JURNAL TEKNOLOGI, Edisi No. 4, Tahun XVIII, Desember 2004, 298-306 ISSN 0215-1685

Ising Model and Magnetic Stirrer In Quantum States For Nuclear Reactor Control ROD Blade Based On $Sr_2 Al_2O_{1,8}$ Material

Moh. Hardiyanto
Industrial Engineering Department
Institut Teknologi Indonesia – Serpong, Tangerang 15320 Indonesia
E-mail : madi_iti@yahoo.com

Abstrak

Fungsi dari batang kendali pada reaktor nuklir riset multiguna adalah membuat stabilisasi dan merupakan alat pengendali dari reaksi-reaksi berantai nuklir, dengan adanya dampak dari radiasi Cerenkov dan fluks neutron termal dalam ruang reaktor. Menggunakan Model Ising dengan pendekatan kondisi-kondisi kuantum dan percobaan melalui peralatan Magnetic Stirrer ditentukan turunan material-material dari $Sr_2Al_2O_{2-x}$. Salah satu dari tiga tipe material itu adalah $Sr_2Al_2O_{1,8}$. Material ini menunjukkan kekuatan pada absorbsi fluks neutron termal sebesar $2,1 \times 10^5 - 1,8 \times 10^6$ currie/mm, nilai Konduktivitas Elektriknya adalah 26,62 – 29,98 pada temperatur $800^0 - 890^0$ C, sedangkan pada kondisi fluks neutron termal sebesar $2,1 \times 10^5$ currie/mm nilai Konduktivitas Elektriknya adalah 29,44 – 37,88 pada standar IAEA. Pada nilai medan magnetik sebesar 459 tesla dan absorbsi yang dilakukan terhadap $2,1 \times 10^5$ currie/mm neutron termal, reduksi struktur kristalnya mencapai 6,88% sampai 10,95% untuk jangka waktu 25 tahun pada daya 45,7 megawatt dengan matriks elemen bahan bakar nuklir adalah UO_2 yang makin diperkaya dan Pu_2O serta Th_2O_y.

Kata kunci : *Model Ising, kondisi-kondisi Kuantum, Magnetic Stirrer, material $Sr_2Al_2O_{1,8}$*

Abstract

The functional of a multi purpose research nuclear reactor control rod blade nuclear reactor is stabilized and controlling devices for nuclear chain reactions, the existing of Cerenkov's radiation impact and thermal neutron flux in reactor chamber. Using Ising Model with quantum states approaching and testing by Magnetic Stirrer equipment had determined the Sr2 Al2O2-x derivatives materials. One of three types is Sr2 Al2O1.8. This material shown the strength of thermal neutron flux absorbed about $2.1 \times 10^5 - 1.8 \times 10^6$ currie/mm, the value of Electrical Conductivity is 26.62 - 29.98 at 800 - 890° C temperature, however at 2.1×10^5 currie/mm thermal neutron flux condition is 29.44 – 37.88 in IAEA standard. At 450 tesla magnetic field and 2.1×10^5 currie/mm thermal neutron absorber, the crystalline structure reducted to 6.88% until 10.95% for 25 years period in 45.7 megawatts with UO_2 more enrichment and Pu_2O also Th_2O_y nuclear fuel element matrix.

Keywords : *Ising Model, Quantum states, Magnetic Stirrer, $Sr_2 Al_2O_{1,8}$ material*

1. Introduction

This research involves a multi purpose research nuclear reactor with increasing of its adjusted power from 30 megawatts (MW) to 50 MW. This process has changed the nuclear fuel element matrix from UO_2 to be UO_2 more enrichment with Pu_2O and Th_2O_y buffer element. This matter could be increasing of thermal neutron flux up to 2.1×10^5 currie/mm in normal condition, much more Cerenkov's radiation figure out and several quantum states in reactor chamber (Stuart, Thomas P., 2001).

The shape and dimensions of control rod blade include 5 meters length, 0.80 meters diameter and thicknes s fit on 0.10 meters. Moving on normally with 76 mm/second speed and reached above on reactor yield is 1.6 meters for normal condition. These values have fixed on

International Atomic Energy Agency (IAEA) regulation (BATAN, 2001).

