with decrease interactions if the magnetic fields and interactions stabilize the rarefied harder electrons, but how so [1]). So fractional, reversible fissing positive NMMs momentarily cause hardening e^- e^- subshells and shells [1]. So fractional, reversible fissing negative NMMs momentarily cause softening of e^- e^- subshells [1].

. On the basis of this theory of the author, novel phenomena of Li can be explained and the new processing for extracting Li^+ from salar brines is discovered by the author by imposing fields to increase fractional, reversible fissing and fusing So also the rotations and faster rotations of the Li^+ cations by the strong electric, strong magnetic and radio frequency fields will cause their greater fractional, reversible fissing and fusing in order to convert their particle natures to waves and fields of spaces for these to motions and refusings, so such particle to field and wave of the Li^+ nuclei will even more alter the surrounding space for seeping electric and magnetic fields for distinct interactions of the Li^+ with the surrounding atoms relative to interactions of Na^+, K^+, Ca^{2+}, Mg^{2+}, … The factors that facilitate this speed of motion of Li nuclei include: the size of the nanopores and nano-channels; the functional groups on the graphene and graphene oxide and nanodiamond in the nanochannels; electric charges; and magnetic moments within and across the nanochannels. This type ferrochemistry as by Little's Effect may be a basis for novel chemistry occurring under high volts in lithium ion batteries causing fires and run away chemical reactions! The application of magnetic fields may control such unusual chemistry in Li^+ ion batteries to prevent fires and explosions. Here also the author notes brain activity and Na^+ and K^+ diseases [14,15] and Li^+ treatments of nervous and mental diseases. These stronger, seeped fields from the Li^+ cation relative to Na^+, K^+, Rb^+ and Cs^+ cations can cause Li^+ to bind OH^- in stronger way than it binds $(CO_3)^{2-}$. Well, the Li^+ cations like protons form revorbitals. The electron can be accelerated relativistically by external electromagnetic fields. But here the author considers the proton, Li^+, Na^+, K^+, $Rb^+$and Cs^+ cations can also be accelerated in rotations relativistically for forming characteristic nuclear orbitals as proton orbitals and neutron orbitals by external strong electric fields, strong magnetic fields, ultrasound, and radio frequency and other type electromagnetic waves for novel relativistic interactions with relativistic electrons in the graphene, nanodiamond membrane, metal organic frames (MOF) and zeolite absorbents. This gives new mechanism may give explanation for current unknowns for how external static magnetic fields and RF fields treat brain injury and depression.

A new technique for extracting Li^+ from geothermal salar brines is disclosed based on the author's theories of fractional, reversible fissing and fusing and external fields driving such for enhancing of interactions of cations with membranes for extraction and separation of alkali and alkaline earth cations in geothermal salar brines. There by the application of the theory of the author is outlined for extracting Li^+ in this following disclosure. The author discovers use of NMMs for separations and realizes that by applications of high temperatures, high pressures, ultrasound, radio frequency stimulations, strong electric fields and/or strong magnetic fields cause motions so the nuclei reversibly, fractionally fiss to spaces and refuse to nuclei during such motions and transiently transmutations of nuclei momentarily, dynamically producing huge surrounding quantum fields and altering surrounding wavefunctions in surrounding shells and subshells in hidden ways. In this model, the electric and magnetic fields are reasoned as divergently integrated thermal spaces. The magnetic and electric fields may therefore also induce reversible fractional fissing and fusing of nuclei with greater fractional amounts relative to thermal spaces. So by imposing strong electric fields and strong magnetic fields and intense radio frequency fields and waves, then the nuclei fractionally, reversibly fiss and fuse to transiently alter surrounding electronic lattices. Thereby the author applies this to the geothermal salar brine by application of heat, mechanical pressures, strong electric and strong magnetic fields and intense radio frequency waves for inducing altered selective interactions of Li^+ cations relative to Na^+, K^+, Rb^+ and Cs^+ cations with graphene and graphene oxide membranes. By such, the author induces larger fractional, reversible fissing of the nuclei and the electronic lattice of Li^+ relative to its smaller NMMs of Na^+, K^+, Rb^+ and Cs^+ cations and their isotopes. So Li^+ interacts more strongly and more easily binds to nearby magnetic fields and electric fields in graphene and graphene oxide membrane than Na^+, K^+, Rb^+ and Cs^+ cations. Li^+ more strongly binds new ligands having nonzero (null) NMMs.

