Neutron Lifetime In Solids

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Abstract

It is shown that a neutron trapped in a solid interacting with nuclei on lattice points might be in a stable state for the β decay when the nuclei satisfy a condition concerning the interaction with the neutron.

1. Introduction

A unified interpretation of the Cold Fusion phenomenon has been proposed[1] which showed[2] that neutrons interacting with nuclei on the lattice points have a band structure in their energy spectrum in a Kronig-Penny model with an attractive δ-function type potential (Fig. 1 of Reference 2). When a solid has a sandwich structure with different lattice constants, for instance, palladium metal occluding hydrogen isotope with different densities from place to place, a part of the neutrons in a large lattice constant is Bragg-reflected at the boundary between small lattice constants and *vice versa.*

When a neutron having a life time of 11 minutes in a free state interacts with nuclei, it was assumed[1,3-6] that its life time changes drastically where the initial state is energetically stabler than the final state of a decayed neutron into a proton, an electron and a neutrino.

In this paper, we show that in Ti, Fe, Ni and Pd metals, a neutron Bloch wave is stable for β decay in the lattice using a simple model where interaction of the nuclei on lattice points with the neutron wave are approximated by an average of interaction of an individual nucleus with a neutron.

2. Neutron Life Time in a Lattice

It is known that a neutron in its free state decays with a decay constant $\lambda = 1/\tau = 1.5 \times 10^{-3}\ s^{-1}$ and decay energy ~ + 0.782 MeV, emitting an electron and a neutrino. The average life time τ of the neutron is 11 minutes. The neutron in a deuteron interacting with a proton in it, however, is stable because the deuteron has lower energy than the state where there are two protons, an electron and a neutrino by an amount 1.44 MeV.

We have given a prediction[2] that the life time of a neutron in a neutron Bloch band interacting with nuclei on lattice points might be lengthened by the same cause, making the neutron in the deuteron stable. To treat this problem, we make an assumption that the interaction of a neutron Bloch wave and a nuclei is approximated by a mean value of the individual interaction of a neutron and each nucleus on the lattice.

A neutron in a lattice of nuclei with mass ${}^{A}_{Z}M$ is stable if $\Delta\varepsilon$ defined below is negative in this approximation :

$$\Delta\varepsilon \equiv ({}^{A+1}_{Z}M - {}^{A+1}_{Z+1}M)c^2$$

Then, for example, the stability of a neutron Bloch wave interacting with ${}^{106}_{46}$Pd nucleus is estimated by taking an energy difference $\Delta\varepsilon$ of two states ${}^{107}_{46}$Pd and ${}^{107}_{47}$Ag.

For metals Ti, Fe, Ni, Pd, Sc, Mn, Co and Cu, the average energy differences $<\Delta\varepsilon>$ are calculated using $\Delta\varepsilon$ for isotopes with natural abundance of these elements[7] and tabulated in Table 1.

This result shows that in metals Ti, Fe, Ni and Pd the neutrons interacting with nuclei are stable for β decay while in metals Sc, Mn, Co and Cu the neutrons are unstable. Thus, in metals of the first four members in Table 1, a neutron trapped in a crystal region surrounded by reflecting walls remains there forever if it does not fuse with an impurity nucleus of a hydrogen isotope occluded there.

In the case of Pd, however, the situation is subtle in this approximation because of the smallness of $<\Delta\varepsilon>$. In metallic Pd, there are strongly unstable isotopes for interaction with neutrons with mass numbers 110 and 108 with $\Delta\varepsilon$ 2.21 and 1.12 MeV and an abundance of 11.8 and 27%, respectively, among other stable isotopes. The experimental result of unstable Cold Fusion phenomenon in Pd changing its characteristics from sample to sample might be dependent on this character of palladium isotopes.

In the case of Fe, the crystal structure is bcc and its property for occlusion of hydrogen isotopes is different from the other transition metals listed here, with negative value of $<\Delta\varepsilon>$. This fact might be a cause of absence of the Cold Fusion phenomenon in Fe.