At present time, the control rod blade material is Zircalloy-4, and according to IAEA recommendation, this material have to change with the best substance fitted on 50 MW adjusted power. The eliminary investigations show that material has found from Sr_2 Al_xO_y types (Moh Hardiyanto, 2001) consists are three types including Sr_2 Al_2O , Sr_2 Al_2O_2 and Sr_2 Al_2O_3 materials. From basic testing with Magnetic Stirrer equipment in few conditions ; normal, sub critical, critical phase 1 and phase 2 have eliminary result such as the highest thermal neutron flux absorber value could reached by Sr_2 Al_2O_2 with much more stability in graduation points. Another thing, when the Cerenkov's radiation shown up, this material expression the more ordered electron clouds track, then could be count to facing neutrino, μ, and anti-neutrino particles bombarding around the reactor chamber. Nevertheless, experimentals have shown that material having the Sr_2 Al_2O_{2-x} derivatives. This paper investigates the best of Sr_2 Al_2O_{2-x} derivation materials using simulation of Ising Model with quantum formulations states approaching and for the justification wearing the several tests in a few specific devices.

Ising Model

The IAEA standard for software and programming to multi purpose nuclear research reactor was written in Modula's language consists are 4 main programmes including numerical processing, begin to simulation, advanced simulation and establishing calculations also display. Additional for this software, Ising Model has 38,700 sub-programmes consists of 8,700 formulations and calculations especially in physics, chemistry and other nuclear reactions. Thereby, include 10,000 sub-programmes for various databases, which is completed with 15,000 sub-programmes for making simulations. After that to work, this software was completed with 5,000 sub-programmes to display with interactive processing, specific in nuclear chain reactions at reactor chamber with all devices (Durant, W.C., 2001).

Magnetic Stirrer

The equipment has developed especially for multi purpose nuclear reactor. Advanced devices will be connected and integrated with reactor chamber and shielding of its reactor and generates with 150 kilowatts power non-stop electrical force, commonly by 2.1 grams Thorium-331, one isotope species from Trans-Uranium series (Waghmare, Y.R., 2001). Various parts will be connected with this equipment test including premier properties such as:

- Thermal neutron flux luminosity between 1.9×10^4 currie/mm to 2.1×10^6 currie/mm with Na_2SO_3 liquid moderator.
- Magnetic field between 400 tesla up 610 tesla of thermal neutron flux existence in reactor chamber when adjusted power increasing around 50 MW.
- The magnetic frequency around 410 MHz until 550 MHz for each chain reaction based on UO_2 more enrichment nuclear fuel.
- Existing of ν and ν̄ particles and more muon-hadron particles when Cerenkov's radiation coming up in reactor chamber.
- The value of temperature around 800° - 890° C, when adjusted power increase to 50 MW.

This part was connected with special device, *catch-nuc power*; the equipment will be generated electrical power amount 70 kilowatts per hour.

Through by Magnetic Stirrer and Ising Model will be determined the derivation of Sr_2 Al_2O_{2-x} covering are Sr_2 $Al_2O_{1.7}$, Sr_2 $Al_2O_{1.8}$ and Sr_2 $Al_2O_{1.9}$ types with involving the quantum states.

Quantum States Approaching

Most formulations will be used in this research based on relativistic quantum mechanics, Einstein's condition, and a few interstellar quantum statistics until the derivation from BCS theory in super-conductivity state (Gomiez, J.A., 2001).

Begin from standard formulation for relativistic wave length, forward to spectrum of nuclear analysis up to super-conductivity state with Fermi, Fermi-Hall condition (Beiser, Arthur, 1998). The first of Compton's wave length in Einstein-Dirac state expressed by:

$$\frac{\{hf_0 - hf + m\}^2}{c^2} - m_\phi^2 c^2 = \left\{\frac{h}{\lambda_\phi}\right\}^2 + \left\{\frac{h}{\lambda}\right\}^2 - \frac{2h^2}{\lambda_0 \lambda}\cos\theta \quad (1)$$

Considering the total energy in relativistic states is:

$$E^2 = p^2 c^2 - m_0^2\, c^4 \quad (2)$$

Meanwhile the formulation of Einstein-Dirac could be written in muon-hadron particle with:

$$E_\varphi = \frac{e^4 \sin\phi}{4\pi\varepsilon_0 c^2 r} \quad (3)$$

In this case, considering that the speed of the electron is small in comparison it the speed of neutron particle, the electric field of Electrical Conductivity (EC) flowing at Einstein-Sommerfeld field in an point H_{11} with polar coordinates.

$$\left(\frac{E_\varphi}{E}\right)^2 = \frac{e^4 \sin^2\phi}{(4\pi\varepsilon_0)^2 m_n^2 c^4 r^2} \quad (4)$$