Problem

There is a current challenge of obtaining Li^+ from terrestrial deposits due to difficulty separating Li^+ from salar geothermal brine in economical fashion [19]. Currently, the extraction of Li^+ from brines and clay minerals require costly, environmentally unfriendly and time consuming processes. For instance, acid leaching is applied to clays containing lithium. The strong sulfuric acid and hydrochloric acid are applied to the clay with heating to extract the lithium [20]. The process is not selective and other cations (Na^+, K^+, Fe^{2+}, Al^{3+}, Ca^{2+}, and Mg^{2+}) are also extracted by the process. Lithium is also currently being extracted from geothermal brines, where it is present in low concentrations of less than 1 to 20 part per million. These brines often contain complex mixtures of various solutes: Cl^-, Na^+, Ca^{2+}, K^+, Fe^{2+}, Mn^{2+}, Zn^{2+}, Sr^{2+}, B^{3+}, As, Cu^{2+}, Fe^{2+}, Ni^{2+}, Zn^{2+}, SO_4^{2-}, HCO_3^-, F^-, Ba^{2+} and Li^{1+} ions. See Table I for list of the spins and NMMs of the elements of these ions. Current techniques for extracting Li^+ from such brines involve evaporations to concentrate the brines [21]. Wells and ponds are formed for such evaporative processes near the mines and such can be time consuming. Concentrated brines are pumped to different ponds to enhance the evaporation processes by solar energy to crystallize NaCl (s), KCl (s) and MgCl (s) with solutions becoming enriched in Li^+(aq) and Cl^- (aq). The LiCl(aq) is further processed to convert it to Li_2CO_3 and/or LiOH. Various new approaches beyond the slow and time consuming solar evaporation processes are currently being considered: precipitation with $AlCl_3$ or $NaAlO_2$; sorbing by (organic) ion exchange resins, crown ethers, cyclic siloxanes, and organic polymers; inorganic sorbing by AlOH, MnO_x, TiO_x; organic solvent extractions using 12 crown-4, 15 crown-5; and 18 crown-6; membrane filtrations like polymer membranes, nanofiltration membranes; and electrochemical extractions like electrodialysis with electric fields and in conjunction with anion exchange membranes, and electrocoagulation [22].

Recently the author invented the idea of using thick graphene oxide membranes to separate alkali and alkaline earth cations from transition metal cations and use of few layer graphene oxide with applied magnetic fields to separate alkali cations from alkaline earth cations [24,25]. The author in 2011 discovered alkali cations selectively interacting magnetically with graphene oxide relative to weaker interactions of alkaline earth cations on basis of the nonzero NMMs (See Table I) in alkali cations and zero (null) NMMs of most isotopes of alkaline earth cations [24]. The author presented his theory in collaboration with Zhu and coworkers [23] in 2012 and a system was developed by Zhu and coworkers [24] for collecting data and the data supported the use of the author's invented graphene separation of the alkali cations by nanofiltration. The author further presented theory of use of graphene and graphene oxide for separating of hydrogen isotopes in 2013 [23, 24, 26]. This theory of the author was proven by subsequent data [23,24,26]. In this current disclosure, the author develops his theory [1,21] more for novel extractions of lithium from salar geothermal brines on basis of Little's Effect and Ferrochemistry.

