

# **New Approach for Extraction of LiOH from Salar Geothermal Brines: Strong Magnetic Stimulations of Nuclear Magnetic Moments**

## **Abstract**

The theory of the author 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 fissioning of nucleons into nuclei and nuclei into surrounding electronic shells is further developed for in general explaining quantum mechanics as by fractional reversible fissioning and fusing of electrons (leptons) and nucleons (hadrons) and nuclei for wave particle duality and the formation of wavefunctions as composite complex electric and magnetic fields and waves. The alterations of the transient fissioned fields by varying nuclear magnetic moments of isotopes of elements is further developed for novel isotope effects on transportations, transformations, thermodynamics, particles/fields and transmutations is further developed as negative NMMs twist the surrounding space counterclockwise to the bright NMMs twisting clockwise. On basis of such different NMMs of alkali cations is considered for inventing novel method of separating alkali from salar geothermal brines and the larger positive NMMs of  $\text{Li}^+$  cations relative to  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$ , and  $\text{Cs}^+$  cations is used to employ strong magnetic fields, strong electric fields and intense radio frequency fields for extracting LiOH from the salar brine in novel way.

## **Introduction**

Theory for NMMs Affecting Surrounding Electronic Shells, Subshells and Orbitals by Reversible, Fractional Fissioning (Seeping)

But how does the co-shell  $e^- e^-$  interactions affect the electrons of p, d and f block elements in comparison to  $e^-$  --- nuclear interactions? Surrounding thermal agitations cause the fractional reversible fissioning and fusing of nuclei of null, positive and negative nuclear magnetic moments (NMMs) [1]. The surrounding thermal space in its irrational feebleness can couple to the dense energy mass of the nucleons and nuclei by Little's Rule #1 for disrupting the nucleons and nuclei against themselves for transient fractional, reversible explosions of the nuclei seeping energy and fields into surrounding electronic shells and continua with classical reversibility but not all components of the fissioned fields are recaptured and new surrounding fields are pulled into the nuclei during reversal by classical nature of nuclei [2,3]. The seeping from fractional, reversible fissioning 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 twist with opposing counter-clockwise symmetry relative to the twist by Br fields from nuclei.

The  $e^-e^-$  interactions involve  $e^-$  Coulomb fields and quantum fields and electrons pushing and pulling each other from quantum fields of spinrotorbits and spinvoborbits into L continua for spintransorbits and spinrevorbits via lepton --- lepton interactions in noncentral ways and nonspherical, quantal symmetries [3]. But the NMMs and nucleons and nuclei are hadronic and denser and central fields and mix of classical and quantum fields acting on s orbitals. The s orbitals are spherical also and more classical. This leads to distinct interactions of  $e^-$  --- NMMs in s subshell relative to  $e^-$  interactions in more quantum mechanical p, d, f, ect subshells of higher angular momenta. Nuclei cause surrounding quantum fields and wavefunctions [2,5]. So by Little's theory, nuclei can alter surrounding wavefunctions and electrons within such wavefunctions and nuclei dictate where electrons likely found and these probability density functions are not static but dynamic and even 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. The NMMs may seep from nuclei to push electrons and fields into surrounding p, d, f, g ect 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 rarefied f, d, p symmetries form bigger s orbital symmetries in some limit. So nuclei create fields that lack electrons that by convention would have been created by electron --- electron interactions. Nuclei create complex electromagnetic fields, which are quantum fields and electrons move in these quantum fields and electrons alter these quantum fields. For instance negative NMMs fractionally, reversibly fiss and fuse to cause strange metals [1]. The nuclei may produce s type fields and greater fractional, reversible fissing produce dense s subshells which transmute to p subshells and p transmute to d subshell and d subshell of denseness transmute to f subshells. And the electrons cause the perturbations of the nuclear fields and assist the nuclear fields producing the p subshell and the nuclear fields producing the d subshells and the nuclear fields producing the f subshells. This is why the order of energies can shift as subshells fill with electrons. The electrons alter the QF released from nuclei.