As the intensity is directly proportional to the square of the electric field. The total amount of energy scattered per unit volume of the scattered per second is given by

$$U_s = \int_0^\pi I_s \left(2\pi r^2 \sin\theta\right) d\theta \quad (5)$$

$$U_s = \left(\frac{1}{2}\right)\left[\frac{2\pi n e^4 r^2}{(4\pi\varepsilon_0)^2 m^2 c^4 r^2}\right] \int_0^\pi \left(1 + \cos^2\right)\sin\theta\, d\theta \quad (6)$$

The first formulation investigated by Arthuro J. Gomiez (Gomiez, J. Arthur, 2001) shown that the crystalline structure will be derived from BCS theory such as

$$H_1 = \sum_i J\left[C^F_{ki\uparrow} C^F_{ki\downarrow}\right] \quad (7)$$

The early equation was given by Abrikosov, Balseiro and Russel in matched on superconductivity crystalline structure (Kempster, M.H.A., 1999) using Fermi's state non reactive electron cloud and Fermi-Hall reactive electron cloud. The completed equation was given by.

$$H_{II} = \sum_i J\left[C^F_{ki\uparrow} C^F_{ki\downarrow}\right] + k\sum_i \sum_j \left[C^F_{kij} C^F_{kij\downarrow}\right] \quad (8)$$

Consider of quantum relativistic field and existence of Gell-Mann's specification particles (Valli, G., 2000) and based on Bose-Einstein state. Begin from electron potential energy up to Rydberg's constant, derived such as:

$$K = \frac{1}{8}\frac{me^4}{\varepsilon_0^2 h^2 n^2} \quad (9)$$

$$V_{(r)} = \frac{-1}{4}\frac{me^4}{\varepsilon_0^2 n^2 h^2} \quad (10)$$

From both Equations (9) and (10) will be found total energy on the *n*-th shell in crystalline structure displacement (Chattopadhyay, C., 1998) at semi-relativistic quantum condition, is:

$$\frac{1}{\lambda_c} = \frac{1}{8}\frac{m_e e^4}{\varepsilon_0^2 h^3 c}\left\{\frac{1}{n_2^2} - \frac{1}{n_1^2}\right\} \qquad (11)$$

Reviewing from a few formulations, it is clear that by measuring σ the value of *n*-th can be determined

$$n = \left(\frac{3}{8\pi}\right)\left[\frac{(4\pi\varepsilon_0)^2 m_n^2 c^4}{e^4}\right]\sigma \qquad (12)$$

At 2.1 x 10^4 currie/mm thermal neutron flux absorption for minimal condition in reactor chamber, the value of *n*-th stage begin from 1 up 2 according the Fermi's interference condition, expressed :

$$E_{n1} - E_{n2} = \frac{1}{8}\frac{m_n e^4}{\varepsilon_0^2 h^2}\left\{\frac{1}{n_2^2} - \frac{1}{n_1^2}\right\} \qquad (13)$$

In this Equation found the value of Rydberg's constant for thermal neutron flux at reactor chamber, the amount is 1.097373 x 10^7 m^{-1}. Based on the Rydberg's constant and wearing the Compton's nuclear wave length for thermal neutron flux scattering in crystalline structure, Pfund at Princeton University (Vasudeva, D.N., 1999) found the new series near in "Doublet-Natrium" red-infra closest with derivation of Dirac's Mirror equation such as:

$$E(eV) = -\frac{1}{e_c}\frac{m_e e^4 z^2}{8\varepsilon_0^2 h^2}\frac{1}{n^2} \qquad (14)$$

When "z" is value for moment-magnetic spin of angular electron in solid state.

According these equations and seem to reactor chamber flow from nuclear fuel reaction until shown up the Trans-Uranium series with UO_2 fuel element, then a few device of Magnetic Stirrer will be recorded a lot of data with many serial repeated reaction. For precisely calculations, many equations will be transferred in group-theory, one of modern mathematical tools in quantum-relativistic phenomena.

In this part will be described the changing of the semi-relativistic formulation to quantum's group-theory, developed by Dirac, Gell-Mann, and other famous physicians (Beiser, Arthur, 1998). Start at the steady force law in relativistic magnetic field up to the connection of phonon-electron cloud in solid state structure. Describing such as:

$$H_{fl} = \sum \varepsilon_k C_{k\sigma}^{F} - \hbar\Delta\sum\left\{C_{k\uparrow}^{F} C_{k\downarrow}^{F} x\hbar c\right\} \qquad .....(15)$$

$$\Delta = g_{BCS}\sum_{k}\left\langle C_{k\downarrow} \bullet C_{k\uparrow}\right\rangle \qquad (16)$$

Derivation of BCS's theory break by abrikosov-Balseiro-Russel formulation energy potential expressed as:

Analysis by Vitalli Ginsburg (Harold, Thomas S., 2001) using with Superconducting Quantum Interference Device (SquID) shown that Fermi's interference displacement caused by UO_2 nuclear fuel in 400 tesla magnetic field reactor chamber.