Solution

The stable isotopes of alkali cations have all positive NMMs and the stable isotopes of alkaline earth cations have mostly null (0) NMMs. See Table I. So the nonzero NMMs of alkali cations are a basis by Little theory for separating the alkali cations from alkaline earth cations. The $^7Li^+$ cation has an even larger NMMs than heavier Na^+, K^+, Rb^+ and Cs^+ cations; so stronger agitations for stronger interactions may separate the $^7Li^+$ based on its larger NMM. This proposed technology measures extractions and concentrations verses intensities by stimulating conditions for separations. Such solution may also explain the use of Li^+ for treating mania and depression as $^7Li^+$ with larger NMM readily replaces Na^+ cations in nanoregions of neutrons and Na^+ conduction nano-channels, which cause mania and high blood pressure. The $^7Li^+$ also readily replaces K^+ cations of smaller NMMs for treating depression and hyperactivity. Some have speculated that spin effects for such biology and Li medicinal effects. But this is the 1st explanation by both nuclear magnetic moments and spins. The author proposes in novel of different combinations of $^7Li^+$ and $^6Li^+$ cations replacing Na^+ and/or K^+ stable isotopes to alter NMMs in complex ways of interactions for treating both mania and depression by different distributions of $^6Li^+$ and $^7Li^+$ in the ion channels. Such replacements as proposed here by the author in nanochannels of these biological systems are similar to the proposed replacements of K^+ and Na^+ ions and other salar brine ions in nanochannels of graphene and nanodiamond nanofiltration membranes for separating Li^+ from geothermal salar brines. Here it is proposed the smaller NMMs of K^+ cause depression by its excess and Na^+ imbalance and the larger + NMM of Na^+ cause mania in its excess. But Li^+ and its ^7Li and ^6Li stable isotopes of larger and smaller positive NMMs can replace both the excessive K^+ and Na^+ ions, to treat depression and mania, respectively. Fisher has introduced the notion in 2014 of ^{31}P as basis for quantum computing in the brain on basis of the spin by the ^{31}P nucleus but here the author introduces NMMs as well as spins for bases of quantum computing in the brain . ^{31}P has + NMM. The Xe is known to have analgesic effects [16,17] and it has ^{131}Xe with 21.18% relative abundance and 0.691 + NMM and ^{129}Xe with 26.44% relative abundance and - 0.778 NMM to interact with to affect nerves and neutrons.

The valance of the s orbitals in alkali and alkaline earth atoms and ions subjects this technique uniquely to Li^+ extraction as these elements and ions have s subshells as valence and empty co-subshells of p, d, f, ect. The electrons in alkali and alkaline earth cations are therefore not as affected by co-shell electrons as is the case for p, d, f, ect subshell electrons. So the e^- e^- and e^- in s subshells of alkali and alkaline earth elements are more strongly affected by their nuclei, effective nuclear charges, and NMMs. The NMMs more escape the s subshell into surrounding atoms and media without alterations by co-shells of p, d, f subshells for novel interactions of s subshells relative to atoms and ions having p, d, f … valence subshell electrons. For other elements (other than alkali and alkaline earth), the electron --- electron interactions compete with these electron --- nuclear interactions via NMMs. So the electron --- electron interactions diminish the NMM effects. Conventional inter-atomic and intermolecular interactions involve electron – electron interactions and are mediated by the electrons. But the alkali and alkaline earth and hydrogen have s orbitals and the unique wide range of angular momenta of s orbitals and the unique more classical interactions of spherical s orbitals for unusual interactions. But the alkali and alkaline earth atoms and ions experience stronger effective nuclear charges and NMMs on their s subshell electrons for transmitting novel fields to surrounding atoms, ions and molecules. This makes use of the author's discovery in 2005 that s orbitals and their e^- are more strongly affected by nuclear charge, spins and NMMs due to nonzero probability of e^- collapse from s orbital into nuclei and vice versa nonzero probability of NMMs fissing into s orbitals. This solution by such nuclear pressures of the author allows extraction with less energy input relative to heating the brine to very high temperatures. This solution provides more rapid separation relative to gravitational and sedentary processes in large holding ponds. The author has previously explained high temperature superconductivity of H containing compounds at high pressures by such symmetry of s orbitals [1].