But now the non-zero nuclear magnetic moments (NMMs) alter the fields released by null NMMs [1, 2, 5]. And this is new isotope effect discovered by RB Little. So scientists currently model the wavefunctions from point electrons and point nuclei. But relativistic fractional, reversible fissing and fusing of electrons as by RBL can alter the produced wavefunctions. Mass, charge, spin of nuclei and NMMs can transmute fractionally, reversibly to energy in fields as nuclear fields  $\rightarrow$  QF for altering the QF relative to conventional quantum mechanics. Currently scientists do not know this and miss this. RBL discovers this and realizes that by high temperatures, radio frequency and static magnetic fields 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 and magnetic fields are dense thermal fields and so E and B also cause such fractional, reversible fissing and fusing of nuclei. So by impose strong electric and strong magnetic fields and intense radio frequencies, then the nuclei fractionally reversibly fiss to alter surrounding electronic lattices. Thereby RBL applies this to the geothermal salar

brine by application of strong electric and strong magnetic fields and intense radio frequency waves. Thereby RBL induces larger fractional, reversible fissioning of the nuclei of the geothermal brines and the electronic lattices of  $\text{Li}^+$  cations are more altered due to their larger NMMs than  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$ , and  $\text{Cs}^+$  cations and their isotopes, so  $\text{Li}^+$  cations more easily bind to nearby magnetic fields and quantum fields of surrounding fermions, spins, atoms and ions.  $\text{Li}^+$  more strongly binds new ligands having NMMs.

The angular momentum of s electrons is less than p, d, f ect subshell electrons, but with denseness the s transforms to p, d, f fields of more complex quanta momenta. 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. But via fractional, reversible fissioning and fusing, the nuclei can blast fields reversibly into surrounding to create these fields from proton and neutron 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 a dark interaction [1,2,5,6]. The positive and negative NMMs thereby alter the surrounding orbitals in different ways for different transport, transform, thermodynamics and transmutations! Positive NMMs make the atom more basic increasing  $e^-e^-$  dense and  $e^-e^-$  interactions; so  $s \rightarrow p \rightarrow d \rightarrow f$  orbital symmetries (by basic the  $e^-e^-$  interactions increase and the shells and subshells are harder, but they can increase with softening if the magnetic field stabilize dense softer electrons). Negative NMMs make the atom more acidic decreasing  $e^-e^-$  denseness and decreasing  $e^-e^-$  interactions so  $f \rightarrow d \rightarrow p \rightarrow s$  orbital symmetries (by acidic 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?). So fractional, reversible fissioning positive NMMs momentarily causes hardening  $e^-e^-$  subshells and shells. So fractional, reversible fissioning negative NMMs momentarily causes softening of  $e^-e^-$  subshells.

On the basis of this theory of RBL, novel phenomena of Li can be explained and the new process for extracting Li from solar brines is discovered by RBL. So also the rotation and faster rotation of the  $\text{Li}^+$  cation by the strong electric, strong magnetic and radio frequency fields will cause its greater fractional reversibly fissioning and fusing in order to convert its particle nature to wave and fields of space for it to move and refuse, so such particle to field and wave of the  $\text{Li}^+$  nuclei will even more alter the surrounding space for seeping electric and magnetic fields for distinct interactions of the  $\text{Li}^+$  with the surrounding atoms. This type of effect introduced by the author 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  $\text{Li}^+$  ion batteries. These stronger seeped fields from the  $\text{Li}^+$  cation relative to  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$  and  $\text{Cs}^+$  cations can cause  $\text{Li}^+$  to bind  $\text{OH}^-$  in stronger way than it binds  $(\text{CO}_3)^{2-}$ . Well the  $\text{Li}^+$  cation like proton forms a revorbital. The electron can be accelerated relativistically by external electromagnetic fields. But here RBL considers the proton,  $\text{Li}^+$ ,  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$  and  $\text{Cs}^+$  cations can be accelerated in rotations relativistically for forming nuclear orbitals as proton orbitals by external strong electric fields and magnetic fields and radio frequency and other type electromagnetic waves for novel relativistic interactions with relativistic electrons in the graphene membrane, metal organic frames (MOF) and zeolite absorbents.