2. Result and Discussion

Ultimate testing for the three types materials including are $Sr_2\ Al_2O_{17}$, $Sr_2\ Al_2O_{18}$ and $Sr_2\ Al_2O_{19}$ covering the Cerenkov's radiation impact existence at reactor chamber. This moment was happened at moderator pool, so to be reactive with Na_2SO_3 liquid. The element of nuclear fuel matrix was using UO_2 with Pu_2O and Th_2O_y buffer element could be increasing for thermal neutron flux until 4.7 x 10^9 currie/mm. In this picture on below, has shown the Cerenkov's radiation was happened at reactor chamber, when the nuclear fuel element covered UO_2 more enrichment.

From the picture above, it has shown the blue color deep at reactor chamber, if look from reactor's yield bottom. It has biggest thermal neutron flux until 5.3 x 10^{10} currie/mm and coming up of ν,ν^- particles in amount is 2.6 x 10^4 mol per 1 activation reaction. This particles has known as Dirac's particle couldn't shield or barrier with Pu or Th up to 10^{10} light-years thickness.

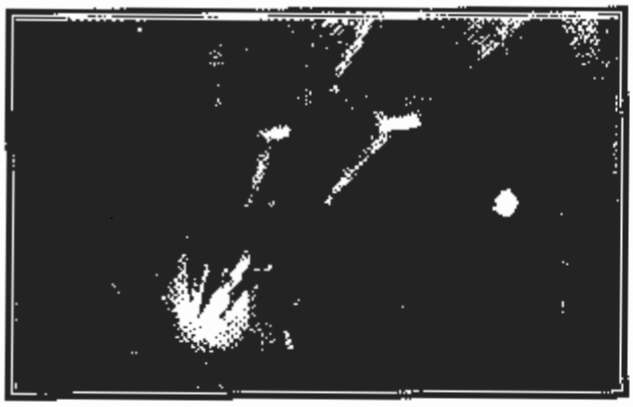

Figure 1
Cerenkov's radiation moment at 45.7 MW with UO_2 more enrichment (Courtesy and special permission of P2RM GAS, BATAN, Serpong)

After through the ultimate test by Cerenkov's radiation, the material of Sr_2 Al_2O_2, derivatives has tested in quantum magnetic-spin and magnetic-resonance at 450 tesla magnetic field on 45.7 MW and detecting by *Electron Spectroscopy for Chemical Analysis to Neutron* (ESCA-N). The picture from its tested has figured out below.

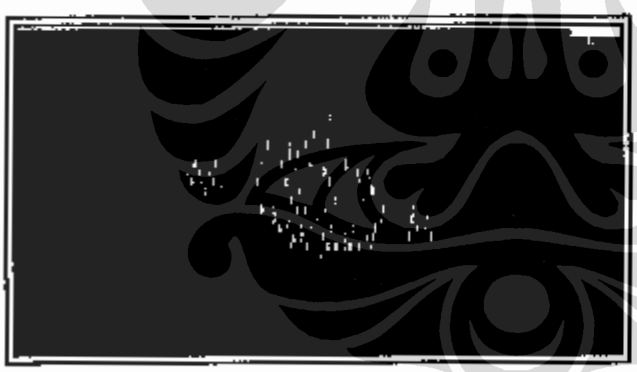

Figure 2
Intersection molecular of Sr_2 Al_2O_{2-x} in 450 tesla magnetic field (*Courtesy of P3IB-BATAN, Serpong*)

Looking forward the picture, find out the nucleus of greatest mass from Sr_2 Al_2O_{2-x} assemble to making a center of gravity's mass surrounding by two interstellar mass. Hosted by Dirac, these interstellar are phonon-electron's active cloud and always pairing together. It will be explained how the quantum magnetic-spin keep on steady state for long period as long as there isn't loosing mass, however a much little bit value. The value is 2.426×10^{-12} m and to converted to relativistic-mass unit by Bose-Einstein multiplier.