Creativity

Solution is created by the applications of high temperatures, high pressures, radio frequency stimulations, strong electric fields and/or strong magnetic fields with ultrasonic vibrations to induce varying motions to cause differences in oriented rotations of nuclei of Li^+, Na^+, K^+, Rb^+ and Cs^+ cations. See Figure I. Thereby the author applies this to the geothermal salar brine by controlled measured applications of heat, ultrasonic vibrations, mechanical pressures, strong electric and strong magnetic fields and intense radio frequency waves for inducing altered and measured selective interactions, separations, penetrations and/or extractions of Li^+ cations relative to Na^+, K^+, Rb^+ and Cs^+ cations within graphene, nanodiamond and graphene oxide membranes and MOF and zeolites. So Li^+ interacts by such more strongly and more easily binds to nearby magnetic fields and electric fields in graphene, nanodiamond and graphene oxide membranes than Na^+, K^+, Rb^+ and Cs^+ cations. Similarly, under the external fields the Li^+ may interact and/or absorb and be separated by the MOF and/or zeolites. Li^+ more strongly binds new ligands having nonzero (null) NMMs due to the driven rotations.

In addition to differences in NMMs and magnetic effects, there are also inertial effects of smaller masses and smaller sizes of Li^+ cations relative to Na^+ cations. See Figure 1. Na^+ cations are smaller than K^+ cations. K^+ cations are smaller than Rb^+ cations. Rb^+ cations are smaller than Cs^+ cations. The smaller size of Li^+ causes smaller rotational paths of Li^+ in the fields cause separation of Li^+ in smaller nanopores and smaller zeolites and accumulations of Li^+ in specific MOF. The controlled rotations by RF frequency can be compared with measured extraction yields verses yields for Na^+, K^+, Rb^+, and Cs^+ cations.

In addition to the separation being driven by differences in nuclear magnetic moments (NMMs) and rotations by applied fields, the electrons in s orbitals have different orbital angular momenta. The alkali and alkaline earth cations have smaller angular momenta of their s electrons, relative to heavier elements of same shell and principle quantum number. But for Li^+ cation in its 2s subshell, the angular momentum is less than the angular momentum of 3s subshell for Na^+ cation; Such different orbital angular momenta of s orbitals involve differences in oriented rotations of s subshell valence electrons. And for Na^+ cation and its 3s subshell, the angular momentum is less than for 4s subshell for K^+ cation as induced by possible NMM differences as discovered by the author. And for 3s subshell of K^+ cation, the angular momentum is less than for 5s subshell for Rb^+ cation. And for 5s subshell of Rb^+ cation, the angular momentum of the 5s subshell is less than the angular momentum of 6s subshell for Cs^+ cation. Such differences in electronic orbital angular momenta are also bases for separations, altered interactions and selective penetrations by selective electromagnetic accelerations of such orbital motions of Li^+ cations relative to Na^+, K^+, Rb^+ and Cs^+ cations. As the cations interact with solvent and functional groups on membranes (graphene and nanodiamond) varying orbital angular momenta of different empty valence s orbitals are reasoned to alter interactions for separations of the cations. Even shorter wavelength electromagnetic waves than radiowaves are reasoned to selectively excite Li^+ cations and Li atoms for greater heightening differences in orbital angular momenta of these cations and the atoms. For instance, controlled measured X-ray excitations of near edge states of the Li^+, Na^+, K^+, Rb^+, and Cs^+ ions in aqueous solutions can be a basis for separating core excited alkali cations as the excited cations may be held metastably by antisymmetry in the strong static magnetic fields for measuring the separations of the ions by different orbital momenta and interactions with the nanodiamond, graphene, MOF, and/or zeolite.

