Integrating Superconductivity in Cu replace Lead Apatite
by Nuclear Magnetic Moment theory of RBL

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Abstract

Recently, scientists proclaimed superconductivity under ambient conditions of room temperature and 1 atmosphere pressure in Cu substituted lead apatite: $Pb_{(10-x)}Cu_x(PO_4)_6$. This paper highlights the application of RBL stable isotope of positive and negative nuclear magnetic moments (NMMs) theory for explaining the heavy isotopic enrichment of this materials as $\{^{207}Pb_{\{10-x\}}{}^{63}Cu_x(`^{31}P^{17}O_4)_6\}$ and the resulting superconductivity and novel room temperature atmospheric pressure superconductivity of this heavy isotopic enriched substance. On the basis of such analysis by RBL theory, the synthesis of high temperature regular pressure superconductivity can be explained and this recent experimental observation of ambient pressure and temperature superconductivity in $^{207}Pb_{\{10-x\}}{}^{63}Cu_x(`^{31}P^{17}O_4)_6$, proves RBL NMMs theory of high temperature superconductivity.

Introduction

Recent declaration of room temperature ambient pressure superconductivity in Cu replaced Lead apatite (LK-99) [1] . Synthesis of LK-99 is reported in 1999 as $Pb_{(}(PO_4)_6$. Recently in 2022, the substitution of Cu for Pb in these materials was observed to cause volume shrinkage and observation of ambient pressure and temperature superconductivity by drop in resistance and Meissner Effect [1]. Scientists have been attempting during last 110 years to discover superconductors at room temperature and normal pressure of sea level atmospheric pressure since Onnes discovered superconductivity in 1911 in Hg at atmospheric pressure and -270 degrees Celsius. A theory of superconductivity has also been sought during the last 110 years. In 2005, RBL by relativistic spinrevorbital gave theory of superconductivity on basis of isotopes and nonzero nuclear magnetic moments [2]. Since Onnes superconductors (like Nb, Pb, Sc, cuprates, iron arsenates and MgB_2) with higher critical temperatures have been discovered but only recent have superconductors near room temperature have been reported in hydrides with huge external mechanical pressures. The aim for greater applications has been to thereby not only raise the temperature for superconductivity but also lower the pressure to normal pressure of the atmosphere at sea level. On July 22, 2023, such superconductivity at room temperature and normal pressure was reported in $Pb_{(10-x)}Cu_x(PO_4)_6$ [1].

In addition to materials for superconductivity under ambient conditions, the understanding and theory of superconductivity at high temperatures and atmospheric pressure has been sought. One of the first successful theories of superconductivity was given by Bardeen, Cooper and Schrieffer during 1950s and it is called BCS theory of superconductivity [3]. But BCS theory was only successful in explaining superconductivity (type I) of earliest superconductors like Hg, Pb and Nb. With the discovery of type superconductivity in cuprates during the 1980s [4], a new theory was needed as BCS theory could not account for superconductivity in cuprates. Some important efforts for explaining type II superconductors were given by Anderson theory of fluctuating electronic orbitals [5] and Pines theory of fluctuating electron spin [6]. Later in 2004, RBL [2] introduced combined fluctuating spin and orbital and included nuclear spin (in particular nuclei of nonzero and negative NMMs) on the quantum fluctuations for causing superconductivity.

Procedure

The synthesis and superconductivity properties of $Pb_{(10-x)}Cu_x(PO_4)_6$ were explored by a method of applying RBL theory of clumping of positive and negative NMMs into covalent and metallic bonds during chemical reactions and the manifestations of quantum fluctuations down to nuclei leading to seeping of positive and negative NMMs from nuclei into surrounding electronic lattices for altering the electronic orbitals in materials by such quantum fluctuations for causing quantum phenomena nonlocally for explaining superconductivity. The method here also provides a basis for considering various elements and their stable isotopes for finding new superconductors and relating superconductive properties to various elements based on the stable isotope distributions and isotopes of positive and negative NMMs.