Based on a few Equations shown that the post result by Magnetic Stirrer experimental with magnetic-spin frequency at 550 MHz and rolling shield of 450 tesla magnetic field, the quantum density from inactive Fermi-Hall's paired cloud has connected with plane wave is homogenous state. Figure out by Bohr-Sommerfeld's formulation has calculated wrote by

$$\mu_{BS} = \frac{e\hbar}{2m_e} \qquad (17)$$

Comparison by the value of Magneton-Bohr's formulation

$$\mu_B = eh/2m_e \qquad (18)$$

There is very tight difference, but a much little value has enough to making Fermi's effect on intersection at Sr_2 Al_2O_2.

The value of nucleus magneton, μ_N, has described by Equation (15) but in group-theory of quantum relativistic, for seem not to be complicated, take a look for semi-relativistic formulation, using :

$$|\mu_N| = |g_N| \frac{e}{2m_p} \sqrt{I(I+1)}\hbar \qquad (19)$$

When $\sqrt{I(I+1)}\hbar$ is quantum moment magnetic-nucleus as describing by Einstein and Sommerfeld (Weigner, Karl P., 2002) took place of the ν particle, and making a good simplify calculation for nucleus magneton such as.

$$\mu_N = \frac{e\hbar}{2m_p} \qquad (20)$$

Therefore nucleus magneton $\approx \frac{1}{1836}$

From Bohr's magneton, it can be divided of interstellar ensemble for a few micro-substances. These was explained how the thermal neutron for

450 tesla magnetic field could reach the quantum boundary layer and affected the Fermi's effect increasing so depth in the crystalline structure.

The phenomena about this matter could see for picture below making by *Kaon* detector, which is integrated by Gell-Mann spectroscopy and connected to Magnetic Stirrer for reactor chamber, was adjusting its power.

The picture has shown one magneton nucleus and five interstellar consists are thousands phonon-electron's paired making a barrier for thermal neutron luminosity and its bombarding, was given such as

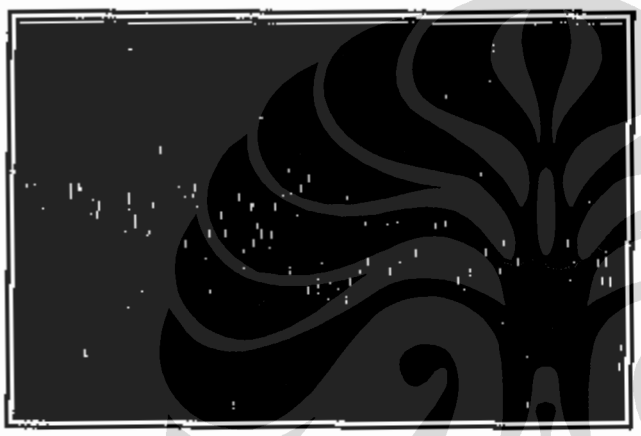

Figure 3
Fermi's effect on intersection molecular of $Sr_2Al_2O_{2-x}$ in 450 tesla (*Courtesy of P3IB-BATAN,Serpong*)

Remaining of Anderson's tunnel fields has found the fluxoid and based on Equations (19) and (20) for deflection requirement crystalline structure, having found the value for distance between one interstellar to other side as written by

$$R_r = \sqrt{\frac{I}{\mu}} = \sqrt{\frac{2.643x10^{-47}}{1.62668x10^{-27}}} = 1.275x10^{-10}{}_m \qquad (21)$$

In quantum magnetic-spin for relativistic field, the reliability of crystalline structure depends on Bohr-Sommerfeld formulation, Fermi-Dirac's state, and Bose-Einstein statistic condition, and reference to Equations (15) and (21), will have investigated each interstellar by :

$$N_i = g_i e^{-\varepsilon_{i/kT}} / \sum_i g_i e^{-\varepsilon_{i/kT}} \qquad (22)$$

Remaining those impact and based on the study about reliability of crystalline structure of substitution material, $Sr_2\ Al_2O_{1.8}$, then this substrate made to a pellet and to be testing in Magnetic Stirrer's tray connected to reactor chamber. According to Equations (10) until (18) above, there is must be existing of quantum magnetic-rotate also magnetic-spin simultaneously from crystalline structure caused by EC effect at the 10_3 nm area depth. Using with ESCA-N, involves bombarding the surface with high-energy of thermal neutron in 45.7 MW adjusting power to emit phonon-electrons cloud pairing together, then making of Fermi-Dirac's state in outer-boundary layer, so it could be analyzed for information on the elemental of the depth surface.

