^{14}N Needles in the Haystack for Near Ambient Superconductivity: Possible ^{15}N Depletion at Lower Temperatures and Pressures

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Abstract

The author has previously noted the effects of stable isotopes having different nuclear magnetic moments on chemistry, catalysis, biochemistry, thermodynamics, optics, superconductivity and more [1]. In this controversy surrounding reported room temperature superconductivity at near ambient pressures by nitrogen doped lutetium hydride, the author hopes to convince and reason that the different synthesis conditions of the original work of Dias and coworkers [2] at low temperature, mild pressures, diamond anvil cell compression and prolong annealing may lead to selective doping of the lutetium hydride by ^{14}N. The later attempted replication of Dias and coworkers by Hai-hu Wen and coworkers [3] may have caused different outcomes as Hai-hu Wen and coworkers appeared to try Dias work and then switched to a different synthetic method whereby Wen and coworkers instead applied high pressures and high temperatures to the reacting hydrogen, nitrogen and lutetium to produce a nitrogen doped lutetium hydride with similar lattice structure as the originally reported by Dias and coworkers [2] but lacking observed superconductivity and evidence of superconductivity by diamagnetism. The author here by his theory notes the possibility that the different later high pressure, high temperature synthesis by Wen and coworkers doped their sample with ^{15}N rather than ^{14}N as originally enriched in Dias's sample. Thereby the author notes by his theory [1] that whereas ^{14}N doped lutetium hydride manifests higher superconductivity due to its positive nuclear magnetic moment (NMM), the ^{15}N doped lutetium hydride of Wen and coworker should not manifest superconductivity at the higher temperatures due to its positive NMM. Thereby the authors' theory gives account of both Dias' and Wen's experiments.

The Unique Role of Hydrogen Due to Its Lack of Core Electrons

Hydrogen lacking core electrons interacts in presence of other protons under high mechanical pressure in dense protons by altering electrons of Cooper pairs to produce negative magnetic moments (NMMs) to bind the protons and by such action of the protons the electrons superconduct. The dense protons under high mechanical pressure induce backward or dark (Dk) motions of electrons and rarefactions of wavefunctions for assisting superconductivity. The NMMs are significant as most atoms of known elements have null or zero NMMs. It is discovered by the author that the few isotopes with positive and negative NMMs manifest substances that can superconduct. Hydrogen and helium are unique among the elements as they have no core electrons and their nuclei act directly on the valence electrons for special properties of hydrogen and helium atoms. Hydrogen (protium) is even more special as it has only one nucleon in its nucleus and the p^+ of its nucleus acts directly on the valence electrons of hydrogen for uniqueness of hydrogen even relative to helium. Due to such hydrogen can behave as metal and nonmetal. It is this complexity of hydrogen that caused me to re draft this paper as the author realized that in interacting with ^{1}H, ^{15}N and its negative NMMs would not serve the same role as ^{17}O (and its negative NMMs) in cuprates as the ^{17}O in cuprate acts upon e^{-} e^{-} of ^{65}Cu and ^{63}Cu of positive NMMs and having intervening nucleons and core electrons of the Cu between its quarks and valence electrons and conduction electrons. But in N doped LuH , the ^{15}N would be acting on H and H lacks nucleons and core electrons between its quark and valence electrons for direct quark electron interactions from perturbations and the ^{14}N (and its positive NMMs) is the needle and not the ^{15}N with its negative NMMs (as ^{17}O and its negative NMMs as in cuprates) in the N doped LuH_x that causes the high temperature superconductivity at ambient. Thereby the protons interact with the Copper pairs to prevent their dissipations of energy for sustaining superconductivity at higher temperatures.

The Lutetium and Its Role by its filled 4f subshell

The 4f electrons of the lutetium experience to protons to host the superconductivity. Lutetium has positive NMMs, see Table I. The ungerard symmetry of the p and f subshells by the authors theory provides both Br and Dk symmetry for chirality for superconductivity. Ungerade has both bright and dark essence of space and time.