Results

Apply Isotope and NMM phenomena to LK-99

Superconductivity is a quantum phenomenon. To raise T_c and lower pressure, one has to cause quantum mechanics on macroscale at higher temperatures and lower pressure. Prior scientists have achieved quantum phenomena by lowering temperature like liquid helium where Onnes first discovered superconductivity. But during last 24 years, RBL has proposed quantum phenomena can manifest at higher temperatures by increasing force density at higher temperatures by strong electric and/or magnetic fields [7]. RBL has reasoned mechanical pressures can cause materials to manifest internal strong electric and magnetic fields for transforming to quantum energies for quantum phenomena at higher temperatures and even room temperature by not only large applied pressures but by strong internal electric and/or magnetic fields. But RBL has previously noted that the applied magnetic fields and electric fields cannot only come from applied external pressures, but RBL noted that internal pressures from nuclei for nuclear pressures can cause pressure and energy densities for superconductivity at higher temperatures. In addition to the high temperature and its prior proclivity to classical mechanics (and RBL resolving by high electric and magnetic fields), quantum mechanics has been restricted and discovered on submicroscopic scales. The challenge for superconductive technologies is macro-size materials. RBL has give resolution to this size effect by isotopes of nonzero NMMs of positive and negative chiralities so that the huge energy densities of nuclei can fractionally fiss and fuse from nuclei into surrounding electronic shells for giving sufficient energy densities for quantum phenomena to exceed nanosize and the energy densities from quantum fluctuations down to nuclei and release and seeping of nuclear fields and NMMs from Avagadro's number of nuclei of positive and negative NMMs can cause the quantum phenomena and in this case the superconductivity to manifest on macroscale. On the basis of these revelations of RBL during last 24 years, the superconductivity synthesis and properties of LK-99 can be explained.

Understanding the synthesis by RBL isotope theory

How does the the $Pb(PO_4)$ reacting with CuS manifest NMMs and they encourage ^{17}O? The synthesis of the $Pb_{(10-x)}Cu_x(PO_4)_6$ can be explained by the prior theory of RBL of positive and negative NMMs more stable clumping in covalent and metallic bonds. Such theory is given as a basis for the synthesis intrinsically enriching the product with ^{17}O under thermodynamic equilibrating conditions. By the theory of stable, isotopes of positive and negative (nonzero) nuclear magnetic moments (NMMs) can explain the synthesis of this $Pb_{(10-x)}Cu_x(PO_4)_6$ with isotopic enrichment of heavier stable isotopes ^{207}Pb, ^{63}Cu, ^{65}Cu, ^{31}P and ^{17}O of positive and negative NMMs under such high temperature conditions. Such intrinsic clumpings of positive and negative NMMs in covalent and metallic bonds have been shown to enrich ^{17}O (of -1.89 NMM and 0.038% relative abundance [RA]]) replacing ^{16}O (of zero [0] NMM and 99.8% RA) in bonds with ^{31}P (of + NMMs and 100% RA) and ^{63}C and ^{65}Cu (of + 2.22 and 2.38 NMMs and combined {69.2%+30.8%} 100% RA) and ^{207}Pb (of + 0.582 NMMs and 22.1% RA). In the $Pb(SO_4)O$ the ^{32}S has null (0) NMM and by RBL theory the ^{16}O preferentially binds the ^{16}O to form $^{32}S^{16}O_2$ (g) for further explaining the ^{17}O enrichment in the [$^{207}Pb_{\{10-x\}}{}^{63}Cu_x(`^{31}P^{17}O_4)_6$]. The gaseous $^{32}S^{16}O_2$ (g) vaporizes away, leaving solid [ $^{207}Pb_{\{10-x\}}{}^{63}Cu_x(`^{31}P^{17}O_4)_6$]. The remaining ^{17}O and ^{18}O enrich in the $Pb_{(10-x)}Cu_x(PO_4)_6$with ^{31}P, ^{63}Cu, ^{65}Cu and ^{207}Pb to form this compound [$^{207}Pb_{\{10-x\}}{}^{63}Cu_x(`^{31}P^{17}O_4)_6$] on the basis of RBL theory of positive and negative NMMs enriching in covalent and metallic bonds. Such NMMs effects on the chemical reactions by RBL explain the $Pb_{(10-x)}Cu_x(PO_4)_6$ discovered by Sukbae Lee et al [1] and its isotopic enrichment as described here by RBL for $^{207}Pb_{\{10-x\}}{}^{63}Cu_x(`{}^{31}P^{17}O_4)_6$ with the alleged normal atmospheric pressure and room temperature superconductivity due to the positive and negative NMMs in this compound enriched with ^{17}O as never before observed since discovery of superconductivity in mercury (Hg) at temp below -269 degrees Celsius (4.2 Kelvins) at atmospheric pressures by Kamerlingh Onnes in 1911.