The picture below could be shown how the enough strongest of $Sr_2\ Al_2O_{1.8}$ material facing the impact of the EC's value at semi-relativistic quantum magnetic-spin and magnetic-rotate for reliability of its crystalline structure, and also facing to thermal neutron flux bombarding at 2.1 x 10^5 currie/mm amount. For better viewing, take a look about its graph comparison between present material, Zircalloy-4, and the $Sr_2\ Al_2O_y$ substances at thermal neutron bombarding for IAEA standard around is 1.9 x 10^5 currie/mm and just only 400 tesla quantum magnetic-rotate and magnetic-spin frequencies, when moderator liquid has still same condition, Na_2SO_3 and the state of muon-hadron particles there weren't detected by *Kaon* and Gell-Mann detectors, and the picture on below

Observing that picture, and concerning of crystalline structure for $Sr_2\ Al_2O_{1.8}$ material for it's crystalline structure reliable value, there is a few points for analyzing that phenomena such as:

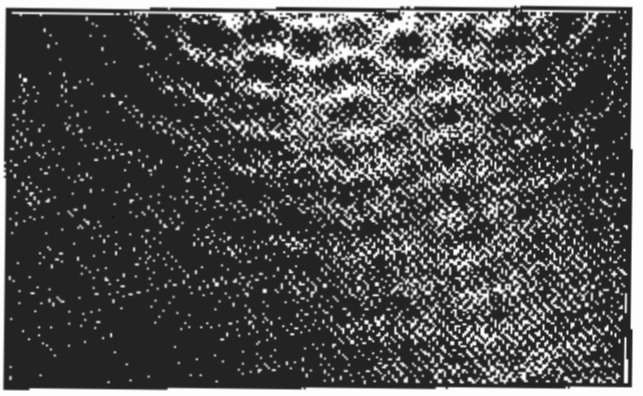

Figure 4
Cross-section effect of EC on sub critical phase based on $Sr_2Al_2O_{1.8}$ (*Courtesy of P2RM-GAS, BATAN, Serpong*)

a. The Compton's displacement wave length has very smooth waving on top side, it means for 0.811752 / 10^{-5} amu magneton's nucleus, the phonon-electron cloud together with Fermi-Dirac state and neither of one pieces of thermal neutron could be breaking the barrier on 10^3 nm depth area.
b. At adjusted power 45.7 MW and 2.1 x 10^5 currie/mm luminosity of thermal neutron, the interstellar of this material able to conduct of quantum semi-relativistic electrical charge, the amount is 7.8114/eV. It can be calculated by Equations (2.45) and (2.47) in group-theory, but with quantum coupling rotation for magnetic-rotate has shown by

$$P^2 = J(J+1)\hbar^2;$$
requirement : J = 0,1,2,... (23)
$$P_z^2 = M^2\hbar^2 \quad ; \text{requirement:}$$

$$\mathbf{M} = 0, \pm 1, \pm 2, \ldots \mathbf{J} \quad (24)$$
$$P_k^2 = K^2\hbar^2 \quad ; \text{requirement:}$$

$$\mathbf{K} = 0, \pm 1, \pm 2, \ldots \mathbf{J} \quad (25)$$

$$E_{RD} = J(J+1)\frac{\hbar^2}{8\pi^2 I_{RD}} + K^2\left(\frac{1}{I_e} - \frac{1}{I_D}\right)\frac{\hbar^2}{8\pi^2} \quad (26)$$

c. At bottom side it looks that the electron-neutron cloud in active reaction, then the electrical charge line could be an ensemble together with notation C ; which one of parity coefficient is up arrow, there is possibility to grew up much more interstellar neighboring as far as 0.001127 x 10^{-10} meter, and fixed on Einstein-Sommerfeld predictable.
d. For magnetic field has reached 450 tesla, the value for quantum magnetic-spin of Sr_2 $Al_2O_{1.8}$ is 7.8114/eV thereby the resonance of spin-rotate has matched with formulation and more completed in quantum states. Additional result, after testing Sr_2 Al_2O_{2-x} derivative, there is tabulation to indicate that the Sr_2 $Al_2O_{1.8}$ has bigger value than another derivative themselves.