The Role of ^{15}N for Supporting Higher Superconductivity

The ^{15}N has negative NMMs and by the author's theory [1] the - NMM provides nuclear pressure for backward motions of the electrons for rarefying and not supporting superconductivity. In the presence of the ^{15}N, the superconductivity occurs at higher required hydrogen content and mechanical pressure. The ^{15}N pulls the protons to rarefy interactions with the e^{-} e^{-} Cooper pairs for assisting and facilitating dissipations of the e^{-} e^{-} pairs during conduction. ^{15}N pushes away e^{-} e^{-} but pulls p^{+} with rarefying molecular orbitals and inducing continua states, disorder and dissipation. But unlike ^{15}N and its negative NMMs pulling p^{+} and pushing e^{-} e^{-} pairs away, ^{14}N has positive NMM and pushes protons away from ^{14}N and pulling e^{-} e^{-} pairs to ^{14}N with increasing the denseness of orbitals and the compression of the e^{-} e^{-} and p^{+} by the ^{14}N for superconductivity at higher temperatures as the higher temperatures cannot jar the e^{-} e^{-} away from the quantum state.

Different Syntheses of Dias and Wen and Different ^{15}N Enrichments

The original synthesis of Dias and coworkers [2] may more likely enrich and dope the forming lutetium hydride with ^{14}N and the attempted replication of Wen and coworkers [3] may less likely enrich with ^{14}N and instead dope their lutetium hydride with ^{15}N. Wen and coworkers form the same structure (with therefore the same diffraction pattern) as dictated by the lutetium and hydrogen, but they have different isotopes of nitrogen. Dias originally synthesized the room temperature near-ambient pressure superconducting nitrogen doped lutetium hydride by compressing a gaseous mixture of hydrogen with 1% nitrogen with lutetium between two diamonds of a diamond anvil cells to pressure of 10,000 atm and warm temperature of 65 °C over night [2].

Wen's Attempted Replication

But Wen used different conditions of much higher pressures and higher temperatures upon nitrogen, hydrogen gaseous reactant with lutetium solid with laser heating [3]. Wen did not use diamond anvil cell, but they used "a piston cylinder type high pressure apparatus (LP 1000-540/50, Max Voggenreiter)". The chemistry employed by Wen and co-workers is different from Dias's original synthesis. Wen and coworkers perform a solid state high pressure synthesis by reacting:

$$2NH_2Cl\,(2) + CaH_2\,(s) \rightarrow CaCl_2 + 2NH_3 + H_2$$

These reactants are compressed into a solid pellet and mixed with separation by a BN with solid lutetium tablets and sealed inside a gold container. The resulting gold contained was placed inside a BN capsule and heated to 300 °C for 1 hours at 2 GPa (19,738 atm). These conditions are much different from the original conditions used by Dias. The starting materials are different as the reactants by Wen have different NMMs and the formed NH_3 is likely enriched with ^{15}N relative to ^{14}N due to positive NMM of proton and its lack of valence favoring ^{14}N over ^{15}N on the basis of Little's Effect at low pressures. But at high pressure as during Wen's synthesis the proton favors ^{15}N over ^{14}N due to the p^+ fissing quarks and the quarks transforming excess electrons fields to Dk and – NMM in rarefaction which bind e e. of the ^{15}N. The positive NMM of ^{35}Cl and ^{37}Cl would favor it binding ^{15}N due to negative NMM of ^{15}N on the basis of Little's Effect. These reactions were performed in BN interface and Au container. The B and Au all have positive NMMs to favor interacting with ^{15}N and cause ^{15}N enrichment in the starting NH_4Cl and BN with subsequent ^{15}N release to NH_3 on basis of Little's Effect. These many factors would diminish the ^{15}N doping with the forming LuH_2.

