3.7.8* Neutron Affinity and the CFP

When neutrons are trapped in a crystal by the neutron band mechanism and are in Cooper pair state, the neutrons may be in a state with an energy lower than that of a state realized by beta decay of the whole neutrons. In this case, the trapped neutron can not decay and stays unchanged for ever except any other causes which destroy the stability. To use this idea for the cold fusion phenomenon, we have defined {¥it the neutron affinity} of lattice nuclei as follows.

3.7.8.1 Definition of the Neutron Affinity of a Lattice Nucleus η

Let us assume that the neutron Bloch wave transforms into a proton Bloch wave when it suffers a β-decay. Furthermore, let us estimate the stability of the neutron wave interacting with a nucleus ${}^{A}_{Z}\mathrm{X}$ with a neutron affinity η defined by a following relation;

$$\eta \equiv - ({}^{A+1}_{Z}M - {}^{A+1}_{Z+1}M) c^2 \qquad (3.7.8.1)$$

Here, c is the light speed in vacuum, ${}^{A}_{Z}M$, in this case, is the mass of the nucleus with a mass number A and an atomic number Z composing the lattice nuclei.

This definition tells us that the neutron affinity is a quantity expressing an energy difference of two nuclear states, one with an extra neutron and the other with an extra proton. The positive value of η means the former is in lower energy than the latter and is more stable.

3.7.8.2 Neutron Affinity of Lattice Nuclei $<\eta>$

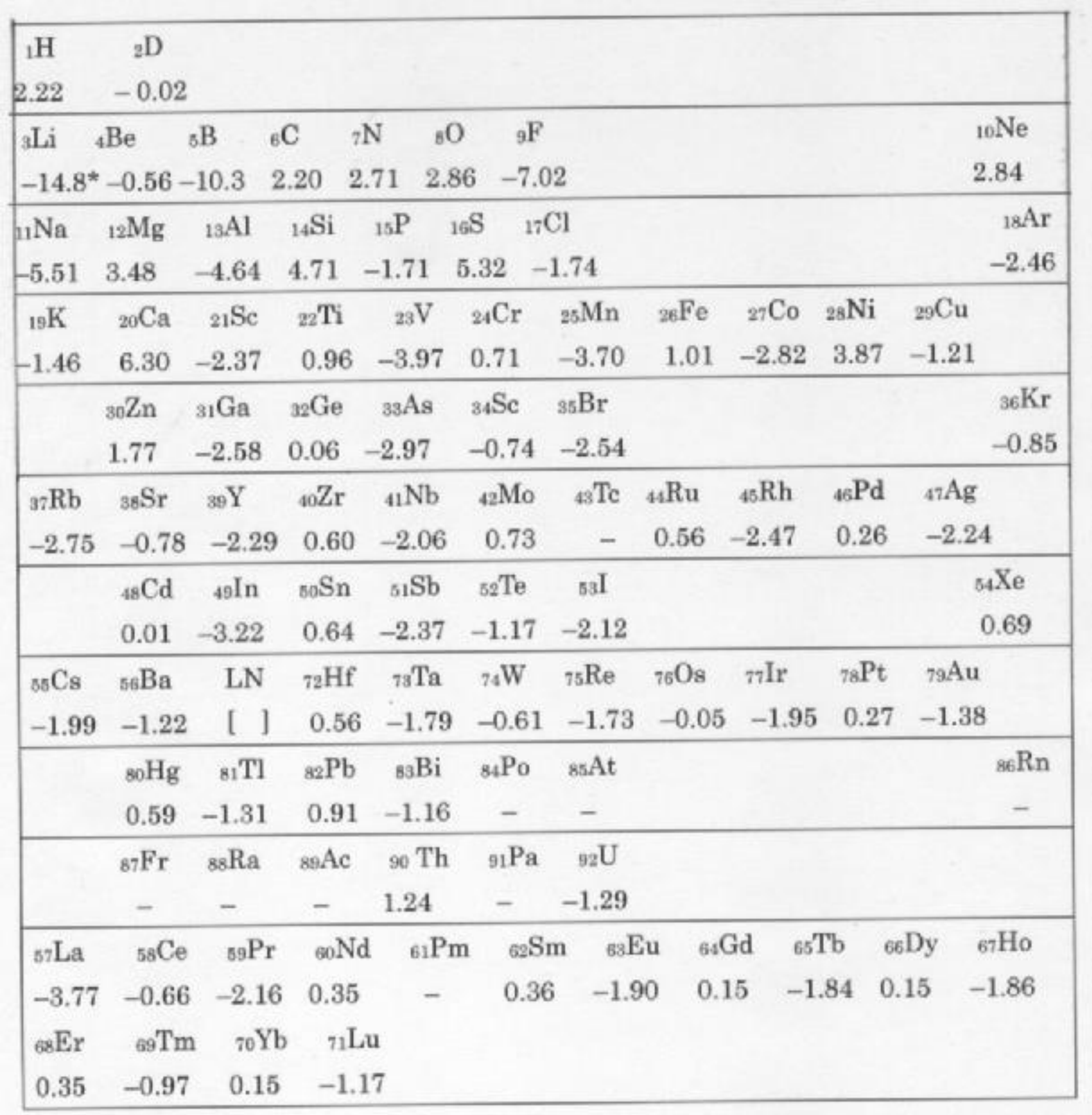
For a crystal, we define the neutron affinity of the crystal $<\eta>$ as an average of η over the lattice nuclei. Therefore, the neutron affinity of a crystal composed of an identical nucleus is the same to that for the nucleus.