Table 1
The properties of quantum magnetic field states

Materials	Quantum magnetic-spin value	Quantum states
Sr_2 $Al_2O_{1.7}$	7.1006/eV	$C^F_{kj\uparrow}; E_{(FD,J)}$
Sr_2 $Al_2O_{1.8}$	7.8114/eV	$C^F_{kj\uparrow}; E_{(FD,P_z}$
Sr_2 $Al_2O_{1.9}$	7.7221/eV	$C^F_{kj^\wedge}; E_{(FD,J)}$

Source: Experimental test at 1.0 μ m Fermi-Dirac area (*Courtesy of P3IB and P2RM-GAS, BATAN, Serpong*)

According of quantum magnetic-spin and magnetic-resonance which are expressed by Equations (11) until (22) that was describing about how strongest impact from thermal neutron bombarding to Fermi-Dirac interstellar area wide. However, the wide is 0.001127 x 10^{-10} meters having magnetic field deflection on resonance of spin-rotate around 6772.55 cm per each Fermi's cloud active reaction. This matter in 500 MHz up to 550 MHz magnetic-spin frequency with Na_2SO_3 liquid moderator's water cooling at reactor chamber. For show

up the impact and existing of Fermi-Dirac's surface effect caused by Anderson's tunnel for floating of thermal neutron electrical charge in quantum magnetic-spin also resonance, it has figure out from Gell-Mann spectroscopy and ESCA-N devices below

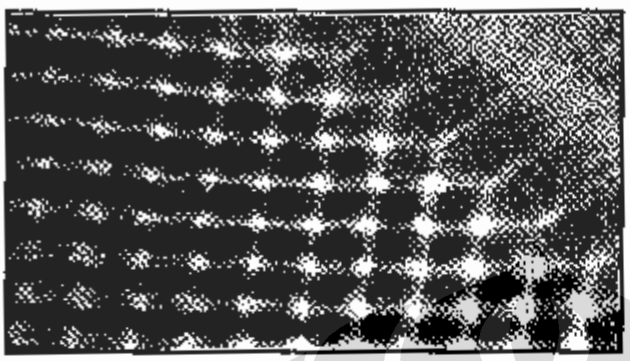

Figure 5
Flux of thermal neutron effect cross-section caused by Fermi-Hall state at 2.1 x 10^5 currie/mm on 450 tesla in critical phase based on $Sr_2 Al_2O_{1.8}$ in 45.7 MW
(Courtesy of P2RM-GAS, BATAN, Serpong)

According the data from quantum's calculations, there is one important conclusion for the thermal neutron flux at 2.1 x 10^5 currie/mm for $Sr_2 Al_2O_{2-x}$ and their derivatives, that is only $Sr_2 Al_2O_{1.8}$ has record for barrier to thermal neutron flux, because :

a. The value of magneton nucleus has enough bigger, 0.811752 / 10^{-3} amu. It means the phonon-electron cloud always paired with Fermi-Dirac state. There is not a needle hole in magnetic-rotate at quantum condition.
b. The distance of interstellar neighboring was very tight, 0.001127 x 10^{-10} , so there's not a little sewing for thermal neutron flash it at 2.1 x 10^5 currie/mm. It is match for Einstein-Sommerfeld calculated at relativistic field.
c. This material, $Sr_2 Al_2O_{1.8}$ having magnetic field deflection on stability, and the value is 7.8114/eV, however the resonance of spin-rotate in quantum relativistic has match for Dirac's equation; see on Equation (17); the value is 6772.55 cm per each Fermi-Dirac's cloud active reaction.

Based on the resonance of magnetic-spin and is rotate. Then using a few formulation will be found the joining between Coulomb nuclear force with Bohr's centripetal force in relativistic quantum area, which is 2.1 x 10^{-4} currie/mm thermal neutron flux absorption for minimal condition in reactor chamber, the value of *n*-th stage begin from 1 up 2 according the Fermi's interference condition. Based on the formulation for Fermi-Dirac's active cloud in coherent Compton's wave length, will be adjoined of critical modulation phonon's vibration and Cooper's pair cloud, there was

$$\text{written by } \varpi = \exp\left(i\dot{p}\bullet\left[\vec{r}x\hbar\right]\right) \quad (27)$$

If using the Einstein-Sommerfeld deflection requirement for the thermal neutron flux from Compton's nuclear wave length after first chain ordered reaction, could be wrote by

$$\iiint_{R} \vec{p}\,x\hbar\,x\left[-\vec{i}\,x\left\{\dot{j}\,x\hbar\right\}dr\,dl\,dS\right]\bullet$$

$$\iiint_{R}\Phi < \xi_{c} > \qquad (28)$$

Through by Anderson's tunnel field could be found of fluxoid value with Einstein-Sommerfeld deflection effect of mesonic in positive charge and lambda point in magnetic field, bring the Equations (18) until (27) in simple value, written by

$$\Phi = \frac{2\pi\ h\ c\ S_{II}}{q^{\pm}_{\uparrow}} \qquad (29)$$

$$\Phi^{\dagger}_{\uparrow\downarrow} = \ddot{\Phi}_{0} \bullet S_{II} \qquad (30)$$

When the value is 2.0678 x 10^{-7} gauss cm^2 and was called the earlier fluxoid reaction in quantum magnetic-spin and magnetic-rotate just like the Figure 5 especially in bottom plane.