Dias Original Synthesis

Dias did not report laser heating his reactants. The different conditions of lower pressures and temperature inside diamond anvil cell caused greater reactivity of the ^{14}N (due to its negative NMM) from N_2 in the ^{15}N and ^{14}N gaseous mixture of Dias for more ^{14}N atoms and $^{14}NH_y$ species for combining with Lu for selective doping of the forming lutetium hydride with ^{14}N [2] as the nitrogen composition is maintained low and ^{15}N is only 0.38 % of the nitrogen. On the other hand, Wen and coworkers [3] used much higher temperatures and pressures with laser heating so the harsher conditions more activated ^{15}N from N_2 for ^{15}N doping the forming lutetium hydride. Dias originally synthesized the room temperature near-ambient pressure superconducting nitrogen doped lutetium hydride by compressing a gaseous mixture of hydrogen with 1% nitrogen with lutetium between two diamonds of a diamond anvil cells to pressure of 10,000 atm and warm temperature of 65 °C overnight [2]. The ^{1}H favors ^{14}N over ^{15}N by Little Effect. The ^{1}H favors the ^{14}N as the p^+ has no valence electrons and the positive NMM of the proton acts directly on the e^- e^- of ^{14}N and the positive NMM of ^{14}N to more strongly bind the ^{14}N but more weakly bind ^{15}N and to release the ^{15}N for less ^{15}N in the product. The ^{175}Lu and ^{176}Lu have positive NMMs and many core electrons and the Lu nuclei having many nucleons transform the nucleon moments in the nucleus to act differently than the bare p^+ by Little Effect so the Lu favors binding ^{14}N and more ^{14}N is doped into the Lu as the ^{14}N compresses e^- e^- of p^+ and induces negative magnetic moments that couple to the Lu positive NMMs well.. The lower temperature and lower pressures of Dias synthesis also favors ^{14}N as the $^{15}N \equiv {}^{15}N$ triple bond is weaker relative to $^{14}N \equiv {}^{14}N$ triple bond due to the negative NMMs of the ^{15}N and positive NMM of the ^{14}N by Little Effect. Therefore the amount of N is very low 1% to prevent the 15N incorporation in Dias' synthesis. The ^{14}N is more inclined to combine with ^{1}H to chemically combine with Lu to form ^{14}N doped LuH_y.

Re-Analyze considering H as Nonmetal at Low Pressure and Metal at High Pressure to Alter Interpretation

Dias reaction involved the following in diamond anvil cell under mild heating and 10,000 bars.

H_2 (g) + N_2 (g) + Lu (s) → N: LuH_x (s)

$^{15}N \equiv {}^{15}N$ triple bond with 0.38 % relative abundance is weaker due to its negative NMM for rarer molecular orbitals. The bond $^{14}N \equiv {}^{14}N$ triple bond is stronger due to ^{14}N and its positive NMM for more dense molecular orbitals. ^{14}N is 99.62% relative abundance. $^{15}N \equiv {}^{14}N$ triple bond is strongest as the positive and negative NMMs both increase molecular orbital density between the nuclei of the atoms.

Negative NMM bonded to negative (-) NMM is weaker covalent bond due to rarefied electron. The sp hybridization in $^{15}N \equiv {}^{15}N$ has negative NMM opposing the gerard 2s orbital of the sp hybrid orbitals in the case of ^{15}N triple bond N_2. But in general this is a general effect of negative NMM weakening Gerard orbitals containing molecular orbitals as discovered by RB Little.

The positive (+) NMM bonded to + NMM is weaker covalent bond due to denser molecular orbitals. The + NMM bonded to negative NMM is strongest covalent bond due to positive NMM coupling favorable to negative NMM. Picture? There is denser region of wavefunctions between the bound atoms to strength the bond. As the - NMM increases e^- denseness about + NMM increasing $e^- e^-$ between nuclei.

So does the ^{15}N compress $e^- e^-$ on the ^1H? Yes - NMM pushes ^{15}N electron from ^{15}N to ^1H and pulls p^+ into ^{15}N core. ^{15}N fisses to many p^+ and n^o it is the n^o that goto p^+ and e^- and excess e^- about H^- and N has 2p ungerard.

