Industrial Engineering Letters
ISSN 2224-6096 (Paper) ISSN 2225-0581 (online)
Vol.3, No.5, 2013
www.iiste.org

Quantum Information Technology Based on Magnetic Excitation of Single Spin Dynamics

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Abstract

The single spin dynamics of a single electron was investigated theoretically by exciting the single electron magnetically. Different possibilities e.g quantum mechanical noise, inelastic collision emerged. To attain high performance of the quantum information technology, a low magnetization favoured the excitation process.

1.0 INTRODUCTION

Coherent time evolution of quantum state (otherwise known as digital information) is the ultimate objective of the quantum information technology (QIT). Its advantages - the simulation of scientific theories e,g Hilbert space; estimating median of M data amongst others - position the QIT to meet the need of versed scientific research and learning. The beauty of the QIT lies in the measurement of the quantum state. The measurement of the quantum state is fast becoming an interesting subject matter due to conflicting views of researchers. Earlier, the quantum cryptography (Ekert *et al.*1996; Sudeepa *et al.* 2011) and quantum non-demolition measurement scheme were propounded to adequately deal with the problems of quantum state measurements. Out of the two methods, quantum cryptography seems to open the research space because of its importance to guarantee secure communication. Sharma *et al*(2012) stated five other alternative tool for substituting the use of photon in quantum cryptography. These tools include electromagnetic trapping of ions, magnetic interactions of electrons in quantum dot, nuclear magnetic resonance (NMR) spin system and superconducting electric charges and magnetic flux. In addition to already known facts (Takayanagi *et al.*2000) about the high-speed electrical signal, and long decoherence time, Fujisawa (2005) expanded on the use of single electron charge quantum bit to improve the functionality of semi-classical device,.

Unlike, the Fujisawa method of exciting an electron in a quantum dot by microwave, another option of exciting single electron theoretically by using a transverse magnetic field was the objective behind this research paper. Its result confirms exciting work and opens the new ideas for research within the quantum technology.

2.0 THEORETICAL JUSTIFICATIONS OF BLOCH-SCHRÖDINGER EQUATION

The time-independent Schrödinger equation is given

$$i\hbar\frac{\partial\Psi(x,t)}{\partial t} = -\frac{\hbar^2}{2m}\frac{\partial^2\Psi(x,t)}{\partial x^2} + V\Psi(x,t) \qquad (1)$$

Adopting the mathematical manipulations of Emetere (2013) in incorporating the Bloch equation into the schrodinger equation, equation (1) transforms into

$$i\hbar\frac{\partial\Psi(x,t)}{\partial t} = -m\,.\,\omega_1 M_y \mathrm{T}_1\Psi(x,t) + V\Psi(x,t) \qquad (2)$$

Where m is the mass of an electron (9.11 X10^{-31}Kg), ω_1 is the NMR Lamour frequency Which is put at a range of 10–100 MHz to enable the single spin dynamics. M_y is the transverse magnetic field which is greater than 1T ($M_y \gg 1Tesla$). T_1 is the decoherence time which is greater than 1ns ($\mathrm{T}_1 \gg$ 1ns).

From the differential equation of the hermit polynomial,

$$y^{\prime\prime}(x) - 2xy^{\prime}(x) + 2\varepsilon y(x) = 0 \qquad (3)$$

To fit equation [5] into the above equation

$y^{\prime\prime}(x) = 0, y^{\prime}(x) = T^{\prime}, y(x) = T\ ,\varepsilon = \frac{[-m\,.\omega_1 M_y \mathrm{T}_1 + V(\mathrm{x})]}{i\hbar}$ This generates equation (4) as shown below

$$-2xp^{\prime} - 2\varepsilon p = 0 \qquad (4)$$

Using separation of variables, $\Psi(x,t) = X(x)T(t)$ equation (2) becomes

$$T^{\prime} - \frac{[-m\,.\omega_1 M_y \mathrm{T}_1 + V(\mathrm{x})]}{i\hbar}\mathrm{T} = 0 \qquad (5)$$