The alkali cations are in aqueous solutions and the presence of p^+ from water molecules are also taken into account as the p^+ and hydrogen isotopes also have nonzero nuclear magnetic moments (NMMs). The proton is less massive than Li^+ and the proton will rotate faster than the Li^+ cations in a specific field. And the Li^+ rotates faster than Na^+; the Na^+ rotates faster than K^+; K^+ rotates faster than Rb^+; and Rb^+ rotates faster than Cs^+. The p^+ rotates faster and the presence of many cations in the aqueous solutions will have interactions between the rotating ions in complex magnetic ways. See Figure 1. So the faster rotation of the p^+ and the p^+ orbital can soak up the energy and momenta of the Li^+ at low pH; so the Li^+ magnetic separation and magnetic binding to OH^- may be disrupted by the presence of proton (p^+). It may be advantageous to change the solvent from water to polar aprotic solvent like heavy alcohol like propanol or butanol or even ethers (R-O-R). In aqueous solutions, p^+ mass transfers angular momenta to Li^+, Na^+, K^+, Rb^+, Cs^+, Cl^-, Br^-, F^-, I^-. Although the exchange of spin angular momentum has been observed and reasoned between nuclei, in this work the author [23] presents unforeseen exchange of nucleon orbital momentum. Indeed, on basis of p^+ interacting and exchanging with alkali cations via their NMMs, the NMMs are used by the author for explaining the global solubilities of alkali salts. On the basis of the role of the p^+ rotation, there will be a pH dependence on rotations, separations and interactions of the Li^+, Na^+, K^+, Rb^+, and Cs^+ cations. So smaller size of Li^+ cation and faster (different) rotations may cause faster penetrations into tiny pores in graphene oxide and into MOFs and zeolites. The smaller sizes and faster (different) rotations due to larger NMMs then cause faster (different) motions into zeolite as by RBL theory.

pH is changed and measured with applications of measured magnetic fields, electric fields and radio frequency waves to increase and measure separations and altered interactions. Li^+ is more acidic than Na^+, K^+, $Rb^+$and Cs^+ cations. Therefore at low pH then the Li^+ is more easily reduced and the Li vs Li^+ may have different magnetic moments for separations and altered interactions. But at high pH and under oxidized conditions, the Li^+ cations lack electrons and the lighter Li^+ cations rotate faster and are more magnetic for selective separatory and interactive activities. So the Li^+ cations can be extracted by the greater rotations of its cations in stronger magnetic and stronger electric fields and intense RF fields. Cations of Li^+ are smaller and less massive.

The presence of halogen anions (bases) affects the rotations and relative rotations for separations and interactions of the Li^+, Na^+, K^+, Rb^+, and Cs^+ cations. Halogen anions all have positive NMMs. So the halides can exchange nuclear angular momenta with cations during separations just as the p^+ exchanged orbital angular momenta. The presence of halides manifest basic conditions. Therefore, the measured rotations of positive NMMs of halogens and positive NMMs of the alkali cations in the aqueous solutions will cause effects as positive NMMs of halogens affect the rotations of the alkali cations for affecting interactions for causing and influencing separations of the Li^+, Na^+, K^+, Rb^+, and Cs^+ cations. So halides may absorb some of the RF to diminish rotations of the Li^+ cations. The halides may be rotated to bind Li^+ as X^- rotate to create opposing fields relative to Li^+ rotations. So removing X^- (halide) anions may cause stronger competition between alkali cations for Li^+ to be more distinct and more easily separated. Or in binding ways, the Li^+ and halides may be rotated to better bind the Li^+. The rotations of cation of + charge and rotation of nuclei of halides of negative charges are different as the alkali cations lack valence e^- and has core hard diamagnetic e^- e^- and + nuclei with net + charge for rotations by + NMMs and + charge for Br type fields. But halogens have + NMMs and soft diamagnetic e^- e^- full valence for nuclei release Br fields and $e^- e^-$ orbital negative charge for Dk orbital field of halogen $e^- e^-$ with net halogen release of Dk fields if their nuclei rotate. The effect of halogen Dk field would be reduced binding of anions, so salts may melt at lower temperatures. The halides may interact less for faster diffusion. The halides may alter interactions with membranes, so they transport faster less basic and alter nucleophilicity. Halides rotate to bind Li^+ cations less by external RF fields.