But ^{14}N also fisses to many p^+ without n^o and not excess e^- more acidic pulling $e^- e^-$ into ^{14}N and many p^+ and pushes H^- away. N has 2p ungerard symmetry. Not the positive NMM alter the ungerade orbital as it causes imbalance of the + vs - lob. So when positive NMM fisses from nuclei the p and f orbitals experience imbalance. The imbalance shifts the electrons in the p and f orbitals. And when negative NMMs fiss they also shift the imbalance in p and f orbitals. When positive NMMs fiss they compress the s and d orbitals. And when negative NMMs fiss they rarefy s and s orbitals. Phonons can cause these shifts by positive and negative NMMs on gerade and ungerade atomic and molecular orbitals. So s and d orbitals rarefy and compress and p and f orbitals become imbalanced by nonzero NMMs. This can alter the transport of e e for superconductivity as when the $e^- e^-$ collide with nuclei rather than dissipating the motion the collision induces compression and rarefactions of s and d and imbalanced p and f orbitals with altered wavefunctions and bond polarities for preventing the creations of phonons. Vibrations cannot occur during the imbalance as it would require huge energies to vibrate against the nuclear fissing. It is as if the collisions create local electric and magnetic fields to reaccelerate the electrons.

Fissed ^{14}N is more powerful and many p^+ to compress $e^- e^-$ of ^{14}N and H^- for superconductivity; pull $e^- e^-$ into ^{14}N, how can $e^- e^-$ hop under different isotopes for differing conduction and resistance?

But fiss ^{15}N pushes $e^- e^-$ away and pulls in p^+ and then the p^+ fisses to push $e^- e^-$ away and help $e^- e^-$ hop from H^- to $^{15}N^-$. ^{15}N fiss push $e^- e^-$ into H^- and then ^1H fisses to transmute its + NMM to - NMM, using $e^- e^-$ to push $e^- e^-$ away to ^{15}N. + NMM an - NMM fiss and fuse out of sync so as ^{15}N fuses, ^1H fisses and as ^1H fuses ^{15}N fuses..

Yes the point is to metalize the p^+--- $e^- e^-$ to induce - NMM and push $e^- e^-$ away as metals. Faster s orbitals and $e^- e^-$ covalence by s orbitals so orbitals rarefy as by p^+ transmute to cause $e^- e^-$ to produce - NMM or what RBL has called asymmetric orbital of e^- CW and e^- counterclockwise (CCW) in s orbital. One e^- moving Clockwise (CW) and other e^- moving CCW for asymmetric orbital. In such asymmetric orbital the H is metallic as $e^- e^-$ orbitals can overlap with transfer of e^- between overlapping orbitals as s gerard goes to s ungerard. H can occlude inside ^{14}N as the asymmetry opposes the repulsions. Not only do orbitals get fatter from nuclear fissing but in some cases they are bigger and denser in the bigness. In other cases, they are bigger and rarer. The may be smaller and denser or smaller and rarer due to nuclei fissing and fusing. But in ^{15}N the p^+ occludes and ^{15}N is not allowing e^- e^- compaction. But p^+ currents may be induced by ^{15}N.

H confounded as it is metal and nonmetal at low pressure. it behaves as metal at high pressure and it behaves as nonmetal at low pressure by its altered NMM and altered NMM by e e.under compression. ^{14}N pulls and compresses H^- to replace mechanical pressure. ^{15}N pulls and compresses p^+ to require mechanical pressure. So now in cupratess Cu --- ^{17}O + NMM of Cu pull e^- e^- to copper to compress e^- e^- to superconduct. So in cuprates the e^- e^- superconduct as ^{63}Cu ^{65}Cu pull e^- e^- into it by + NMM and ^{17}O pushes e^- e^- negative charge in Cu 4s orbital the e^- e^- are compressed to superconduct by fiss + NMM of Copper. So - NMM of ^{17}O is needed on Cu. But - NMM by ^{15}N is not needle on H as H has quark acting on e^- e^- but Cu has nucleon acting on e^-. So nucleons acting on e^- e^- by + NMM cause e^- e^- to superconduct by nuclear pressure.