RBL theory of such positive and negative NMMs affect on chemical reactions and isotopic enrichments are descried in previous archived paper on Aug 14, 2021 [8]. Also in 2018, RBL aricheved part of his book [9], where he gave general theory of chemistry of enriching these stable isotopes of positive and negative NMMs (^{63}Cu, ^{63}Cu, ^{33}S, ^{31}P, ^{17}O) for enriching in chemical bonds and manifesting superconductivity. On page 4, in 2021, RBL disclosed general theoretical framework explaining this superconductivity as observed by Sukbae Lee et al on July 22, 2023 [1], therein on page 4 in 2021 RBL [8] previously disclosed: "Such type I mix of positive and negative NMMs are proposed to manifest ... as by mix of ^{13}C, ^{15}N, ^{17}O, ^{25}Mg, ^{33}S with normal ^{1}H , ^{14}N, ^{31}P for mix of positive and negative NMMs to alter enzymatics and motions and chemical changes .... by altering the effects of all positive NMMs of ^{1}H, ^{14}N, and ^{31}P in normal biomolecules (1,2). The type II mix of positive and negative NMMs are of heterogeneous mix ... Such type II heterogeneous mixture in single nanodomain effects also explain the superconducting properties in nano-size ".

You do not believe my theory of positive and negative nuclear magnetic moments enriching in materials due to forming stronger covalent bonds by Little Effect and ferrochemistry of the nuclear angular momentum of different chiralties and nuclear spins for ^{17}O enriching in $^{31}PO_4^{3-}$ structures as in apatite. I gave direct observation of the enrichment in phosphates of ^{17}O in reference [10] under thermodynamic equilibrating conditions. Here is a second fact that substantiates my theory and discover as in 2020 researchers report data of ^{17}O enriching in zeolite structures having Si-O-Si and Si-O-Al bonds in frame worker.

To really drive home the factual basis of my theory, the Si-O-Al enriches more in ^{17}O than Si-O-Si cites and this follows directly from RBL NMM driven enrichment as Si has few isotopes of nonzero NMM as its stable isotope ^{29}Si with negative (-0.555) NMM at only 4.68% relative abundance accounting for lower ^{17}O enrichment in Si-O-Si sites due to low relative abundance of ^{29}Si and its negative NMM. But the Al as by ^{27}Al has large positive NMM of +3.64 and 100% relative abundance such that to huge + NMM pulls in ^{17}O of negative NMMs by RBL theory to explain the data and the data proves RBL theory! In ref [11] .

Therefor, yes in Dec 2019 this paper was submitted to JACS where they observed ^{17}O enrichment in zeolite. But prior to the submission of this paper, RBL had archived the phenomena in many papers and publications. For instance in Nov 2019 before this JACS paper, RBL archived on page 4 [8].

In Nov 2019, RBL archived on page 4 [8] : "The fractional, reversible fissing and fusing of nuclear (NMM) alter surrounding atomic orbitals and such altered atomic orbital alter molecular orbitals and alter chemical dynamics, catalysis and enzymatics by the Little Effect: “spins alter orbitals during chemical reactions and orbitals altering spins”. The Little Effect not only involves e^- spins altering orbitals but nuclear spins also alter orbitals for Little Effect as manifested by these nonzero NMMs of nonprimordials relative to more null NMMs of primordials. For instance, the fractional, reversible fissing and fusing of the nonprimordial isotopes in enzymes can alter the stereochemistry of the substrate as the enzyme catalyzes the chemical transformation of the substrate. For instance, ^{14}N and ^{15}N nuclei motions have different chiralities as ^{14}N has positive NMM and ^{15}N has negative NMM; so changing ^{14}N to ^{15}N by this prior theory (1-3) would cause the fractional fissed field of ^{15}N (relative to native ^{14}N in the enzyme) to alter the chirality of wavefunctions from the enzymatic catalyzing transition state of the substrate relative to such fissed fields from primordial ^{14}N." …. " Also such single domains of all positive NMMs manifest in normal cells of living organisms for exhibiting energetic and motional dissipative orders on nanoscales for normal operations of biochemical molecules for media for life (1,2). The functions of molecules like proteins, ATP and DNA and RNA can be reasoned by such dissipative phenomena of their all positive NMMs in ^{1}H, ^{14}N and ^{31}P. But single domains composed of mixed + NMMs and – NMMs have yet a different but distinct and novel properties of two general types. Unlike the dissipative properties of all + and/or all negative NMMs, the mix of + and – NMMS cause dissipative to → quantizating phenomena and transforming disorder to order for novel energy accumulation, transport, catalysis, enzymatics, optics, thermodynamics, magnetics, transmutations and biology (1,2). Type 1 mix of positive and negative NMMs are of homogeneous mix of the + and – NMMs more may locally accumulate the many fractional, reversible fissed and fused NMMs into chemical for altering chemical bonds and catalyzing chemical changes, even enzymatics of biomolecules. Such type I mix of positive and negative NMMs are proposed to manifest in some regions in cancer cells as by mix of ^{13}C, ^{15}N, ^{17}O, ^{25}Mg, ^{33}S with normal ^{1}H , ^{14}N, and ^{31}P for mix of positive and negative NMMs to alter enzymatics and motions and chemical changes of proteins, nucleic acids, sugars, fats, and other biomolecules by altering the effects of all positive NMMs of ^{1}H, ^{14}N, and ^{31}P in normal biomolecules (1,2). The type II mix of positive and negative NMMs are of heterogeneous mix as the positive NMMs are separated in subdomain from negative NMMs for positive NMMs and negative NMMs subdomains within the nano domain for heterogeneous mix of positive and negative NMMs. Such type II heterogeneous mixture in single nanodomain effects also explain the superconducting properties in nano-size silver particles within nano-size gold matrix (of Thapa and Pandey,2018) as the silver has all negative NMMs and the gold has all positive NMMs."

