Decoherence of one-dimensional electron system

Toshifumi Itakura and Fumitada Itakura

ASPRO TEC. Takabaridai 3-506 Meito-ku, Nagoya 465-0054, Japan

e-mail address: itakurat@s6.dion.ne.jp

Among the various proposals for quantum computation, quantum bits (qubits) in solid state materials, such as superconducting Josephson junctions [1] and quantum dots, [2, 3] have the advantage of scalability. Such a coherent two-level system constitutes a qubit and the quantum computation can be carried out as a unitary operation functioning on the multiple-qubit system. Essentially, this quantum coherence must be maintained during computation. However, it is difficult to avoid dephasing due to the system's interaction with its external environment. Various environments can cause dephasing. Reentry, the qubit system of coupled dots has been examined. [4] In this study we examine the 2-qubit system which coupled with acoustic phonon system. We treat boundary condition as periodic. The examined system is equivalent with the two site unit cell Hubbard model coupled with dimeried acoustic phonon system. We specially examine about the interaction between electron systems. Present study treats the one dimensional system, therefore the importance exist in mesoscopic physics also. We solve time-dependent Hatree-Fock equation numerically. First we examine the half-filled electron system. The metallic phase is ferroelectric and insulating phase is quantum paraelectric. This result is because of the umklapp process and electron-phonon interaction. The auto-correlation function of $4k_F$-CDW order parameter shows quantum chaos. In Fourier space the T_2 torus appears for metallic side, the bifurcation to T_3 torus appears for insulator side. The Ruelle-Takens type chaos appears. The Bang-Bang controls do the binary change of total wave function phase. The recovery of coherence appears, in spite of that the time trajectory show oscillation by external force. The Fourier transforms of auto correlation function shows periodic many bifurcation. With changing the time constant of binary Bang-Bang control, one can do control of decoherence. The Fourier transform of auto-correlation function consists of T_2 torus and bifurcated high frequency mode. We propose this induced periodic structure for the photo-induced ferroelectric state.

[1] Y. Nakamura, Yu. A. Pashkin, and J. S. Tsai: Nature **398** 786 (1999).

[2] T. Hayashi, T. Fujisawa, H-D. Cheong, Y-H. Jeong and Y. Hirayama: Phys. Rev. Lett. **91** 226804 (2003).

[3] T. Tanamoto: Phys. Rev. A **61** 22305 (2000).

[4] T. Itakura and Y. Tokura: Phys. Rev. B **67** 195320 (2003).