By compression by + NMM, there are many protons compressing the e^- e^- to cause asymmetric orbital. But now in arsenides, Fe As ----O are similar as As has + NMM and ^{17}O pushes e^- e^- into As. But Hg has + NMM and - NMM and liquid Hg associates + NMM and - NMM as temp goto 0 Kelvin. So - NMM Hg pushes e^- e^- into + NMM Hg. So now with $^{25}MgB_2$ the magnesium pushes e^- into B of positive NMM. to cause superconductivity by compression of e^- e^-.

Now ReInterpret Wen on Basis of Metal H with Induced Negative Magnetic Moments on Electrons

So with ^{15}N LuH , ^{15}N would push e^- e^- into Lu and under pressure many H^- would induce - NMM to cause e^- e^- go into Lu but requires high pressure. Wen probably enriched with ^{15}N and did not see superconductivity. So also Wen used $NH_4Cl + CaH_2 \rightarrow CaCl_2 + NH_3 + H_2$. So in NH_4Cl Cl is positive NMM and would favor - NMM of ^{15}N. So at high pressure ^{14}NH unstable. So at high pressure ^{15}NH stable . . Also BN has ^{15}N enriched in it. So the high pressure of Wen with ^{15}N enriched the NH_4Cl and BN with ^{15}N and would cause NH_4Cl + Lu + NH_3 to → ^{15}N: LuHx

As the high pressure causes H to act as metal. This is the purpose to metalize H and it is to become superconductor. And - NMM of high pressure metallic H then binds Lu and its + NMM covalently. At high pressure ^{15}N interacts with ^{1}H? As H gives e^- e^- to ^{15}N then ^{15}N-H is concentrated. But ^{14}N interacts with H to take e^- from p^+ for ^{14}N --- p^+. RBL notes the fissing proton produce backward moving space that binds electrons. But the backward moving space bends so the vibrations transform to rotating smaller e^- e^- back into orbitals so as not to dissipate the conduction energy.

So ^{15}NH is enriched in NH_4Cl as H acts as nonmetal at low pressure. But at high pressure H acts as metal so ^{15}N is enriched with e^- e^- to cause - NMM of [$^{15}NH_4$] to bind Cl^- and its + NMM. Thereby Wen lutetium hydride is enriched with ^{15}N.

It is important to note that the ^{14}N is as ^{13}C as they both have positive NMMs; and the both act on protons in these recent superconductor for rasing Tc and lowering needed mechanical pressure. The older superconductors of cuprate family have ^{17}O acting on ^{63}Cu ^{65}Cu

Possible Similar Isotopic Effects for Carbonaceous Hydride Controversy

In considering the isotopic effects here, isotopic effects may give sound scientific basis for why researchers have had tough time replicating the carbonaceous hydride work of Dias [4]. Carbon has two stable isotopes in larger relative abundances: ^{12}C and ^{13}C. The ^{12}C makes up 99% of carbon by relative abundance on earth. ^{13}C makes up about 1% of the carbon on earth by relative abundance. During syntheses different synthetic conditions may enrich samples differently with ^{13}C for variation in superconducting properties and other properties made from different laboratories. The doping of sulfur hydride with ^{13}C is important as ^{13}C has nonzero positive NMM, but ^{12}C has null (0) NMM. The positive NMM of ^{13}C may contribute to superconductivity of the hydrogen sulfide.

References

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2. Dasenbrock-Gammon, N. et al. Evidence of near-ambient superconductivity in a N-doped lutetium hydride. Nature 615, 244-250 (2023).
3. Ming, X. et al. Absence of near-ambient superconductivity in $LuH_{2+/-x}N_y$. arXiv:2303.08759v2 [cond-mat.supr-con].
4. Hiranya, P. et al. Observation of conventional near room temperature superconductivity in carbonaceous sulfur hydride. arXiv:2302.08622v2 [cond-mat.supr-con] (2023).
5. Webelements website for NMMs.