Understanding the superconductivity by RBL theory of superconductivity
How does the ^{17}O in the resulting Cu $Pb(PO_4)$ cause the superconductivity? Such apatite is related to cuprates as both cuprates and apatite have chemical structures of anionic complications of oxygen's by centers having positive NMMs by Cu and P (phosphorus) with surrounding cations. RBL had previously published in respected journal that ^{17}O in cuprates due to negative NMM as "the needles in the haystack" for superconductivity in cuprates. Now researchers in Korea as led by Sukbae Lee (CEO of the Quantum Energy Research Centre (Q-Centre) at Korea University) have experimentally discovered room temperature and ambient pressure superconductivity in apatite by replacing lead cations by copper cations. Such proves RBL theory of superconductivity and material conditions for ambient superconductivity as it has been measured that apatite rocks are inherently enriched in heavy isotopes of ^{18}O and ^{17}O. This is facts recently published. Please see facts in ref [12]. RBL notes whereas Pb has one stable isotope of positive NMM, Cu has all its stable isotopes of ^{63}Cu and ^{65}Cu of positive NMMs. The negative NMM of ^{17}O and perhaps induced negative NMM in ^{18}O and positive NMMs of ^{63}Cu and ^{65}Cu in this Cu substituted apatite manifest the positive and negative NMMs for phenomena of nuclear pressures for superconductivity by RBL theory!

Discussion

RBL related N: LuH to LaH, CSH, SH, Cuprates , Arsenates [13]. But now how does $Cu\text{-}Pb(PO_4)$ relate to these prior superconductors? RBL NMM theory can relate the $Cu\text{-}Pb(PO_4)$ to the other superconductors. The superconductivity in the Cu replaced lead apatite is related to other superconductor by the isotope effect by nuclear magnetic moments (NMMs) as discovered by RBL. The ^{17}O is intrinsically enriched in $Cu\text{-}Pb(PO_4)$, RBL has previously noted ^{17}O is intrinsically doped in cuprates. The $Cu\text{-}Pb(PO_4)$ superconductivity is thereby related to cuprate superconductivity by both having enriched ^{17}O (of negative NMMs) an the 100% P by relative abundance enrich the ^{17}O in $Cu\text{-}Pb(PO_4)$, just as ^{63}Cu and ^{65}Cu of positive NMMs enrich ^{17}O in cuprates. The $Cu\text{-}Pb(PO_4)$ is further related to the other superconductors by periodic table as the ^{31}P binding the ^{17}O is above ^{75}As and the stable isotope ^{75}As in iron arsenate has 100% positive NMMs. The same physical phenomena of positive and negative NMMs in cuprates and iron arsenates between ^{63}Cu (and ^{65}Cu) and ^{17}O and ^{75}As and ^{17}O manifest between ^{31}P and ^{17}O to explain the superconductivity in the new Cu-Ph(PO_4).