Furthermore, we may assume that when a neutron is trapped in a crystal with a positive neutron affinity η, then the neutron is stable against beta decay.

We have calculated $<\eta>$ for elements using their natural abundance to take an average and the result is tabulated in Table 3.7.8-1.

It is interesting to notice that almost all materials used successfully in cold fusion experiments hitherto, e.g. **C**, **Pd**, **Ti** and **Ni** (bold typed in the Figure), have positive values of $\boldsymbol{\eta}$ (or $\boldsymbol{<\eta>}$) while alkali metals used in electrolytes have negative values. This empirical rule may have real meaning in the occurrence of the cold fusion phenomenon.

Other elements with positive values of the neutron affinity, e.g. N, Mg, Si. S, Cr, Fe, Zn, Mo, Pt, Hg, Pb, Th, may be used as a component of CF materials if they could occlude large amount of hydrogen isotopes. In reality, Romodanov et al. observed large amount of tritium in high-current glow discharge experiments with Mo cathodes [Alekseev 1994, Romodanov 1996, 1998].



$_{1}$H	$_{2}$D										
2.22	−0.02										
$_{3}$Li	$_{4}$Be	$_{5}$B	$_{6}$C	$_{7}$N	$_{8}$O	$_{9}$F					$_{10}$Ne
−14.8*	−0.56	−10.3	2.20	2.71	2.86	−7.02					2.84
$_{11}$Na	$_{12}$Mg	$_{13}$Al	$_{14}$Si	$_{15}$P	$_{16}$S	$_{17}$Cl					$_{18}$Ar
−5.51	3.48	−4.64	4.71	−1.71	5.32	−1.74					−2.46
$_{19}$K	$_{20}$Ca	$_{21}$Sc	$_{22}$Ti	$_{23}$V	$_{24}$Cr	$_{25}$Mn	$_{26}$Fe	$_{27}$Co	$_{28}$Ni	$_{29}$Cu	
−1.46	6.30	−2.37	0.96	−3.97	0.71	−3.70	1.01	−2.82	3.87	−1.21	
	$_{30}$Zn	$_{31}$Ga	$_{32}$Ge	$_{33}$As	$_{34}$Sc	$_{35}$Br					$_{36}$Kr
	1.77	−2.58	0.06	−2.97	−0.74	−2.54					−0.85
$_{37}$Rb	$_{38}$Sr	$_{39}$Y	$_{40}$Zr	$_{41}$Nb	$_{42}$Mo	$_{43}$Tc	$_{44}$Ru	$_{45}$Rh	$_{46}$Pd	$_{47}$Ag	
−2.75	−0.78	−2.29	0.60	−2.06	0.73	–	0.56	−2.47	0.26	−2.24	
	$_{48}$Cd	$_{49}$In	$_{50}$Sn	$_{51}$Sb	$_{52}$Te	$_{53}$I					$_{54}$Xe
	0.01	−3.22	0.64	−2.37	−1.17	−2.12					0.69
$_{55}$Cs	$_{56}$Ba	LN	$_{72}$Hf	$_{73}$Ta	$_{74}$W	$_{75}$Re	$_{76}$Os	$_{77}$Ir	$_{78}$Pt	$_{79}$Au	
−1.99	−1.22	[ ]	0.56	−1.79	−0.61	−1.73	−0.05	−1.95	0.27	−1.38	
	$_{80}$Hg	$_{81}$Tl	$_{82}$Pb	$_{83}$Bi	$_{84}$Po	$_{85}$At					$_{86}$Rn
	0.59	−1.31	0.91	−1.16	–	–					–
	$_{87}$Fr	$_{88}$Ra	$_{89}$Ac	$_{90}$Th	$_{91}$Pa	$_{92}$U					
	–	–	–	1.24	–	−1.29					
$_{57}$La	$_{58}$Ce	$_{59}$Pr	$_{60}$Nd	$_{61}$Pm	$_{62}$Sm	$_{63}$Eu	$_{64}$Gd	$_{65}$Tb	$_{66}$Dy	$_{67}$Ho	
−3.77	−0.66	−2.16	0.35	–	0.36	−1.90	0.15	−1.84	0.15	−1.86	
$_{68}$Er	$_{69}$Tm	$_{70}$Yb	$_{71}$Lu								
0.35	−0.97	0.15	−1.17								

Table 3.7.8-1 Neutron Affinity of Elements $<\eta>$ (MeV) defined by the relation (3.7.8.1) between two nuclear states interacting with neutron Bloch wave and with proton Bloch wave averaged over isotopes with natural abundance [Kozima 1998a (Table 12.1)].

*The value for Li was calculated with an assumption $^{8}_{4}$Be = 2 $^{4}_{2}$He because of the absence of $^{8}_{4}$Be in nature.