Table I – Nuclear Magnetic Moments of Stable Isotopes of Elements (from Webelements)

Hydrogen						
	1H	99.98%		1½		2.79
	2H	0.01%	0		0.85	
Helium						
	3He	.00001	½		-2.12	
	4He	99.99%		0		0
Lithium						
	6Li	7.59%	1		0.82	
	7Li	92.4%	3/2		3.52	
Beryllium						
	9Be	100%	3/2		-1.17	
Boron						
	10B	19.9%	3		1.80	
	11B	80.1	3/2		2.68	
Carbon						
	12C	98.9%	0		0	
	13C	01.07%		½		0.702
Nitrogen						
	14N	99.6%	1		0.40	
	15N	0.36%	½		-.283	
Oxygen						
	16O	99.7%	0		0	
	17O	0.03	5/2		-1.89	
	18O	0.21%	0		0	
Fluorine						
	19F	100%	½		2.62	
Neon						
	20Ne	90.5%	0		0	
	21Ne	0.27%	3/2		-0.66	
	22Ne	9.25	0		0	

Sodium				
	23Na	100%	3/2	2.21
Magnesium				
	24Mg	78.99	0	0
	25Mg	10.0%	5/2	-0.86
	26Mg	11.0%	0	0
Aluminum				
	27Al	100%	5/2	3.64
Silicon				
	28Si	92.2%	0	0
	29Si	4.68%	½	0.55
	30Si	3.08	0	0
Phosphorus				
	31P	100%	½	1.31
Sulfur				
	32S	94.9%	0	0
	33S	0.76	3/2	0.64
	34S	4.29	0	0
Chlorine				
	35Cl	75.8%	3/2	0.82
	37Cl	24.22	3/2	0.68
Argon				
	36Ar	0.33%	0	0
	38Ar	0.06%	0	0
	40Ar	99.6	0	0
Potassium				
	39K	93.9%	3/2	0.39
	40K	0.012%	4	-1.2
	41K	6.7%	3/2	0.21
Calcium				
	40Ca	97%	0	0
	42Ca	.65%	0	0
	43Ca	.14%	7/2	-1.31
	4Ca	2.09%	0	0
Scandium				

	45Sc	100%	7/2	4.76
Titanium				
	46Ti	8.35%	0	0
	47Ti	7.4%	5/2	-0.79
	48Ti	73.7%	0	0
	49Ti	5.4%	7/2	-1.10
	50Ti	5.18	0	0
Vanadium				
	50V	.25%	6	3.35
	51V	99.8%	7/2	5.15
Chromium				
	50Cr	4.3	0	0
	52Cr	83.8	0	0
	53Cr	9.5	3/2	-0.47
	54Cr	2.4%	0	0
Manganese				
	55Mn	100%	5/2	3.45
Iron				
	54Fe	5.85%	0	0
	56Fe	91.75%	0	0
	57Fe	2.12%	½	0.091
	58Fe	0.28%	0	0
Cobalt				
	59Co	100%	7/2	4.63
Nickel				
	58Ni	68.1%	0	0
	60Ni	26.2%	0	0
	61Ni	1.1%	3/2	-.75
	62Ni	3.63	0	0
Copper				
	63Cu	69.17	3/2	2.22
	65Cu	30.8	3/2	2.38
Zinc				
	64Zn	48.6	0	0
	66Zn	28%	0	0