If continuing for mathematically in group-theory working, it has found the solutions for describing around the two transversal Compton's wave length; illustrated on picture below for special material, $Sr_2 Al_2O_{1.8}$ with completed experimental testing

In a few Equations (27) until (30) have shown $Ae^{ik_0 x}$ represents the wave traveling along the x-axis with amplitude A and $Be^{-ik_0 x}$ represents the reflected Compton's wave along negative x-axis with amplitude B for quantum resonance state.

3. Conlusions

Investigations and research using by Ising Model software and programming also Magnetic Stirrer equipment based on $Sr_2\ Al_2O_{1.8}$ material for control rod blade nuclear reactor 50 megawatts have a few result, expressed:

a. The strength of thermal neutron flux absorbed is $2.1 \times 10^5 - 1.9 \times 10^6$ currie/mm.
b. The values of Electrical Conductivity (EC) about 26.62 – 29.98 in 800° - 890° C temperature for IAEA standard. At thermal neutron flux amount 2.1×10^5 currie/mm then the value of EC is 29.44 – 37.98 in IAEA standard. For magnetic field has reached 450 tesla, the value for quantum magnetic-spin is 7.8114/eV and Anderson's tunnel between interstellar area around 0.001127×10^{-10} meters, then the thermal neutron electrical charge could be flowing smoothly.
c. For magnetic field is 450 tesla and thermal neutron absorption exactly 2.1×10^5 currie/mm, the crystallization structure reduction is 6.88% - 10.95% for 25 years period in 45.7 megawatts.

References

BATAN, (2001). Outline-report GSR-GAS, Jakarta, pp. 12-27.

1. Beiser, Arthur, (1998). Earth Sciences, Newly Edition, Mc-Graw Hill Book Company, New York, pp. 367-426.
2. Betingthon, Dominique F., (2001) Making of Control Rod Blade in Magnetic Stirrer, CANDU Reactor of Canada Atomic Journal, 18, pp. 111-125.
3. Chalotra, G.P., (1999). Electrical Engineering Materials, Khana Publishers, New Delhi.
4. Chattopadhyay, C., and Rakshit P.C., (1998). Quantum Machanics and Solid State Physics, Mc-Graw Hill Book Co., New York.
5. Durant, W.C.,(2000).manufacturing of Control Rod Blade by Simulation, Journal of PWR and BWR Reactor, 15, pp. 156-164.
6. Gomiez, Arthuro J., (2001). Idle Time and Power in Sr_2O_3 . H_2O for High Energy, British Atomic Energy Journal, 44, pp.110-123.
7. Harold, Thomas S., (2001). Unsteady Condition for Sr in Multi Purpose Reactor, British Atomic Energy Journal, 44, pp. 137-151.
8. Kempster, M.H.A., (1999). Materials for Engineers, Mc-Graw Hill Book Co., New York.
9. Moh. Hardiyanto, Johny Wahyuadi S., Hendri DS. Budiono, (2001). Eliminary Study for Control Rod Blade Nuclear Reactor Based on Sr + Al Alloy, JAPAN Prosiding Siptekgan, ISBN 979-8554-51-8.
10. Stuart, Thomas P., (2001). Muon Particle to be Absorbed by Sr_2Cr_3O in PWR, IAEA Journal, 34, pp. 85-99.
11. Thorton, Ian, (2001). Preorientation Sr_2O_2 Compound in Control Rod Blade",CANDU Reactor of Canada Atomic Journal, 18, pp. 77-89.
12. Valli, G., (2000). The Experimental Programme for the Development of The Multi Purpose Reactor, IAEA Journal, 21, pp. 141-145.
13. Vasudeva, D.N., (1999). Fundament als of Magnetism and Electricity, S. Chand and Company Ltd., New Delhi.
14. Vialli, T., (2000). Ising Model for Control Rod Blade Moderator, IAEA Journal, 27, pp. 187-199.
15. Waghmare, Y.R., (2001). Strontium Elements in Multi Purpose Reactor at 25 MW, CANDU Reactor of Canada Atomic Journal, 17, pp. 56-69.
16. Weigner, Karl P., (2002). Buffer Element of Thermal Neutron Flux in CANDU, CANDU Reactor of Canada Atomic Journal, 2, pp. 44-57.