3. Conclusion

There are still controversies over the reality of the so-called Cold Fusion phenomenon. Special attention is concentrated in a problem of reproducibility of experimental results and absence of the phenomenon in experiments with very low background neutrons.

One author (H.K.) has proposed a model[1] to explain the phenomenon based on an existence of stable trapped neutrons in a crystal lattice and has consistently explained the various experimental results obtained during these more than six years.

The approximate estimation of the stability of a neutron Bloch wave given above shows a possibility of the existence of stable neutrons in a crystal lattice, as assumed in the model. The result given in Table 1 is in accordance with experimental facts for a selection of the matrix metal for Cold Fusion.

Table 1. Average energy differences $<\Delta\varepsilon>$ between two nuclear states interacting with neutron Bloch wave and with proton Bloch wave averaged over isotopes with natural abundance.

Element	${}_{22}$Ti	${}_{26}$Fe	${}_{28}$Ni	${}_{46}$Pd	${}_{21}$Sc	${}_{25}$Mn	${}_{27}$Co	${}_{29}$Cu
$<\Delta\varepsilon>$ (MeV)	−0.959	−1.01	−3.87	−0.264	2.27	3.70	0.82	1.21

An investigation of non-metallic substances which show the Cold Fusion phenomenon will be more complicated and should be researched. Another cause of neutron stabilization, the neutron Moessbauer effect[5], should also be taken into consideration in future Cold Fusion research.

This result supporting the "Trapped Neutron Catalyzed Model" is, in turn, a proof of reality of Cold Fusion. It is desirable to check and reinforce weak points of the model and compare them with experimental results. It is also desirable to do experiments to check the predictions and conclusions[1-6] of the model, though some of the earlier predictions should be reconsidered using new theoretical data given in this paper.

References

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3) H. Kozima, "Trapped Neutron Catalyzed Fusion of Deuterons and Protons in Inhomogeneous Solids", *Trans. Fusion Tech.* **26**, p.508 (1994); *Proceedings of ICCF 4*, Vol. 1, p. 5-1. Electric Power Research Institute, Palo Alto, California (1994).

4) H. Kozima and S. Watanabe, "$t-d$ and $d-d$ Collision Probability in the Trapped Neutron Catalyzed Model of the Cold Fusion", *Proceedings of International Symposium "Cold Fusion and Advanced Energy Sources"* (Minsk, May 24-26, 1994.) (in Russian) p. 299.

5) H. Kozima, "Neutron \Moessbauer Effect and the Cold Fusion in Inhomogeneous Materials", *Il Nuovo Cimento* **27A**, p.1781(1994).

6) H. Kozima and S. Watanabe, "Nuclear Processes in Trapped Neutron Catalyzed Model for Cold Fusion ", *Cold Fusion*, **10**, p.2 (1995): *Proc. ICCF 5* (Monaco, April 10 - 14, 1995).

7) For instance, *American Institute of Physics Handbook*, 3rd edition, Chapter 8b, McGraw-Hill, New York, 1972.

Monomania

Wayne Green

Yes, of course you're interested in cold fusion. And so am I. But I have a few other interests which are worth your checking out. No, I'm not (at least now) going to try and sell you on amateur radio as a hobby, even though it has provided me with a lifetime of excitement, adventure and friends.

One of the results of my being appointed by the Governor to the New Hampshire Economic Development Commission was it helped focus my attention on the problems impacting our American quality of life. Things like health and our medical industry, our school system, our growqing federal and state bureaucracies, crime and drugs, and so on.

In addition to endless subcommittee Commission meetings, where we heard testimony from experts in many fields, I started reading everything that was recommended on these subjects and then providing written reports on what I'd found to the full Commission, the Governor and the NH legislature.

One result of all this has been my compiling the reviews of the most important books I've found and making it available as a $5 28-page "review of books you're crazy if you don't read." This is stuff they don't teach in school.

There are books on health such as the one by Dr. Comby who explains how a diet change can cure cancer,

(Continued on page 47)