The carbonates (verses halides) on the other handle lacks NMMs and do not compete with the Li^+, Na^+, K^+, Rb^+, and Cs^+ cations for radio frequency waves in static magnetic fields for rotations. Carbonates are therefore good as they lack NMMs and are heavier and rotate at slower rates than Li^+, Na^+, K^+, Rb^+, and Cs^+ cations. So the rotating $(CO_3)^{2-}$anions would not interfere with the rotations of Li^+, Na^+, K^+, Rb^+, and Cs^+ cations. So the Li^+, Na^+, K^+, Rb^+, and Cs^+ cations can be selectively rotated with measured rates to measure the separation of the cations. Carbonates with no NMMs may bind more in magnetic field than halides with nonzero NMMs as magnetic field and rf waves rotate halides and Li^+, Na^+, K^+, Rb^+, and Cs^+ cations to diminish coulombic binding. But less rotations of the carbonate occur, so the carbonates more strongly bind Li^+, Na^+, K^+, Rb^+, and Cs^+ cations relate + cation and – anions may inverse binding magnetically and reduced binding electrically. So Li^+ binding carbonates even without water in the separation stage. Also carbonates $Li(CO_3)_2$ may be employed in separatory stage and then form $Li(CO_3)_2$ then convert the $Li(CO_3)_2$ to LiOH final product. Prior approaches may be limited by differences in band gaps but the theory proposed in this work [1,3,5] determines the strong magnetic field and radio frequency stimulation can accumulate energy across the gap. So the $Li(CO_3)_2$ lacks the protons to interfere with the rotation of the Li^+ cations. So driving the Li^+ cations in aprotic polar ether with $(CO_3)^{2-}$ and the carbonates (verses halides) is good for separations as carbonates lack NMMs and are heavier and rotates at slower rates than Li^+, Na^+, K^+, Rb^+, and Cs^+ cations. But the OH^- has proton with nonzero NMMs and can be induced to bind Li^+ to displace $(CO_3)^{2-}$ due to the null NMMs in the carbonates. So the rotating carbonate anion would not interfere with the rotating cations. So the Li^+, Na^+, K^+, Rb^+, and Cs^+ cations can be selectively rotated to separate the cations. And the less rotation of carbonate is basis for inducing selective binding of Li^+ cations to rotating OH^- anions. But there may be a way to involve the rotations of anions in judicious ways for separating the cations involving the anions.

The stationary cations of Li^+ are stronger electrophiles and are more reduced and the electrons on Li^+ are polarized with nuclei for larger net spin momenta. Rotations increase nucleophilicity of cations magnetically; but decrease electrophilicity of nuclei electrically. And the Li^+, Na^+, K^+, Rb^+, and Cs^+ cations interact electrically with the $(CO_3)^{2-}$ in porous graphene, nanodiamond, MOF and zeolites. But external fields can alter the interactions from electrical to magnetic interactions of cations with graphene, nanodiamond graphene oxide, MOF and zeolites with control of the magnitude of the interactions for different cations by the field strength and frequency of the electromagnetic radio frequency fields. The interactions can be stimulated by external ultrasound, radio frequency waves and strong electric and magnetic fields so the radio frequency waves induce strong magnetic moments in rotating Li atoms and the Li^+ cations interact with relativistic electrons in graphene to bind the Li atoms and Li^+ cations in their rotations in different ways than the Na^+, K^+, Rb^+, and Cs^+ cations as these more electrically interact with the $(CO_3)^{2-}$ in the graphene oxide filter. The Li^+ cations more magnetically interact in motions and the Li^+ spinon can move in its magnetic interactions with the relativistic electrons in the graphene membrane. Furthermore, the classic Coulombic interactions of the Li^+, Na^+, K^+, Rb^+, and Cs^+ cations with the MOF and zeolites may be judiciously modified by external electromagnetic fields of specific frequency radio waves for transducing the electric interactions of the cations to magnetic interactions selectively. It may be good to drive current through the graphene membrane to create added effects.