Where $T(t) = T$,

Let $p = \sum_{n=0}^{\infty} c_n\, x^n$. This generated a relationship as shown

$$c_{n+1} = -\frac{\varepsilon}{n(n+1)}c_n$$

Where $c_1 = -\varepsilon c_0$

The solution of the first part of equation[5] is

$$T_1 = c_0\left[-\frac{\left(\frac{[im\,.\omega_1 M_y \mathrm{T}_1 + V(\mathrm{x})]}{\hbar}\right)}{2} - \frac{\left(\frac{[im\,.\omega_1 M_y \mathrm{T}_1 + V(\mathrm{x})]}{\hbar}\right)^3}{12} - \frac{\left(\frac{[im\,.\omega_1 M_y \mathrm{T}_1 + V(\mathrm{x})]}{\hbar}\right)^5}{2880}\right] \qquad (6)$$

$$T_2 = c_1 \left[-\frac{\left(\frac{[im\,.\omega_1 M_y \mathrm{T}_1 + V(\mathrm{x})]}{\hbar}\right)}{2} - \frac{\left(\frac{[im\,.\omega_1 M_y \mathrm{T}_1 + V(\mathrm{x})]}{\hbar}\right)^3}{144} - \frac{\left(\frac{[im\,.\omega_1 M_y \mathrm{T}_1 + V(\mathrm{x})]}{\hbar}\right)^5}{86400} \right] \qquad (7)$$

Where T_1 & T_2 are performance time of the quantum computer
Equations[6&7] are expressed graphically as shown in figure[1-4] below