There by the application of the theory of RBL is outlined for extracting Li in this following disclosure. RBL discovers use of NMMs for separations and realizes that by applications of high temperatures, high pressures, radio frequency stimulations, strong electric fields and/or strong magnetic fields cause motions so the nuclei reversibly, fractionally fission to space and recombine nuclei during such motions and transient transmutations for nuclei momentarily, dynamically producing huge surrounding quantum fields and altering surrounding wavefunctions in surrounding shells and subshells in hidden ways. So by Little's theory, the electric and magnetic fields are dense thermal fields and so strong electric fields and strong magnetic fields also cause such reversible, fractional fission and fusion of nuclei. So by impose strong electric fields and strong magnetic fields and intense radio frequency fields and waves, then the nuclei fractionally, reversibly fission and fuse to transiently alter surrounding electronic lattices. Thereby Little applies this to the geothermal solar brine by application of heat, mechanical pressures, strong electric and strong magnetic fields and intense radio frequency waves for inducing altered selective interactions of  $\text{Li}^+$  cations relative to  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$  and  $\text{Cs}^+$  cations with graphene and graphene oxide membranes. By such, RBL induces larger fractional, reversible fission of the nuclei and the electronic lattice of  $\text{Li}^+$  relative to its smaller NMMs of  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$  and  $\text{Cs}^+$  cations and their isotopes. So  $\text{Li}^+$  interacts more strongly and more easily binds to nearby magnetic fields and electric fields in graphene and graphene oxide membrane than  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$  and  $\text{Cs}^+$  cations.  $\text{Li}^+$  more strongly binds new ligands having nonzero (null) NMMs.

## Problem

Difficulty separating Li from solar geothermal brine in economical and monetized fashion. 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 acids are applied to the clay with heating to extract the lithium. The process is not selective and other cations ( $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Fe}^{2+}$ ,  $\text{Al}^{3+}$ ,  $\text{Ca}^{2+}$ , and  $\text{Mg}^{2+}$ ) 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 (here listed from highest to lowest concentrations in the brines):  $\text{Cl}^-$ ,  $\text{Na}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{K}^+$ ,  $\text{Fe}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Sr}^{2+}$ ,  $\text{B}^{3+}$ ,  $\text{Ba}^{2+}$  and  $\text{Li}^+$  ions. Current techniques for extracting Li from such brines involve evaporations to concentrate the brines. 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  $\text{NaCl}$ ,  $\text{KCl}$  and  $\text{MgCl}$  with solution becoming enriched in  $\text{Li}^+(\text{aq})$  and  $\text{Cl}^-(\text{aq})$ . The  $\text{LiCl}(\text{aq})$  is further processed to convert to  $\text{Li}_2\text{CO}_3$  and/or  $\text{LiOH}$ . Various new approaches beyond the slow and time consuming solar evaporation processes are currently being considered: precipitation with  $\text{AlCl}_3$  or  $\text{NaAlO}_2$ ; sorbents (organic) of ion exchange resins, crown ethers, cyclic siloxanes, and organic polymers; inorganic sorbents like  $\text{AlOH}$ ,  $\text{MnOx}$ ,  $\text{TiOx}$ ; organic solvent extractions using 12 crown-4, 15crown-5; and 18crown-6; membrane filtrations like polymer membranes, nanofiltration membranes; and electrochemical extraction like electrodialysis with electric fields and in conjunction with anion exchange membranes, and electrocoagulation.

Recently Reginald B. Little 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. RB Little in 2011 discovered alkali cations selectively interacting magnetically with graphene oxide relative to weaker interactions of alkaline earth cations on basis of the nonzero nuclear magnetic moments in alkali cations and zero (nll) NMMs of most isotopes of alkaline earth cations. RB Little presented his theory in collaboration with a group in China in 2012 and a system was developed in China for collecting data and the data supported the use of RBL invented graphene separation of the alkali cations by filtration. RBL further presented theory of use of graphene and graphene oxide for separating of hydrogen isotopes in 2013. This theory of RB Little was proven by subsequent data. In this current disclosure, the author develops RB Little theory more for novel extraction of Lithium from salar geothermal brines on basis of author's theory.

## Solution

The stable isotopes of alkali cations have all positive nuclear magnetic moments (NMMs) and the stable isotopes of alkaline earth cations have mostly null (0) NMMs. So the nonzero NMMs of alkali cations are a basis by author's theory for separating the alkali cations from alkaline earth cations. The  $\text{Li}^+$  cation has an ever larger NMMs than heavier  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$  and  $\text{Cs}^+$  cations; so stronger agitations for stronger interactions may separate the  $\text{Li}^+$  based on its larger NMMs. Measure extraction concentrations verses intensities stimulating conditions for separations.

The valance of the s orbitals in alkali and alkaline earth atoms and ions subjects this technique uniquely to  $\text{Li}^+$  extraction as these elements have s subshell as valence and empty co-subshells of p, d, f, ect. For alkali and alkaline earth cations therefore, electrons are not as affected by co-shell p, d, f, ect subshell electrons. So the 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-shell p, d, f subshells for novel interactions relative to atoms and ions having p, d, f ect valence 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 solution 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.