67Zn	4.10	5/2	.87
Gallium			
69Ga	60.1	3/2	2.01
71Ga	39.9%	3/2	2.56
Germanium			
70Ge	20.84%	0	0
72Ge	27.5%	0	0
73Ge	7.7%	9/2	-.88
74Ge	6.3%	0	0
76Ge	7.61%	0	0
Arsenics			
75As	100%	3/2	1.43
Selenium			
74Se	.89	0	0
76Se	9.37%	0	0
77Se	7.63	½	.53
78Se	23.8	0	0
80Se	49.6	0	0
82Se	8.73	0	0
Bromine			
79Br	50.7%	3/2	2.11
81Br	49.3%	3/2	2.27
Krypton			
78Kr	.35%	0	0
80Kr	2.28%	0	0
82Kr	11.6%	0	0
83Kr	11.5%	9/2	-0.97
84Kr	57.0%	0	0
86Kr	17.3%	0	0
Rubidium			
85Rb	72.1%	5/2	1.35
87Rb	27.8	3/2	2.75
Strontium			
86Sr	9.86%	0	0
87Sr	7.0%	9/2	-1.09
88Sr	82.6%	0	0

Yttrium			
89Y	100%	½	-.137
Zirconium			
90Zr	51.45%	0	0
91Zr	11.2%	5/2	-1.30
92Zr	17.15	0	0
94Zr	17.4%	0	0
96Zr	2.8%	0	0
Niobium			
93Nb	100%	9/2	6.17
Molydenum			
92Mo	14.8%	0	0
94Mo	9.25%	0	0
95Mo	15.9%	5/2	-.91
96Mo	16.7%	0	0
97Mo	9.5%	5/2	-.93
98Mo	24.13	0	0
100Mo	9.6%	0	0
Technetium			
Radioactive			
Ruthenium			
96Ru	5.4%	0	0
99Ru	12.8%	5/2	-.64
100Ru	12.6%	0	0
101Ru	17.1%	5/2	-.72
102Ru	31.5%	0	0
104Ru	18.6%	0	0
Rhodium			
103Rh	100%	½	-0.088
Palladium			
104Pd	11.1%	0	0
105Pd	22.3%	5/2	-.64
106Pd	27.3%	0	0
108Pd	26.5%	0	0
110Pd	11.7%	0	0
Silver			

	107Ag	51.8%	½	-.113
	109Ag	48.2%	½	-.131
Cadmium				
	110Cd	12.5%	0	0
	111Cd	12.8%	½	-.59
	112Cd	24.1%	0	0
	113Cd	12.2%	½	-.62
	114Cd	28.7%	0	0
	116Cd	7.5	0	0
Indium				
	113In	4.3%	9/2	5.53
	115In	95.7%	9/2	5.54
Tin				
	116Sn	14.5%	0	0
	117Sn	7.7	½	-1.00
	118Sn	24.2%	0	0
	119Sn	8.6%	½	-1.04
	120Sn	32.6%	0	0
	122Sn	4.6%	0	0
	124Sn	5.8%	0	0
Antimony				
	121Sb	57.2%	5/2	3.36
	123Sb	42.8%	7/2	2.55
Tellerium				
	122Te	2.5%	0	0
	123Te	0.9%	½	-0.7
	124Te	4.7%	0	0
	125Te	7.1%	½	-.89
	126Te	18.8%	0	0
	128Te	31.7%	0	0
	130Te	34.1%	0	0
Iodine				
	127I	100%	5/2	2.81
Xenon				
	128Xe	1.9%	0	0
	129Xe	26.4%	1/2	-0.78
	130Xe	4.1%	0	0
	131Xe	21.2%	3/2	0.69
	132Xe	26.9%	0	0

	134Xe	10.4%	0	0
	136Xe	8.9%	0	0
Cesium				
	133Cs	100%	7/2	2.58
Barium				
	134Ba	2.4%	0	0
	135Ba	6.6%	3/2	.83
	136Ba	7.9%	0	0
	137Ba	11.2%	3/2	0.93
	138Ba	71.7%	0	0
Lanthanum				
	138La	0.1%	5	3.7
	139La	99.9	7/2	2.7
Cerium				
	136Ce			
	138Ce			
	140Ce	88.4%	0	0
	142Ce	11.1%	0	0
Praseodymium				
	141Pr	100%	5/2	4.136
Neodymium				
	142Nd	27.2%	0	0
	143Nd	12.2%	7/2	-1.065
	144Nd	23.8	0	0
	145Nd	8.3	7/2	-0.65
	146Nd	17.2%	0	0
	148Nd	5.7	0	0
	150Nd	5.6	0	0
Promethium				
	Null			
Samarium				
	147Sm	15%	7/2	-0.81
	148Sm	11.2%	0	0
	149Sm	13.8%	7/2	-0.67
	150Sm	7.38%	0	0
	152Sm	26.75	0	0