In addition to a new basis for separation of Li^+ from other ions, RB Little introduces new way of inducing distinct bonding of Li^+ cations to OH^- for replacing $(CO_3)^{2-}$ of $Li_2(CO_3)$ by OH^- . Here it is invented that the use of ^{17}O in ^{17}O enriched water can create ferrochemistry in a stage of the process involving recycled $H_2{}^{17}O$ for converting Li_2CO_3 to $Li^{17}OH$ in static magnetic field and suitable stimulating radio frequency waves and then recovering the $^{17}OH^-$ by replacing with $^{16}OH^-$ under zero static field and absence of radio frequency waves. The LiX in current salar brines may be converted to Li_2CO_3 on basis of the nonzero NMMs of halides (X^-) so the halides may be rotated by external static magnetic fields and radio frequency waves so as to diminish ionic binding to Li^+ and the $CO_3{}^{2-}$ lacking NMM can then preferentially bind the Li^+ to form Li_2CO_3 and then the Li_2CO_3 can be converted to LiOH by the prior disclosed ^{17}O enriched water ($H_2{}^{17}O$).

Some prior and current researchers are considering magnetic field effects on motions of solutes and solvents. But these studies unlike the author’s current study focus more on magnetic field effects involving spin only. The author’s current work is original as it introduces both spin and nuclear magnetic moments as listed in the Table I. Recently Pasha and coworkers study the classical and nonrelativistic effects of magnetic parameters and Brownian motion on fluid flow [27]. Their calculations involve only spin and random motions of spins. The author’s study involves relativistic revolutionary motions compounded with orbital motions of nucleons inside nuclei and nuclei motions. Peiravi and Alinejad [28] recently explored classical thermal conductivity conductivity and effects of fiber matrix, but the authors work pertains to thermal space not only thermal particles and not only classical limit of macroscopic numbers of such but atomic and nuclear sizes of quanta and coupling to thermal spaces relativistically. Rajabi and Alinejad [29] also study melting in an electrofusion joint but under conditions of classical particles and classical physics. Alinejad and Esfahani [30] further study heat transfer about macroscopic objects embedded with macroscopic cylinders, but such involves classical effects and differ from the author’s current manuscript as the author considers nano-channels and energy densities much greater than Alinejad and Esfhani.

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Table I - The Nuclear Magnetic Moments (NMM) of the Isotopes of the Elements