## Creativity

Solution is created by the applications of high temperatures, high pressures, radio frequency stimulations, strong electric fields and/or strong magnetic fields to induce varying motions to cause differences in oriented rotations of nuclei of  $\text{Li}^+$ ,  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$  and  $\text{Cs}^+$  cations. Thereby Little applies this to the geothermal salar brine by controlled measured applications of heat, mechanical pressures, strong electric and strong magnetic fields and intense radio frequency waves for inducing altered measured selective interactions, separations, penetrations and/or extractions of  $\text{Li}^+$  cations relative to  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$  and  $\text{Cs}^+$  cations with graphene and graphene oxide membranes and MOF and zeolites. So  $\text{Li}^+$  interacts more strongly and more easily binds to nearby magnetic fields and electric fields in graphene and graphene oxide membrane than  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$  and  $\text{Cs}^+$  cations. Similar under the external fields the  $\text{Li}^+$  may interact and/or absorbed and be separated by the MOF and/or zeolites.  $\text{Li}^+$  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 mass and smaller size of  $\text{Li}^+$  cation relative to  $\text{Na}^+$  cation.  $\text{Na}^+$  cation is smaller than  $\text{K}^+$  cation.  $\text{K}^+$  cation is smaller than  $\text{Rb}^+$  cation.  $\text{Rb}^+$  cation is smaller than  $\text{Cs}^+$  cation. The smaller size of  $\text{Li}^+$  causes smaller rotational path of  $\text{Li}^+$  in the fields for separation in smaller pores and smaller zeolites and accumulations in specific MOF. The controlled rotations by RF frequency can be compared with measured extraction yields verses yields for  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$ , and  $\text{Cs}^+$  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 numbers. But for  $\text{Li}^+$  cation in its 2s subshell, the angular momentum is less than the angular momentum of 3s for  $\text{Na}^+$  cation; Such different orbital angular momenta of s orbitals involve differences in oriented rotations of s subshell valence electrons. And for  $\text{Na}^+$  cation and its 3s subshell, the angular momentum is less than for 4s subshell for  $\text{K}^+$  cation. And for 3s of  $\text{K}^+$  cation, the angular momentum is less than for 5s for  $\text{Rb}^+$  cation. And for 5s of  $\text{Rb}^+$  cation, the angular momentum of the 5s is less than the angular momentum of 6s for  $\text{Cs}^+$  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  $\text{Li}^+$  cation relative to  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$  and  $\text{Cs}^+$  cations. Even shorter wavelength electromagnetic waves than radiowaves are reasoned to selectively excite  $\text{Li}^+$  cations and Li atoms for greater heightening differences in orbital angular momenta of these cations and the atoms. For instance, controlled measured X-ray excitation near edge states of the  $\text{Li}^+$ ,  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$ , and  $\text{Cs}^+$  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 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. 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  $p^+$  rotations faster and the presence of many cations in the aqueous solutions will have interactions between the rotating ions in complex magnetic ways. 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 to polar aprotic solvent like heavy alcohol like propanol or butanol or ethers. R-O-R. On the basis of the role of the  $p^+$  rotation, there will be a pH dependence on rotations and separations and interactions of the  $Li^+$ ,  $Na^+$ ,  $K^+$ ,  $Rb^+$ , and  $Cs^+$  cations. So smaller size of  $Li^+$  cation and faster rotations may cause faster penetration to tiny pores in graphene oxide and into MOF and zeolites. The smaller size and faster rotation due to larger NMMs then cause faster motions into zeolite as by RBL theory.

pH is changed and measured with applications of measured magnetic fields and electric fields and radio frequency waves to increase and measure separations and altered interactions.  $Li^+$  is more acidic than  $Na^+$ ,  $K^+$ ,  $Rb^+$ ,  $Cs^+$  cations. Therefore at high 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 low 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. 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 separations of the  $Li^+$ ,  $Na^+$ ,  $K^+$ ,  $Rb^+$ , and  $Cs^+$  cations. So they may absorb some of the RF to diminish rotations of the  $Li^+$  cations. The halogens may be rotated to bind  $Li^+$  as  $X^-$  rotate to create opposing fields to  $Li^+$  rotations. So removing  $X^-$  halogen anions may cause stronger competition between alkali cations for  $Li^+$  to be distinct and separation of the  $Li^+$ . Or in binding ways, the  $Li^+$  and halogen may be rotated to better bind the  $Li^+$ .