	154Sm	22.75%	0	0
Europium				
	151Eu	47.8%	5/2	3.4
	153Eu	52.2%	5/2	1.53
Gadolinium				
	154Gd	2.18	0	0
	155Gd	14,8%	3/2	-.26
	156Gd	20.5%	0	0
	157Gd	15.7%	3/2	-.34
	158Gd	24.8%	0	0
	160Gd	21.8%	0	0
Terbium				
	159Tb	100%	3/2	2.014
Dysprosium				
	160Dy	2.34%	0	0
	161Dy	18.91%	5/2	-0.4806
	162Dy	25.51%	0	0
	163Dy	24.90%	5/2	0.6726
	164Dy	28.18%	0	0
Holmium				
	165Ho	100%	7/2	4.173
Erbium				
	164Er	1.61%	0	0
	166Er	33.61%	0	0
	167Er	22.93%	7/2	-0.56
	168Er	26.78%	0	0
	170Er	14.93%	0	0
Thulium				
	169Tm	100%	½	-0.2316
Ytterbium				

170Yb	3.04%	0		0	
171Yb	14.28%		½		0.4919
172Yb	21.83%		0		0
173Yb	16.13%		5/2		-0.6776
174Yb	31.83%		0		0
176Yb	12.76%		0		0

Lutetium

173Lu	97.41%		7/2		2.23
176Lu	2.59%	7		3.19	

Hafnium

176Hf	5.26%	0		0	
177Hf	18.60%		7/2		0.7936
178Hf	27.28%		0		0
179Hf	13.62%		9/2		-0.6409
180Hf	35.08%		0		0

Tantalum

180Ta	0.012%		8		
181Ta	99.98%		7/2		2.31

Tungsten

182W	26.50%		0		0
183W	14.31%		½		0.1177
184W	30.64%		0		0
186W	28.43%		0		0

Rhenium

185Re	37.40%		5/2		3.18
187Re	62.60%		5/2		3.21

Osmium

186Os	1.59%	0		0	
187Os	1.96%	½		0.064	
188Os	13.24%		0		0
189Os	16.15%		3/2		0.66
190Os	26.26%		0		0
192Os	40.78%		0		0

Iridium

	191Ir	37.3%	3/2		0.146	
	193Ir	62.7%	3/2		0.159	
Platinum						
	192Pt	0.72%	0		0	
	194Pt	32.97%		0		0
	195Pt	33.83%		½		0.61
	196Pt	25.24%		0		0
	198Pt	7.16%	0		0	
Gold						
	197Au	100%	3/2		0.148	
Thallium						
	203Tl	29.52%		½		1.62
	205Tl	70.48%		½		1.64
Lead						
	204Pb	1.4%	0		0	
	206Pb	24.1%	0		0	
	207Pb	22.1%	½		0.58	
	208Pb	52.4%	0		0	
Bismuth						
	209Bi	100%	9/2		4.11	
Polonium						
	Unstable					
Astatine						
	unstable					
Radon						
	Unstable					
Francium						
	Unstable					
Radium						
	Unstable					
Actinium						
	Unstable					

Thorium				
	232Th	100%	0	0
Protactinium				
	231Pa	100%	3/2	
Uranium				
	235U	0.72%	7/2	-0.35
	238U	99.27%	0	0
Lawrencium				
	Unstable			
Rutherfordium				
	Unstable			
Dubnium				
	Unstable			
Seaborgium				
	Unstable			