Elements	Relative Abundances	Spins	Nuclear Magnetic Moments
^{6}Li	7.59 %	Spin (1)	+0.822 NMM
^{7}Li	92.41%	Spin (3/2)	+3.26 NMM
^{23}Na	100 %	Spin (3/2)	+2.21 NMM
^{39}K	92.3 %	Spin (3/2)	+0.39 NMM
^{40}K	0.017 %	Spin (4)	-1.30 NMM
^{41}K	6.73 %	Spin (3/2)	+0.214 NMM
^{24}Mg	79 %	Spin (0)	0 NMM
^{25}Mg	10 %	Spin (5/2)	-0.855 NMM
^{26}Mg	11 %	Spin (0)	0 NMM
^{40}Ca	96.94 %	Spin (0)	0 NMM
^{42}Ca	0.65 %	Spin (0)	0 NMM
^{43}Ca	0.135 %	Spin (7/2)	-1.31 NMM
^{44}Ca	2.1 %	Spin (0)	0 NMM
^{86}Sr	9.86 %	Spin (0)	0 NMM
^{87}Sr	7.00 %	Spin (9/2)	-1.093 NMM
^{88}Sr	82.58 %	Spin (0)	0 NMM
^{134}Ba	2.42 %	Spin (0)	0 NMM
^{135}Ba	6.59 %	Spin (3/2)	0.838 NMM
^{136}Ba	7.85 %	Spin (0)	0 NMM
^{137}Ba	11.23 %	Spin (3/2)	0.937 NMM
^{138}Ba	71.70 %	Spin (0)	0 NMM
^{59}Co	100 %	Spin (7/2)	+4.62 NMM
^{63}Cu	69.17 %	Spin (3/2)	2.22 NMM
^{65}Cu	30.83 %	Spin (3/2)	2.38 NMM
^{55}Mn	100 %	Spin (5/2)	3.45 NMM
^{59}Co	100 %	Spin (7/2)	4.627 NMM

^{54}Fe	5.84 %	Spin (0)	0 NMM
^{56}Fe	91.75 %	Spin (0)	0 NMM
^{57}Fe	2.12 %	Spin (1/2)	0.091 NMM

^{55}Mn	100 %	Spin (5/2)	3.45 NMM

^{64}Zn	48.63 %	Spin (0)	0 NMM
^{66}Zn	27.90 %	Spin (0)	0 NMM
^{67}Zn	4.10 %	Spin (5/2)	0.875 NMM
^{68}Zn	18.75 %	Spin (0)	0 NMM

^{10}B	19.9 %	Spin (3)	1.801 NMM
^{11}B	80.1 %	Spin (3/2)	2.689 NMM

^{19}F	100 %	Spin (1/2)	2.629 NMM

^{35}Cl	75.78 %	Spin (3/2)	0.822 NMM
^{37}Cl	24.22 %	Spin (3/2)	0.684 NMM

^{79}Br	50.69%	Spin (3/2)	2.106 NMM
^{81}Br	49.31%	Spin (3/2)	2.271 NMM

^{127}I	100 %	Spin (5/2)	2.813 NMM

^{3}He	0.0001%	Spin (½)	-2.12 NMM
^{4}He	99.9999%	Spin (0)	0 NMM

^{20}Ne	90.48%	Spin (0)	0 NMM

^{21}Ne	0.27 %	Spin (3/2)	-0.662 NMM
^{22}Ne	9.25 %	Spin (0)	0 NMM

^{36}Ar	0.337 %	Spin (0)	0 NMM
^{38}Ar	0.063 %	Spin (0)	0 NMM
^{40}Ar	99.600 %	Spin (0)	0 NMM

^{78}Kr	0.35 %	Spin (0)	0 NMM
^{80}Kr	2.28 %	Spin (0)	0 NMM
^{82}Kr	11.58 %	Spin (0)	0 NMM
^{83}Kr	11.49 %	Spin (9/2)	-0.971 NMM
^{84}Kr	57.00 %	Spin (0)	0 NMM
^{86}Kr	17.30 %	Spin (0)	0 NMM

^{128}Xe	1.92 %	Spin (0)	0 NMM
^{129}Xe	26.44 %	Spin (1/2)	-0.777 NMM
^{130}Xe	4.08 %	Spin (0)	0 NMM
^{131}Xe	21.18 %	Spin (3/2)	+0.692 NMM
^{132}Xe	26.89 %	Spin (0)	0 NMM
^{134}Xe	10.44 %	Spin (0)	0 NMM
^{136}Xe	8.87 %	Spin (0)	0 NMM

Figure I

Illustration of Spins, NMMs and Charges Interacting with Graphene and Graphene Oxide Membrane in NanoChannels