The carbonates (verses halides) on the other hand 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

$\text{Cs}^+$  cations to diminish coulombic binding. But less rotations of the carbonate occur, so the carbonates more strongly bind  $\text{Li}^+$ ,  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$ , and  $\text{Cs}^+$  cations. So  $\text{Li}^+$  binding carbonates even without water in the separation stage. Also carbonates  $\text{Li}(\text{CO}_3)_2$  may be employed in separatory stage and then form  $\text{Li}(\text{CO}_3)_2$  then convert the  $\text{Li}(\text{CO}_3)_2$  to  $\text{LiOH}$  final product. So the  $\text{Li}(\text{CO}_3)_2$  lacks the protons to interfere with the rotation of the  $\text{Li}^+$  cations. So driving the  $\text{Li}^+$  cations in aprotic polar ether with  $(\text{CO}_3)^{2-}$  and the carbonates (verses halides) is good for separations as carbonates lack NMMs and are heavier and rotates at slower rates than  $\text{Li}^+$ ,  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$ , and  $\text{Cs}^+$  cations. But the  $\text{OH}^-$  has proton and can be induced to bind  $\text{Li}^+$  to displace  $(\text{CO}_3)^{2-}$  due to the null NMMs in the carbonates. So the rotating carbonate anion would not interfere with the rotating cations. So the  $\text{Li}^+$ ,  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$ , and  $\text{Cs}^+$  cations can be selectively rotated to separate the cations. And the less rotation of carbonate is basis for inducing selective binding of  $\text{Li}^+$  cations to rotating  $\text{OH}^-$  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  $\text{Li}^+$  are stronger electrophiles and are more reduced and the electrons on  $\text{Li}^+$  are polarized with nuclei for larger net spin momenta. Rotations increase nucleophilicity of cations magnetically; but decrease electrophilicity of nuclei coulombically. And the  $\text{Li}^+$ ,  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$ , and  $\text{Cs}^+$  cations interact Coulombically with the  $(\text{CO}_3)^{2-}$  in porous graphene, MOF and zeolites. But external fields can alter the interactions from electrical to magnetic interactions of cations with graphene, 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 radio frequency waves and strong electric and magnetic fields so the radio frequency waves induce strong magnetic moments in rotating Li atoms and the  $\text{Li}^+$  cations interact with relativistic electrons in graphene to bind the Li atoms and  $\text{Li}^+$  cations in their rotations in different ways than the  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$ , and  $\text{Cs}^+$  cations as these more electrically interact with the  $(\text{CO}_3)^{2-}$  in the graphene oxide filter. The  $\text{Li}^+$  cations more magnetically interact in motions and the  $\text{Li}^+$  spinon can move in its magnetic interactions with the relativistic electrons in the graphene membrane. Furthermore the classic Coulombic interactions of the  $\text{Li}^+$ ,  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$ , and  $\text{Cs}^+$  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  $\text{Li}^+$  from other ions, RB Little introduces new way of inducing distinct bonding of  $\text{Li}^+$  cations to  $\text{OH}^-$  for replacing  $(\text{CO}_3)^{2-}$  of  $\text{Li}_2(\text{CO}_3)$  by  $\text{OH}^-$ . Here it is invented that the use of  $^{17}\text{O}$  in  $^{17}\text{O}$  enriched water can create novel chemistry of the author in a stage of the process involving recycled  $\text{H}_2^{17}\text{O}$  for converting  $\text{Li}_2\text{CO}_3$  to  $\text{Li}^{17}\text{OH}$  in static magnetic field and suitable stimulating radio frequency waves and then recovering the  $^{17}\text{OH}^-$  by replacing with  $^{16}\text{OH}^-$  under zero static field and absence of radio frequency waves. The  $\text{LiX}$  in current solar brines may be converted to  $\text{Li}_2\text{CO}_3$  on basis of the nonzero NMMs of halides ( $\text{X}^-$ ) so the halides may be rotated by external static magnetic fields and radio frequency waves so as to diminish ionic binding to  $\text{Li}^+$  and the  $\text{CO}_3^{2-}$  lacking NMM can then preferentially bind the  $\text{Li}^+$  to form  $\text{Li}_2\text{CO}_3$  and then the  $\text{Li}_2\text{CO}_3$  can be converted to  $\text{LiOH}$  by the prior disclosed  $^{17}\text{O}$  enriched water ( $\text{H}_2^{17}\text{O}$ ).



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