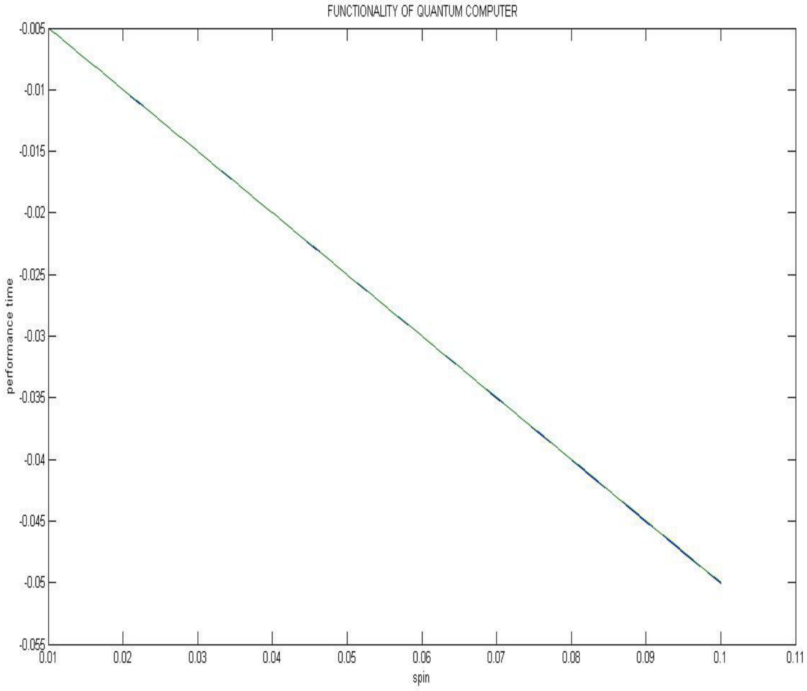

Figure 1: performance time-spin relationship when $M_y \leq 7.6\ X\ 10^{-4} T$

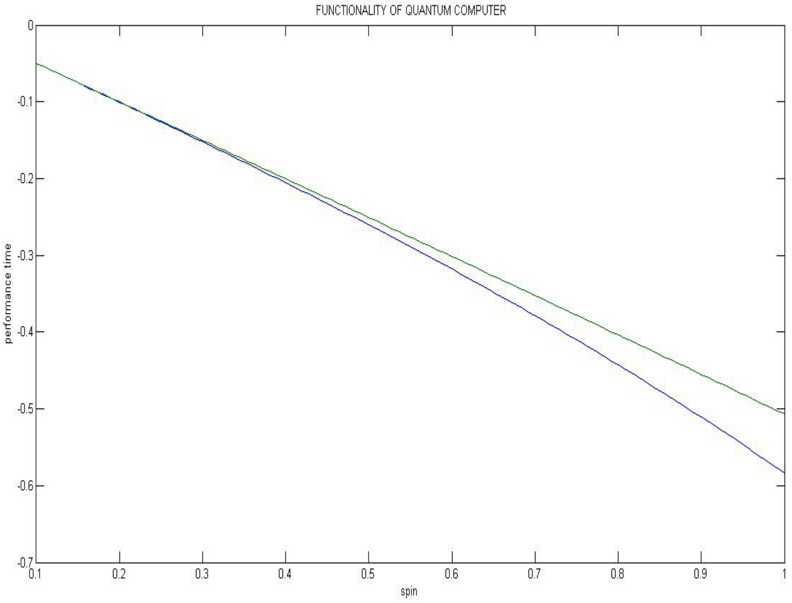

Figure 2: performance time-spin relationship when $M_y \leq 7.6\ X\ 10^{-3} T$

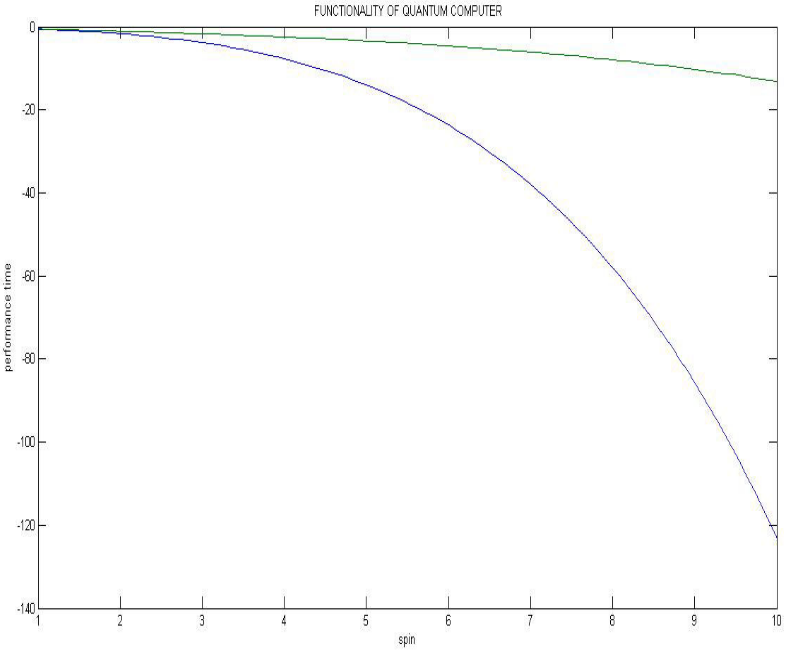

Figure 3: performance time-spin relationship when $M_y \leq 7.6\, X\, 10^{-2} T$

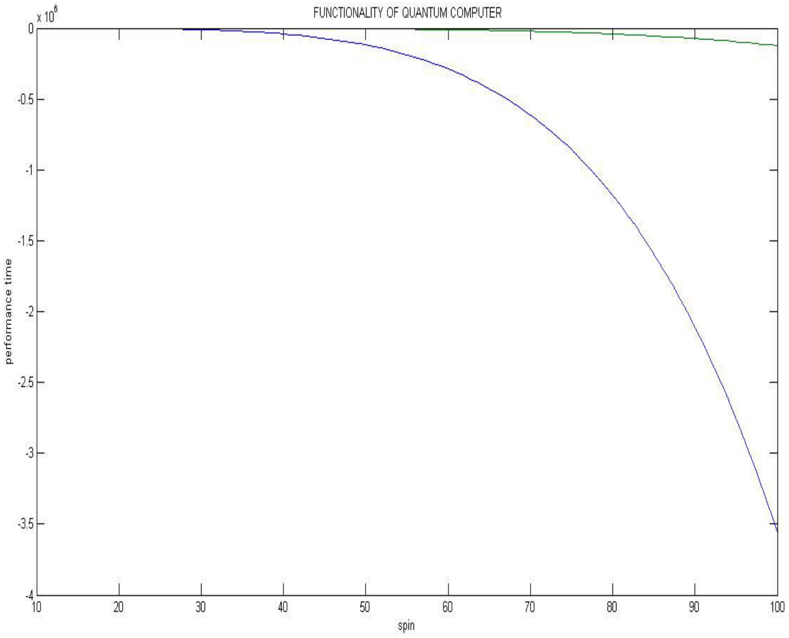

Figure 4: performance time-spin relationship when $M_y \leq 7.6\, X\, 10^{-1} T$

3.0 INTERPRETATIONS OF THEORY TO QUANTUM INFORMATION TECHNOLOGY

Spin-based information transport and processing with electrons and photons are basic elements of the quantum information technology which is captured in the quantum cryptography, quantum computation and spintronics. The green line depicts the solution T_2 while the blue line depicts the solutionT_1. In figure (1), the performance time increases when the spin is low when the transverse magnetization $M_y \leq 7.6\, X\, 10^{-4} T$ is used to excite the single electron. The two solutions are equalized ($T_1 = T_2$) with a linear nature. In figure (2), the performance time slightly decrease when the spin is slightly higher. The transverse magnetization $M_y \leq 7.6\, X\, 10^{-3} T$ was used to excite the single electron. There is slight deviation in the solutions. In figure (3), the performance time decreases when the spin is moderately increases. The transverse magnetization $M_y \leq 7.6\, X\, 10^{-2}T$ was used to excite the single electron. The deviation between the solutions increases. Both solutions show a parabolic relationship. In figure (4), the performance time decreases when the spin is increases. The transverse magnetization $M_y \leq 7.6\, X\, 10^{-1}T$ was used to excite the single electron. The deviation between the solutions greatly