In prior papers RBL [13] related superconductity in cuprates and iron arsenates (and therefore now Cu-Pb(PO_4) to superconductivity in Hg and Nb and Sc and also to superconductivity in H_2S and LaH_{10} under high pressure. Therein RBL noted the internal pressure of the positive and negative ions in cuprates and iron arsenates (and now Cu-Pb(PO_4)) for causing the Cooper pairs to superconduct in the QF released by the positive and negative NMMS. But in Hg and Nb the metals are less bound and the phonons can more easily disrupt the cooper pairs in the Hg and Nb as the positive and negative NMMs in the Nb and Hg and Sc cannot bind the $e^- e^-$ Cooper pairs as well as in the ionic structures in cuprates and iron arsenates. In more recent years scientists have discovered high pressures induce superconductivity in some materials. RBL theory can explain such mechanical pressure as it externally pushes the positive and negative NMMs together to induce the superconductivity. The temperature is chaotic and disrupt. The NMM organize the disorder and temperature can release more NMM. Pressure causes more frequent collisions to release more NMM and order NMM by pressure. So ions can pressurize to release NMM for QF. So ions in cuprates cause internal pressure for superconductivity by collisions of NMMs. External pressure can also raise T_c to release NMM to order QF.

Conclusion

RBL Theory of NMMs causes the synthesis and the resulting superconductive properties of Cu-Pb(PO_4).

References

1. Lee, Sukbae; Kim, Ji-Hoon; Kwon, Young-Wan. The First Room Temperature Ambient Pressure Superconductor. arXiv:2307.12008 July 22, 2023.
2. Little R B. A Theory of the Relativistic Fermionic Spinrevorbital. International Journal of Physical Science. 10 (1), 1-37 (2015).
3. Bardeen J, Cooper L. N., and Schrieffer J. R. Microscopic Theory of Superconductivity. Physical Review 106 (1), 162-164 (1957).
4. Bednorz J. G. and Muller K. A. Possible Superconductivity in the Ba-La-Cu-O System. Zeitschrift Fur Physik 64(2) 189-193 (1986).
5. Anderson, P. W. The resonating Valence Bond State in La2CuO4. Science 235, 1196 (1987).
6. Monthoux P. , Balatsky A. V., Pines D. Toward a Theory of High Temperature Superonductivity in Antiferromagnetically Correlated Cuprate Oxides Phys. Rev. Lett. 67, 3448-3451 (1991).
7. Little RB. The needle in the haystack for theory of high temperature superconductivity: Negative nuclear magnetic moments. Journal of Superconductivity and Novel Magnetism 33 (7567), 1-10 (2020).
8. Little RB. Positive Nuclear Magnetic Moments Driving Ferrochemical Cycles of Life: Negative Nuclear Magnetic Moments for Neutrons Altering Biochemistry for Disease. VixRa (2021) viXra.org.Condensed Matter>viXra:2018.0068 (2021).
9. Little RB. On the Carcinogenic Mechanism and Cure for Cancer: Ferrochemistry for Cause of Warburg Effect. Published as Book (BP International). viXra Preprint (2018) Available from: https://vixra.org/abs/1802.0338.
10. Alexandrine Flambard, Lionel Montagne and Laurent Delevoye. A New 17O isotopic Enrichment Method for the NMR Characterisation of Phospahate Compounds. Chem Commun (Camb). 2006, Aug 28 ; (32): 3426-8. Doi: 10.1039/b604803j. Epub 2006 Jul6.
11. Suzi M. Pugh, Paul A. Wright, David J. Law, Nicholas Thompsom, and Sharon E. Ashbrook. Facile, Room Temperature 17O Enrichment of Zeolite Frameworks Revealed by Solid State NMR Spectroscopy. J am. Chem. Soc. 2020, 142, 2 900-906.
12. Alicja Wudarska, Michael Weidenbeck, Ewa Slaby, Malgorzata Lempart-Drozd, Chris Harris, Michael M. Joachimski, Christophe Lecuyer, Kenneth G. MacLeod, Andreas Pack, Torsten

Vennemann, Frederic Couffignal, Dingsu Feng, Johannes Glodny, Christof Kusebauch, Sathish Mayanna, Alexander Rocholl, Laura Speir, Yadong Sun, Franziska D. H. Wilke. Inter-laboratory Characterization of Apatite Reference Materials for Oxygen Isotope Analyusis and Associated Methodological Considerations. Geostandards and Geoanalytical Research (2022) 46 (2): 277-306.

13. Little RB. Near Ambient Superconductivity by 15N as Needles in the Haystack: Lower Temperatures and Pressures for Possible 15N Enrichment in LuH2 . European Journal of Applied Physics (2023) 5: (3).