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RABI OSCILLATION IN COUPLED SYSTEM OF COOPER PAIR BOX AND CAVITY PHOTON

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The quantum coherent oscillations of a Josephson charge qubit prepared in a superposition of two charge states. A purpose of different quantum computing scheme based on Josephson charge qubits. Multiphoton processes was studied in Josephson charge qubit in contrast to the usual Jaynes-Cumming model, the Hamiltonian includes higher order interactions between the two levels system and the non-classical microwave field. M.A. Nielsen [1], demonstrated the coherent manipulation of the qubit state in Rabi oscillation. The temporal coherent oscillation of the population inversion in a two level system driven by external electromagnetic field is known as Rabi oscillation [2].

INTRODUCTION

Rabi oscillations are periodical transitions of a two state quantum system between its stationary states in the presence of an oscillatory driving field [3]. Theoretically predicted by Rabi in 1937 [4], Rabi oscillations were firstly observed by Torrey in 1949 on nuclear spins in radio frequency magnetic field [5]. Rabi oscillations were performed in many other systems, such as electromagnetically driven atoms [6], semiconductor quantum dots [7], Josephson qubits [8], spin qubits [9].

MATHEMATICAL CALCULATION

The Hamiltonian for a spherical of *Ta/In Ox/Ta* quantum dotes in effective mass approximation is given by

$$H = -\nabla^2 + \nu l_z + \nu^2\rho^2/4 - V_b(\mathrm{r}) - 2/r$$

The rms vacuum electric field amplitude E_{vac} in a mass of frequency is

$$E_{vac} = \left(\frac{\hbar\omega}{2\varepsilon_0 V}\right)^{1/2}$$

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where ε_0 is the permittivity of free space is in the size of an arbitrary quantization volume and $\hbar\omega$ are in S.I. unit. The coupling of an atom to a field mode is described by frequency $-\Omega_{ef} = \dfrac{D_{ef} - E_{vac}}{\hbar}$

The Josephson phase qubit is simply a hysteric current biased Josephson junction that is well isolated from dissipation. The Hamiltonian is-

$$H = 4E_c \hbar^{-2} P_\nu^2 - E_j \left\{\cos\nu + \left(\frac{I}{I_c}\right)\nu\right\}$$

where ν is Gauge invariant.

The experimental value for effective mass approximation given data for (figure) for Rabi frequency in table 1

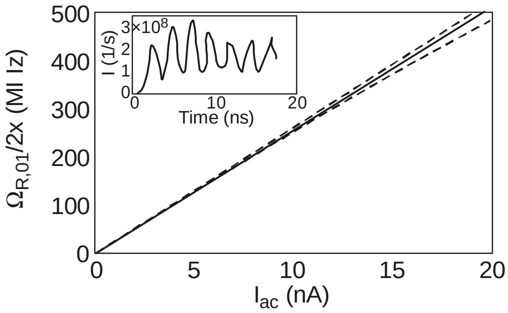
Table-1

S. No.	**Metal**	**Atomic Mass**	**Rabi-frequency (0→1, transition)** $\boldsymbol{\Omega_{R,01}^{(1)} = \Omega_{01}^{(1)} \times \left(1 - \frac{[\Omega_{01}^{(1)}]^2}{4(\omega_{01-}\omega_{12})}\right)}$ **MHz**	**Micro-wave current** $\boldsymbol{I_{ac}}$	**The a.c. stark shift** $\boldsymbol{\Delta\omega_{01}}$ **of the one photon**
1	In	114.82	68	2.50	15
2	Al	269.82	96	3.75	20
3	As	799.22	110	8.75	40

Author has calculated value for x =1 given data for (0→1 transition) Rabi frequency in table 2.

Table- 2

S. No.	**Metal**	**Atomic mass**	**Rabi-frequency (0→1, transition)** $\boldsymbol{\Omega_{R,01}^{(1)} = \Omega_{01}^{(1)} \times \left(1 - \frac{[\Omega_{01}^{(1)}]^2}{4(\omega_{01-}\omega_{12})}\right)}$ **MHz**	**Microwave current** $\boldsymbol{I_{ac}}$	**The a.c. stark shift** $\boldsymbol{\Delta\omega_{01}}$ **of the one photon**
1.	Ta	180.95	66	2.50	14.98
2.	In	114.82	95	3.75	20.45
3.	O	15.99	108	8.75	40.35



Experimental value for Rabi frequency (0→1, transition) agrees well with the calculated value for *Ta/In Ox.* High power Rabi Oscillation can in principle be used for high fidelity microwave central of super conduction phase qubit. Multiphoton Rabi Oscillation and a.c. stark shift can also be explained.

REFERENCES

1. M.A. Nielsen and I.L. Chang, Quantum computation and Quantum Information (*Cambridge University Press*, Cambridge), (2000).
2. Rabi II *Phys. Rev* 51652 (1937).
3. M. O. Scully, M. S. Zubairy, Quantum optics, *Cambridge Univ. Press*, Cambridge (2001).
4. I. I. Rabi, *Phys., Rev.* **51** 652 (1937).
5. H.C. Torrey, *Phys, Rev.* **76** 1059 (1949).
6. **G.** B. Hocker, Phys., C.I. Tang, Phys., *Rev. Lett.* **21,** 591 (1968).
7. H. Kamada, H. Gotoh, J. Temmyo, T. Takagahara, H. Ando, Phys., *Rev. Lett.* **87**, 246401 (2001).
8. A. Blais, J. Gambetta, A. Wallraff, D. I. Schuster, S. M. Girvin, M. H. Devoret, R. J. Schoelkopt, *Phys., Rev.* A **75**, 032329 (2007).
9. S. Schumacher, J. Forstner, A. Zrenner *et. al.*, “avity-assisted emission of polarization-entangled photons from biexcitons in quantum dots with fine-structure splitting,” *optics express*, Vol. 20. no. 5, pp. 5335-5342, (2012).

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