increases. The deviation in the solution depicts the presence of quantum mechanical noise. The spin in the diagrams represents the intrinsic quantum of freedom. The parabolic diagram depicts the presence of inelastic collisions of the single electrons with other carriers and the bulk metal or semiconductor material. The negativity of the performance time is as a result of the imaginary part of equation (6&7).

4. CONCLUSION

When the transverse magnetization used for the excitation of single electron increases, the spin increases, quantum mechanical noise increases, inelastic collisions of the single electrons with other carriers and the bulk metal or semiconductor material increases and the quantum computation decreases greatly. Therefore a low magnetization i.e $M_y \leq 7.6\, X\, 10^{-4}T$ favoured the improvement on the output of quantum information technology.

APPRECIATION

This work is self-funded. I appreciate Mrs. Jennifer Emetere for editing the script. I appreciate the Head of Physics Department of the above named institution.

REFERENCES

1. A. K. Ekert and R. Jozsa, Rev. Mod. Phys. 68, 733 (1996).
2. Sudeepa Roy Dey and Madhu Chauhan (2011). Quantum Information Technology .CPMR-IJT, Volume 1, No. 1, pp36-43
3. Toshimasa Fujisawa(2003) Quantum Information Technology based in Single Electron Dynamics, Selected papers Vol. 1 No. 3 pp 41-45
4. H. Takayanagi, H. Ando, and T. Fujisawa, (2000).“From Quantum Effects to Quantum Circuits, Toward the Quantum Computer,” NTT REVIEW, Vol. 12, No. 1, pp. 17-25,
5. N.A. Gershenfeld, L.L. Chuang, Science 275 (1997) 350.
6. Moses E. Emetere(2013) Moses E Emetere (2013): Mathematical Modelling of Bloch NMR to Solve the Schrodinger Time Dependent Equation. *Africa Review of Physics8:10 pp65-68*

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